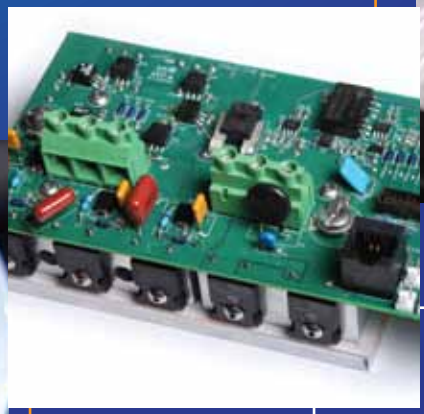
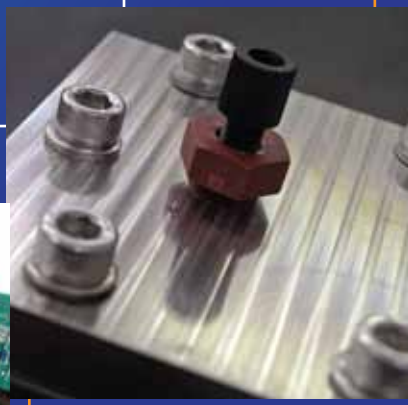
NSF SBIR/STTR

PHASE II GRANTEE CONFERENCE

GRANTEE ABSTRACTS





RENAISSANCE BALTIMORE HARBORPLACE HOTEL • MAY 13-16, 2013

IMAGES AND CREDITS

Images from left:

Phase II # 0924037
Credit: ***Ekso Bionics, Inc****.; Description: The SBIR grant-funded research helped to develop core technologies that enabled this exoskeleton device.*

Phase II # 1230442
Credit: ***Halotechnics Inc****.; Description: Halotechnics Green Glass. The grant-supported research resulted in the development of stable, low melting point, thermal storage materials such as Saltstream 700.*

Phase II # 1127397
Credit: Zack Anderson, ***Levant Power Corporation****; Description: GenShock electronic control unit actively controls the GenShock valve in order to improve ride and handling while recovering energy.*

Phase II # 1152040
Credit: Jerry Martin, ***Boulder Ionics Corporation****; Description: Miniature membrane reactor developed by Boulder Ionics Corporation for the synthesis of ionic liquids for advanced battery electrolytes.*

INTRODUCTION

The Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program were conceived at that National Science Foundation (NSF). In 1976, Roland Tibbetts initiated an NSF program that would support the small business community with a specific objective to provide early-stage financial support for high-risk technologies with commercial promise. Today the government-wide program is administered by the Small Business Administration (SBA) and includes eleven federal departments that collectively award over $2 billion to small high-tech firms.

NSF SBIR/STTR Program

The primary objective of the NSF SBIR/STTR Programs is to increase the incentive and opportunity for small firms to undertake cutting-edge, high-risk, high-quality scientific, engineering or science/engineering education research that would have a high-potential economic payoff if the research is successful.

The current portfolio of the NSF SBIR/STTR program covers three broad areas/topics:

- **Biological & Chemical Technologies (BC)**
- **Electronics, Information & Communication Technologies (EI)**
- **Nanotechnology, Advanced Materials & Manufacturing (NM)**

To learn more about NSF SBIR/STTR Program, visit our website at http://www.nsf.gov/eng/iip/sbir/

Accelerating Innovation Research (AIR) Technology Translation Showcase

The AIR technology translation showcase includes ten projects on existing science- and engineering-based research that have been translated towards a potential innovative commercial reality. In some instances, there is a functioning prototype of the product, process or system that is market-worthy. In others, the output is a proof-of-concept which demonstrates that the translated science-based discovery is poised to fill a technology gap. Still other projects demonstrate a scale-up from bench to pilot scale to incorporate real-world constraints and needs. Grantees were selected to participate in the showcase following a rigorous review process at NSF.

To learn more about the Partnerships for Innovation - Accelerating Innovation Research program, visit the website at http://www.nsf.gov/eng/iip/pfi/index.jsp.

NSF SBIR/STTR Phase II Grantees Conference

The annual NSF SBIR/STTR Phase II Grantees Conference is an opportunity for small businesses that have received NSF Phase II awards and supplements to:

- Share technical and commercial achievements with the NSF Program Directors and staff;
- Receive educational information that is critical for small high-tech start-ups;
- Learn about the supplemental funding opportunities available to Phase II awardees at NSF;
- Network with other NSF SBIR/STTR grantees as well as potential investors and strategic partners.

In the spirit of networking and resource sharing, we have designed this Abstract Book as a resource for grantees, conference attendees, potential investors and strategic partners. We also hope to provide a snapshot of the current portfolio of NSF SBIR/STTR program. During the conference, there will be Poster Sessions on two evenings which provide an opportunity to visit and discuss the projects described within this book with the Principal Investigators and other company representatives.

ENJOY THE CONFERENCE!

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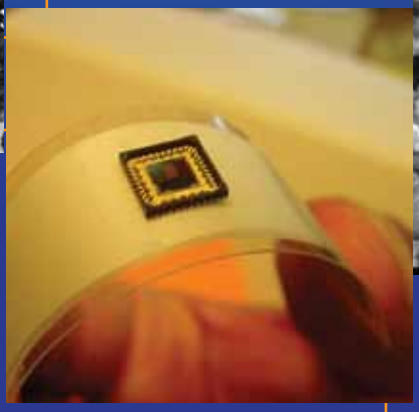

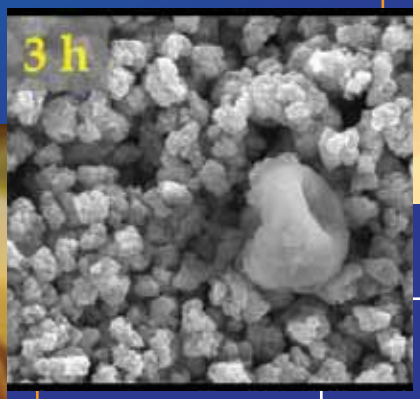

RENAISSANCE BALTIMORE HARBORPLACE HOTEL • MAY 13-16, 2013

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Images from left:

Award # 1127817
*Credit: Fred S. Cannon, **Penn State University**, Furness-Newburge-Cross Creek; Description: Hydroacoustic Cavitation for cleaning ultrafine coal, for bindered briques as fuel.*

Award # 1127606
*Credit: Shantanu Chakrabartty, **Michigan State University**; Description: Prototype of the self-powered sensor developed with NSF funding.*

Award # 1127830
*Credit: Applied Catalysis B: Environmental (courtesy of the Center for Particulate and Surfactant Systems at the **University of Florida**); Description: Black mold spores are destroyed within hours by the University of Florida developed antimicrobial coating.*

Award # 1127833
*Credit: George Daaboul, **Boston University**; Description: Multiplexed, high-sensitivity biosensor platform for automated direct virus detection. Photograph is of the alpha prototype instrument and controlling computer.*

Carnegie-Mellon University

Award No.: 1127832

Award Amount: $300,000.00

Start Date: August 1, 2011
End Date: July 31, 2013

PI: Tuomas Sandholm
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Program Director: Karlene Hoo

AIR: Sophisticated Electronic Markets for TV Advertising, Powered by Novel Optimization

The proposed project utilizes advances in key classic computer science problems such as search tree restructuring to implement an optimized auction system for acquisition/sale of media advertising time. The proposed system would move away from the current manually negotiated approach to an expressive auction approach in which buyers can express rich preferences and constraints through which they can more effectively conduct their campaigns. The optimization software of the PI currently underlies the nationwide kidney exchange. This effort will scale and adapt the PI's prior work in expressive auctions for transportation and medical markets to match the richness of the TV market. Based on requirements gathering to be undertaken, a prototype application for the TV ad market will be completed.

The proposed work has the potential to reap significant savings though efficiencies and added derived value obtained for the expressive auction approach. This is anticipated by the PI to be anywhere from 13-41% of the current $75B market. Moreover, implementation of these approaches has the potential to create fairer and open markets while consumers benefit from viewing of ads relevant to their interests and needs. The approach has broader application in other areas such as electricity and pollution rights/credits as well as other media markets. The effort has a relationship within an established innovation ecosystem at CMU and a new small company will be launched.

Michigan State University

Award No.: 1127606

Award Amount: $208,000.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

AIR: Development and Evaluation of Self-Powered Piezo-Floating-Gate Sensor Chipsets for Embedded and Implantable Structural Health Monitoring

This proposal leverages prior NSF funded work that resulted in the patent of a self-powered piezo-floating-gate (PFG) wireless sensor. The sensor is ultra low power and capable of storing strain data, making it highly suitable for embedding in safety-critical physical structures and infrastructure for structural health monitoring via wireless RFID readers over the lifetime of the structure. The proposed effort will address the technological gaps necessary to lead to a robust prototype and subsequent manufacture and commercialization, namely development of all supporting sensing circuitry and wireless interface circuitry and software, demonstrating remote configuration and interrogation of the PFG wireless sensor.

The PFG wireless sensor when incorporated into a prototype system via the proposed work, has the potential to have significant impact in the health monitoring and fault diagnosis of large classes of systems for which such monitoring systems must be autonomous, self-contained, generate their own power and be zero-maintenance. As a result such sectors as civil infrastructure, biomedical devices and systems, individual and civil transportation, and energy represent potential markets. Adoption of such embedded sensor elements in the safety critical systems used in these sectors can ultimately result in fewer injuries and fatalities arising from unexpected system failures.

North Carolina State University

Award No.: 1127793

Award Amount: $182,925.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

AIR: Transforming nanofiber technology through scalable fabrication

The proposed AIR project will allow construction of a prototype of a new scaled-up device for continuous fabrication of nanofibers, as well as to investigate and model the fiber formation processes in the device, including hydrodynamic liquid jet deformation, phase separation, polymer precipitation and fiber deformation. The proposed work would also allow efficient and reliable control of the diameter, length and aspect ratios of nanorods and nanofibers in the scaled-up process; and will be performed in collaboration between the North Carolina State team and Xanofi, a new small spin-off company.

The proposed work would make possible the transition from an innovative technique into a breakthrough technology that can profoundly change the emerging market of nanomaterials. The scaled-up technology developed in this proposal could bolster the $100 million market for nanofibers. The envisioned applications of these nanofibers in energy-efficient filters and solid-state lighting would help develop a new generation of greener industrial and consumer products. The commercial development of this platform technology would bolster the economy of North Carolina through job creation in partnerships with local and national companies. The plans for educational outreach include internships for community college students at North Carolina State and Xanofi, and demonstrations of nanomaterial fabrication in local high schools.

Penn State University

Award No.: 1127587

Award Amount: $208,000.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

AIR: The Separation of Hydrocarbons from Sand Using Ionic Liquids - Technology Translation Plan

The technology being developed involves a novel method to separate oil, bitumen or tar from sand or other types of mineral matter using ionic liquids (ILs). The processes presently used to separate or extract hydrocarbons from sand are expensive and result in environmental problems associated with the disposal of waste products and contaminated water. The intellectual merit of the proposed work lies in the ability of this class of solvents to obtain a very clean separation at ambient temperatures without the generation of waste process water, thus achieving large energy savings and alleviating major environmental problems.

The science and engineering involved in applying Ionic liquids to the separation of oil from sand or other minerals is not only a novel and potentially extremely effective way of cleaning sand and olis after an environmental disaster, but also applies to other areas, such as extracting bitumen and asphalt from tar sands, separating oil from drilling muds and cleaning sand from oil well operations. Thus, there are numerous potential benefits of the proposed activity to society, mostly related to energy and the environment. The interaction between science and engineering students and business interns should also instruct both in the art of innovation and the development of new companies.

Penn State University

AIR: Materials Translation for Bindered Anthracite Briques in Foundry Cupolas

Award No.: 1127817

Award Amount: $316,000.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

This proposal focuses on developing well-suited materials for use in bindered anthracite briques that can replace conventional coke in foundry cupolas. The objectives of this NSF AIR project will be to: (1) Carry forward the market development of biomaterial-bindered anthracite briques as a replacement for coke in foundry cupolas, (2) Translate research-based results into full-scale market potential by conducting the research and development that resolves how industry can supply ultra-fine anthracite grains, mitigate potential brique biodegradation, and diminish air pollution, (3) Work with an anthracite supplier, two pulp miller, two cupola foundries, and others in industry, to demonstrate at full-scale this novel bindered anthracite opportunity. The needs and potential impact of having this replacement material, ultra-fine anthracite, for coke are clearly stated, where the environmental, financial, and industrial impacts are large. As stated in the proposal, this work will help advance the areas of sustainable manufacturing, high temperature bindering, ultrasonics, microbiology, coal processing, and wood (i.e., lignin) products.

The broader impacts of this proposal could help the US coke industry in addressing the need for more manufacturing capability. The proposal puts forth alternative materials that require less energy to manufacture and release less CO2 and volatile organic carbon air emissions. Successful completion of this project will increase American business competitiveness by transforming otherwise wasted coal and biomaterials into value-added products, while sustainably making manufactured goods for the US population. The proposed research will also offer excellent opportunities for teaching, training, learning, and discovery relative to sustainable manufacturing. The PI also plans to bring a minority Ph.D candidate into this program to broaden the participation of underrepresented groups and integrating diversity into learning.

Trustees of Boston University

Award No.: 1127833

Award Amount: $165,999.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

AIR: Rapid Label-Free Single Virus Detection Platform for Multi-Pathogen Diagnostics

Rapid detection and surveillance of infectious agents is an unsolved challenge in the medical and biodefense communities. The lack of rapid and accurate diagnostics at the point of care (POC) has led to mismanagement of the newly developed drugs rendering them ineffective through the emergence of drug resistant pathogens. The PI proposes the development of a prototype instrument that does not require highly skilled technicians for POC settings. Issues which will be addressed in the development of the functioning field-deployable prototype include: (1) optimization of the illumination uniformity, (2) auto-focusing onto the sample, and (3) mechanical stability of the setup. The proposed instrument will be integrated with proven sample preparation techniques and evaluated against the bench top platform.

Successful development and launch of the proposed prototype will drastically improve the speed of disease diagnosis, expedite treatment options and ultimately produce better patient outcomes at a lower cost to the healthcare system. The simplicity and ease-of-use of the proposed system augurs well for the use of the technology in point-of-care settings and in providing improved healthcare in developing countries. In the proposed work, the industry participation and mentorship utilizing experienced entrepreneurs and executives will enhance the undergraduate and graduate educational experience by providing an environment for fostering entrepreneurialism and a parallel pipeline for talented engineers and scientist to industry. The strong ties of the executive mentorship program to the Boston business community also contributes to the economic development of the region by launching new businesses and job creation.

University of Florida

Award No.: 1127830

Award Amount: $306,005.00

Start Date: August 1, 2011
End Date: July 31, 2013

PI: Brij Moudgil
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Program Director: Karlene Hoo

AIR: Visible Light Activated Transparent Antimicrobial Coatings

The University of Florida (UF) has developed the intellectual property for a novel visible light activated transparent antimicrobial coating. NanoHygienix LLC, a UF spin-off company headed by a UF business school graduate, is interested in commercializing this technology for preventing surface-mediated infections in hospitals, skilled nursing facilities, etc. The proposed research program will leverage the expertise in materials science, environmental engineering, chemistry, entrepreneurship, finance, marketing and business management. The PI has expertise in engineering and scale-up of particulate systems and their translation to various industry sectors including chemical, mineral, microelectronics, nano and biotechnology.

The proposed technology has the potential to significantly reduce the incidence of infections in hospitals and other healthcare settings. The PI is committed to recruit students from underrepresented groups through well established college and university programs such as SEAGEP and LSAMP. This project will promote innovation ecosystem infrastructure development across campus by bringing together engineering and business students and faculty. Project outcomes will include invention disclosures/patents, peer reviewed journal publications, dissertations, and presentations at professional society meetings. Ultimate benefits of the proposed activity will be best practices for commercializing the university innovations resulting in spin-of companies that will provide jobs and contribute to the economic well-being of the nation.

University of Kansas Center for Research Inc.

Award No.: 1127765

Award Amount: $209,998.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

AIR: Towards a CO2-free, Sustainable, Ethylene Oxide Technology

Conventional ethylene oxide (EO) processes emit CO2 as byproduct (roughly 3.4 MM tons/yr) from the combustion of both the ethylene and EO, the elimination of which has been a major grand challenge in industrial chemistry for decades. In a NSF-funded project, an alternate technology concept that is >99% selective toward EO was recently demonstrated at the University of Kansas with no detectable CO2 formation. This alternate process is based on homogeneous ethylene oxidation with H2O2 at 25-40C and ~50 bars using methyltrioxorhenium (MTO) as catalyst. This proposal addresses the key barrier to commercialization, viz., the design and demonstration of a recyclable MTO catalyst. Both heterogeneous supports and bulky soluble polymers (capable of retention in solution by nanofiltration membranes) are being considered. Quantitative catalyst performance metrics (activity, selectivity and durability) for practical viability have been established through preliminary economic analysis and will guide catalyst design.

Successful completion of the project objectives will result in novel, recyclable catalyst formulations for epoxidation reactions in general. The demonstration of a continuous ethylene-expanded liquid phase catalytic reactor will be the first of its kind. The project guidance from ADM (interested in epoxidation of vegetable oils), Evonik (a major H2O2 producer) and P&G (a major EO consumer) personnel increases the probability of project success and eventual commercialization. The proposed concept has the potential to result in significant conservation of oil and gas reserves (~13 million barrels crude oil/year) and reduction of carbon emissions as byproduct (3.4 million metric tons of CO2 each year). The application of this technology to mixed feeds containing ethylene and ethane will also result in significant energy savings associated with their separation required in conventional processing. The technical outcomes from this proposed work will be integrated into an ongoing course titled Development of Sustainable Chemical Processes, impacting both the undergraduate and graduate curricula.

University of Southern Mississippi

Award No.: 1127846

Award Amount: $185,000.00

Start Date: August 1, 2011
End Date: July 31, 2013

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Program Director: Karlene Hoo

AIR: First stage commercialization of Oil Anti-Deposition Dispersant technology for spilled oil

This project seeks to develop a class of bio-derived, biodegradable, oil dispersants which resist wetting and spreading on solid substrates such as plants and animals. The intellectual merit of this project is that more safe and effective dispersants are needed to help mitigate the impacts of oil spill disasters such as the Deepwater Horizon incident. The PIs have effectively used funds from the NSF RAPID program to identify a class of dispersants that are macromolecular aggregates of natural cellulose polymers and soy bean lecithin. A clear case is made that these compounds do not allow oil to foul bird feathers, and it is presumed that since they are natural in origin, they would be a safer alternative to the current petrochemically derived dispersants. The PIs have a strong record of expertise in this area, and are uniquely suited to this work. They clearly outline a detailed list of scientific and business-related questions that must be answered to push this product to the marketplace.

The broader impact of discovering more effective and non-toxic oil dispersants is clear. The PIs have a strong record of incorporating others into their work, such as the local junior college students and instructors, some of whom are included as inventors of the disclosed technologies. There is a plan for student and workforce training that will span both the academic laboratory and associated industrial partner operations.

University of Texas at Dallas

Award No.: 1127761

Award Amount: $316,000.00

Start Date: August 1, 2011
End Date: July 31, 2014

PI: Walter Hu
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Richardson, TX 75080-3021
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Program Director: Karlene Hoo

AIR: Si nanoelectronic FemtoSensor as ultrasensitive, label-free, protein based molecular diagnostic platform

This proposal aims to translate a unique Si nanoelectronic biosensor technology well developed at the University of Texas at Dallas (UTD) towards commercial products through a strong academia-industry partnership. The proposed work will develop a prototype instrument called FemtoSensor (femtoMolar sensitivity) Application Development Kit (ADK) based on a nanoscale Si on insulator (SOI) field effect transistor (FET) and to establish proof-of-concept protein-based tests towards a portable and low-cost diagnostic platform capable of label-free, rapid and early diagnostics of various diseases. The novel design of multiple Si nanochannel architecture brings critical advantages over previous bio-FETs, e.g. simultaneously achieving high sensitivity (femtoMolar), selectivity, and stability, as demonstrated by repeated tests in serum and tumor-cell lysate sample without pre-purification.

The full exploitation of the multi-nanochannel bio-FETs will contribute novel knowledge to the field of biosensor. The parametric evaluation of the sensor will address major unknowns of biosensing mechanism where strong electric field is applied, which is highly transformative to many types of sensors using electrokinetics. The proposed study will establish a numerical model of the performance curves to possibly predict sensing results, estimate correlation errors, and eliminate the need for sensor calibrations. If successful, the FemtoSensor ASK instruments with much better figure of merits than ELISA ($240M market size/year) would enable many researchers in university, research institutes, pharma, hospitals/clinics, diagnostics companies, government/defense facilities, to develop many new assays for diseases. The proposed activity will advance discovery and understanding of bio-FETs, while also promoting academic and industrial learning and training experiences. Inclusion of MBA students for entrepreneurship will complement the science and engineering student team members and give a more rich opportunity for learning and practicing innovation. Existing outreach programs from the PI's NSF CAREER award will be leveraged for this project.

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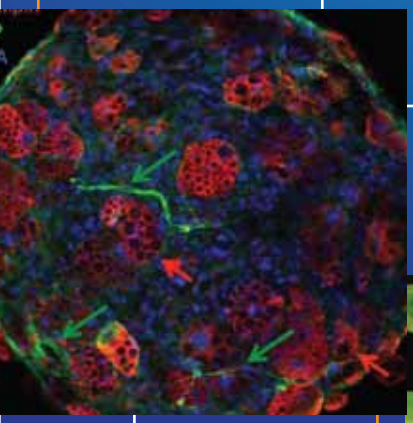
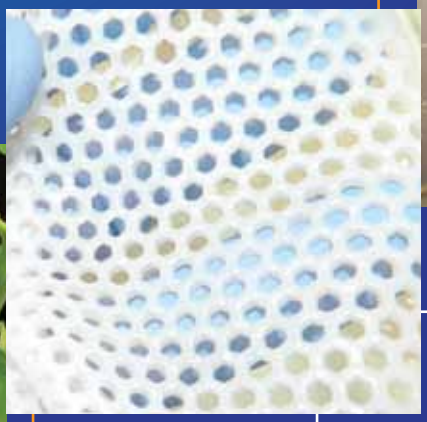
BIOLOGICAL AND CHEMICAL TECHNOLOGIES





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IMAGES AND CREDITS

Images from left:

Phase II # 1127551
Credit: ***Nano3D Biosciences, Inc.*** *(Daquinag et al., Professor Kolonin's laboratory, University of Texas Health Science Center at Houston); Description: Vascularized adiposphere generated using 3D Cell Culturing by Magnetic Levitation.*

Phase II # 1230075
Credit: Ryan Shepherd, ***PhylloTech, LLC****; Description: An introductory view of the leaf surfaces of N. tabacum (tobacco) plants.*

Phase II # 1026421
Credit: ***BC Genesis LLC*** *in collaboration with Prof. Rafael Davalos, Biomedical Engineering, Virginia Tech; Description: Medical implants and devices from biosynthetic nano-cellulose (BNC) or BNC composites.*

Phase II # 1127222
Credit: ***Green Revolution Cooling, Inc****.; Description: OEM servers submerged in GreenDEF high performance dielectric fluid coolant. Server fans are removed before submersion, resulting in power savings of 10%-20%.*

Affinity Biosensors

Phase II Award No.: 1127393

Award Amount: $499,861.00

Start Date: November 1, 2011
End Date: October 31, 2013

PI: Ken Babcock
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Program Director: Ruth M. Shuman

Sector: Biological Technologies

SBIR Phase II: Rapid Assessment of Antibiotic Resistance by Mass Measurement

This Small Business Innovation Research Phase I project proposes to develop a "close-to-care" instrument that can assess antibiotic susceptibility of infection-causing bacteria in less than one hour. MEMS-fabricated sensors and integrated fluidics will measure the mass and growth rate of a small number of bacteria in-vitro with a resolution near 1 femtogram. By exposing the bacteria to a panel of antibiotics while monitoring growth rate, an infection's susceptibility profile will be determined very rapidly. Using this information, doctors will be able to select targeted antibiotic treatment much faster than is possible using conventional methods that require incubation and take 24 hours or longer - a crucial time savings. The platform will be validated on multiple E. coli strains that have a range of susceptibility, in both saline and healthy urine matrices. To demonstrate clinical value, the results will be compared to conventional methods. Additional tests will be performed on clinical isolates of E. coli and K. pneumoniae that cause urinary tract infections, and on MRSA (methicillin-resistant Staphylococcus aureus).

The broader impact/commercial potential of this project will be to improve medical outcomes of infection and to facilitate antibiotic stewardship. The rapidly expanding prevalence of resistant bacteria, combined with a decline in the discovery of new antibiotics, pose one of today's most dire health threats. More than 100,000 people die of infections each year in the U.S., behind only cancer and heart disease. There is unanimous consensus among infectious disease experts that rapid diagnostics to identify resistance are crucial for administering targeted antibiotic therapy, leading to better outcomes, and for minimizing the spread of resistant strains. The test to be developed here directly addresses these needs. The project targets UTI (urinary tract infections) that are responsible for the majority of hospital-acquired infections; and MRSA (methicillin-resistant Staphylococcus aureus) that kills more than 20,000 Americans every year. The platform will be configured for "close-to-care" use in microbiology labs found in most hospitals, and capture a significant fraction of the $500M U.S. market for susceptibility testing equipment and reagents. The platform also will address nearer-term markets in antibiotic discovery and laboratory research.

Bioo Scientific Corporation

Phase II Award No.: 1230440

Award Amount: $500,000.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Program Director: Ruth M. Shuman

Sector: Biological Technologies

SBIR Phase II: Biomolecular Detection of microRNA

This Small Business Innovation Research Phase II project examines high throughput methods to quantify intacellular microRNA (miRNA) concentrations in cells that have shown to be associated with normal physiological processes, as well as diseases, including cancer. Currently there are no rapid, quantitative methods available to measure miRNA expression in living cells or tumor tissue. All current in vitro approaches require extensive preparation involving extraction, reverse transcription of miRNA into cDNA and amplification. These methods are not only time consuming, but require that the low abundance miRNA be several fold greater than background to give a meaningful result. To meet the demand for a diagnostic/prognostic tool, development of a biomolecular detection device is proposed based on a single electron transistor to bind and measure the concentration of miRNAs. This will provide a researcher or clinician an accurate profile to make proper clinical assessments. Bringing this device to market will provide scientists with direct information on intracellular miRNA levels, enhancing predictions of miRNAs that are essential for tumor maintenance or metastasis, and creating new diagnostic and therapeutic opportunities.

The broader impact of this project will be to enhance current diagnostic and prognostic tools for early detection of disease. Today, early cancer detection and treatment offers the best outcome for patients. This has driven the search for effective diagnostics. The identification of a universal tumor specific epitope or marker has remained elusive. While many types of serological and serum markers have included enzymes, proteins, hormones, mucin, and blood group substances, at this time there are no effective diagnostic tests for cancer that are highly specific, sensitive, economical and rapid. This deficiency means that many cases of malignancy go undetected long past the time of effective treatment. The goal of this research is to bring a device to market for the research market and a device that can examine miRNA profiles from patient samples immediately in a hospital or clinical setting. The current size of the in vitro diagnostic market was over $40 billion in 2008. Unique diagnostic kits developed from this technology will likely fulfill an unmet market opportunity with the potential to exceed $100 million in the first 3 - 5 years.

DNA Polymerase Technology, Inc.

Phase II Award No.: 1127479

Award Amount: $500,000.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Program Director: Ruth M. Shuman

Sector: Biological Technologies

SBIR Phase II: Inhibition-Resistant DNA Polymerases and Other Improvements for Detection of Food-borne Pathogens.

This Small Business Innovation Research (SBIR) Phase II project proposes the development of novel enzymes (DNA polymerases) and other improvements for rapid detection of food-borne pathogens by DNA detection and amplification (PCR). PCR is a very fast and accurate method of pathogen detection, typically giving results in about a day, instead of several days required to grow and identify pathogens by cultural methods. But some foods, such as chocolate, dairy products, meat, and spices, contain components that inhibit the PCR assay. Current strategies for rapid pathogen testing in these foods include long cultural enrichment steps followed by dilution of inhibitors and/or labor intensive sample preparation (DNA extraction) to remove inhibitors. Inhibition-resistant DNA polymerases and food-specific PCR enhancers represent elegant, high-tech alternatives to dilution or DNA extraction. They could be integrated into existing rapid-detection systems to facilitate rapid accurate testing in inhibitory foods.

The broader impacts of this research are reducing the number and severity of outbreaks of food-borne illnesses in the United States due to early detection of food-borne pathogens. Faster, more accurate detection of pathogens will save time and money for food manufacturers, and reduce the need for costly product recalls. Technology developed here could also extend the disciplines of forensics, where recovery of small amounts of DNA in the presence of a variety of inhibitors is critical, and national defense, where rapid detection of biological agents used as weapons could save lives.

GC Image, LLC

Phase II Award No.: 1127264

Award Amount: $499,976.00

Start Date: October 1, 2011
End Date: September 30, 2013

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Sector: Biological Technologies

SBIR Phase II: Sample Classification and Biomarker Discovery by Comprehensive Metabolomic Analysis

This Small Business Innovation Research Phase II project proposes to develop a system for automated classification of biological samples and discovery of biomarkers. The system will be designed to perform comprehensive pattern analysis of state-of-the-art biochemical separations generated by comprehensive two-dimensional chromatography (GCxGC) with high-resolution mass spectrometry (HRMS). The pairing of GCxGC and HRMS combines highly effective molecular separations with precise elemental analysis. A critical challenge for effective utilization of GCxGC-HRMS for biochemical sample classification and biomarker discovery is the difficulty of analyzing and interpreting the massive, complex data for metabolomic features. The quantity and complexity of the data, as well as the large dimensionality of the metabolome, and the possibility that significant chemical characteristics may be subtle and involve patterns of multiple constituents, necessitate investigation and development of new bioinformatics. The principal technical objective is an innovative framework for comprehensive feature matching and analysis across many samples. Specifically, the framework will incorporate advanced methods for multidimensional peak detection, peak pattern matching across large sample sets, data alignment, comprehensive feature matching, and multi-sample analyses (e.g., classification and biomarker discovery) with large sample sets. The anticipated result is a commercial system for automated multi-sample analysis.

The broader impact/commercial potential of this project will be realized through improved informatics for biological classification and biomarker discovery. These tools will enable researchers to better understand biochemical processes and to discover metabolic biomarkers, which could lead to improved methods for disease diagnoses and treatments. These information technologies will foster utilization of advanced GCxGC-HRMS instrumentation, thereby contributing to the impetus for future instrument development. The informatics developed in this project also will be relevant for other classification problems involving multidimensional, multispectral data, including other applications (such as biofuels), other types of chemical analyses (such as multidimensional spectroscopy), and other fields (such as remote-sensing multispectral geospatial imagers). This project will contribute to national competitiveness in the global market for analytical technologies and will contribute to workforce development by involving students in research experiences through internships and student projects. Software developed in the project and an example dataset will be available to educational institutions to allow students to more easily explore biochemical complexity.

GenEndeavor

Phase II Award No.: 1230464

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Ruth M. Shuman

Sector: Biological Technologies

SBIR Phase II: Autoligation Chain Reaction: DNA Amplification Without Enzymes or Nucleotides

This Small Business Innovation Research (SBIR) Phase II project proposes to develop novel products for routine genetic testing by demonstrating feasibility of an innovative technology called Autoligation Chain Reaction (ACR). The intellectual merit of ACR is an enabling nucleic acid amplification technology that requires no nucleotides or enzymes. Polymerase inhibitors are found in many laboratory samples and clinical specimens, and contribute to the high cost of molecular-based assays in routine genetic tests because labor-intensive sample preparation and assay development are required to optimize around these inhibitors with current molecular technologies. Because ACR does not involve any reagents sensitive to polymerase inhibitors, the requirement for sample preparation is expected to be low and overall assay development and testing turnaround times are expected to be much faster. Specific key research objectives of the project include design and synthesis of thermal-stable ACR reagents, and the demonstration that ACR can exponentially amplify DNA target sequences without enzymes or nucleotides. Research will be carried out using low copy-number target nucleic acid sequences containing bio-relevant SNPs across multiple loci. The anticipated technical results should show robust, specific, and reproducible amplifications of multiple SNPs on multiple loci in the absence of enzymes or nucleotides.

The broader impact/commercial potential of this project, if successful, is the innovation of an enabling technology that could dramatically reduce sample preparation and assay optimization times, and significantly increase the efficiency and quality, and lower the cost of clinical diagnostics and routine genetic testing. Since non-enzymatic amplification coupled with the inherent simplicity of ACR makes this technology more amenable to standardization in clinical and lab settings across different sample types than existing molecular technologies, it is expected that ACR technology will drive the development of a new generation of molecular diagnostic and screening products. These products are expected to provide more efficient, simpler, cheaper, faster, and accurate routine genetic testing of a broad range of biomarkers for a wide range of diseases and genetic disorders, including those currently unattainable by traditional molecular methods. As a result, ACR will potentially not only advance the understanding of diseases at the genetic level, but also bring broader benefits to human health and society at large through enhanced biomedical discovery, diagnostics, and personalized medicine.

GigaGen Inc.

Phase II Award No.: 1230150

Award Amount: $500,000.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Biological Technologies

SBIR Phase II: Multiplexed Single Cell Analysis

This Small Business Innovation Research Phase II project will enable a completely new approach to biology. The fundamental unit of biology is the single cell, and each cell contains complex genetic machinery. Many fundamental questions could be answered if biologists could perform genetic analysis on large numbers of single cells derived from tissues. The vast majority of useful applications would require detection of multiple genetic loci in single cells. For example, immunologists would like to measure co-expression of multiple T cell receptors and inflammatory molecules in hundreds of thousands of single T cells circulating in human blood. Currently, biology lacks elegant tools to perform this type of analysis. The current project aims to solve this problem with an innovative approach for analysis multiple genetic loci in hundreds of thousands of single cells analyzed in parallel. The technology uses a device to isolate single cells into aqueous-in-oil picoliter microdroplets, amplifies and links two or more genetic loci by intermolecular hybridization, and then sequences linked loci in reversed emulsions by next-generation sequencing. This enables far more complicated biological analysis than is possible if analyzing only a single locus in a single cell, or a single locus across many single cells.

The broader impact/commercial potential of this project includes commercial applications in genetics and immunology research as well as molecular diagnostics and pharmaceutical development. Immunology researchers worldwide are eager to understand T cell and B cell immune repertoires. Immune repertoires respond to factors such as infectious disease, age, and obesity, so immune repertoire profiling is of great interest worldwide. The innovation of this proposed research is to link subunits of antibody genes to reveal a more complete immune repertoire profile. A similar method could be used to link subunits of T cell receptor genes. The platform will also enable unique and innovative approaches to a number of currently intractable problems in molecular diagnostics, including noninvasive monitoring of immunotherapy, noninvasive monitoring of autoimmune disease, and inflammatory response to allograft procedures. Finally, T cells and antibodies are increasingly used as therapy for disease, and immune repertoire profiling technology will be critical to the development of such therapies. In summary, the technology developed in this project will be marketed to research immunologists, leading to fundamental improvements in our understanding of immunology. Eventually, the technology could be extended to the fields of molecular diagnostics and immune therapy, which could help cure intractable diseases.

Ginkgo BioWorks

Phase II Award No.: 1256446

Award Amount: $499,971.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Biological Technologies

SBIR Phase II: Novel Proteolysis-based Tools for Metabolic Engineering

This Small Business Innovation Research (SBIR) project aims to engineer microbes for the cost-effective production of specialty chemicals. Currently, engineered microbial strains bear mutations that increase the production of chemicals of interest by inhibiting the cell's ability to produce off pathway chemicals. These "loss-of-function" mutations are critical as they effectively channel the cell's metabolic flux toward the product of interest. This both boosts the production efficiency and eases downstream purification by eliminating the accumulation of undesirable but chemically-similar contaminants. Unfortunately, these mutations may also decrease the fitness of the cells and, as a result, the growth media must be supplemented with costly nutrients. Technical research herein will assess the feasibility of applying novel regulated proteolysis technology to simultaneously direct maximal metabolic flux toward the target chemical of interest while avoiding the need to supplement the growth media. If successful, this technology would provide a great cost savings and enable fermentative production to be applied more broadly in the production of specialty chemicals.

The broader impact/commercial potential of this project is to provide a stable and cost-effective fermentative production route to a specialty chemical. Fermentative production of chemicals offers many advantages over traditional petrochemical or extraction-based production processes. Petrochemical production maintains the nation's reliance on an unsustainable feedstock (oil) and also leads to national security issues as the US is largely dependent on foreign oil sources. Chemical production via extraction from plant materials also has ecological challenges. The process often uses toxic solvents, and may rely on unsustainable farming practices for many plants that are not traditional food crops. Engineered microbes fermented on sugar feedstock produced using high-efficiency agricultural practices offer a stable alternative for producing specialty chemicals, both in terms of supply and price.

GrassRoots Biotechnology, Inc.

Phase II Award No.: 0957836

Award Amount: $1,000,000.00

Start Date: January 15, 2010
End Date: August 31, 2014

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Program Director: Ruth M. Shuman

Sector: Biological Technologies

STTR Phase II: Constitutive Promoters for Crop Improvement

This Small Business Technology Transfer (STTR) Phase II project seeks to identify new and improved promoters to create enhanced genetically modified crops. Plant biotechnology relies on the insertion of promoter-gene constructs into plants. The promoter is the portion of DNA that controls when and where a gene is expressed. The relatively few plant promoters in use today have significant limitations including inconsistent effects across different growing conditions and a lack of predictability. This project involves developing and implementing a novel pipeline for promoter discovery that starts with a sophisticated bioinformatics analysis to identify high confidence promoter candidates. Using fluorescent reporters and confocal imaging, these candidates are assessed in transgenic plants for cell-type-specific expression, developmental-stage-specific expression, and responsiveness to environmental stimuli. This pipeline was validated in the Phase I component of the project where four novel and patentable constitutive promoters were identified.

The broader impacts of this research are the development of superior genetically modified crops. Genetically modified plants already play an important role in world agricultural production and will play a central role in averting widespread food shortages in the future. In addition, substantial research is being conducted to improve bioenergy crops though genetic engineering. Genetically enhanced bioenergy crops are predicted to play a key role in reducing our dependence on fossil fuels and in cutting greenhouse gas emissions. A critical innovation that will facilitate advances in all of these areas will be the introduction of new and enhanced plant promoters.

HEPREGEN

Phase II Award No.: 0956888

Award Amount: $1,000,000.00

Start Date: January 15, 2010
End Date: June 30, 2014

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Sector: Biological Technologies

SBIR Phase II: Development of a Human Liver Platform for High-Throughput Screening of Drug-Induced Liver Injury and Drug-Drug Interactions

This Small Business Innovation Research (SBIR) Phase II project is aimed towards development of a human micro-liver platform and assay technologies for cost-effective, high-throughput, and quantitative screening of drug-induced liver injury (DILI) and drug-drug interactions (DDI) following chronic exposure to pharmaceuticals. While primary human hepatocytes isolated from the liver are widely utilized in the pharmaceutical industry for drug screening, these cells rapidly (hours) lose phenotypic functions under conventional culture conditions. Recently, a human liver tissue model with defined microscale architecture has been developed that maintains phenotypic functions of primary hepatocytes for several weeks in vitro (micro-livers). This project proposes to develop assay technologies (gene expression, reporter-based, and high content imaging) with micro-livers in a high-throughput multi-well format for DILI and DDI screening in early drug discovery.

The broader impacts of this research are novel approaches for the development of high-throughput, physiologically-relevant platforms for assessing the potential of compounds to cause adverse effects on organs. The liver platforms developed here may enable the elimination of drugs with problematic toxicity profiles much earlier in the drug development pipeline towards substantially reducing the cost to develop a successful drug ($1 billon per drug), increasing the likelihood of clinical success, and limiting human exposure to unsafe drugs. In the future, these platforms may be useful for evaluating the injury potential of environmental toxicants, in fundamental investigations of liver physiology and disease, and for personalized medicine.

InnoGenomics Technologies, LLC

Phase II Award No.: 1230352

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Biological Technologies

SBIR Phase II: Method for Genetic Detection Using Interspersed Genetic Elements

This Small Business Innovative Research (SBIR) Phase II project will further develop the next-generation DNA test kits for forensic DNA testing. DNA profiling has developed significantly over the past 20 years and is routinely used to solve crime. Despite improvements in DNA testing technologies and equipment, a significant number of investigative biological samples do not yield informative results, due to excessive degradation of DNA. A significant number of crime scene and mass disaster samples are still unable to produce useful profiles due to current technology limitations. This research project utilizes a proprietary primer design approach in to analyze a significant number of degraded DNA samples. This project will also contribute to a basic understanding of human populations and their ancestral origins.

The broader impact/commercial potential of this proposed project, if successful, will allow society to obtain answers to identification questions that could not previously be obtained, due to the limitations of current technology. Some of the benefits that can be expected from the development of this technology include: Solving more crimes using next generation DNA tests, including cases that were previously not testable, due to excessively degraded samples; assisting in the resolution of missing persons cases; provide closure to families of mass disaster victims such as the 9/11 terrorist attacks, Hurricane Katrina as well as identifying human remains of soldiers who lost their lives on foreign soil; provide ancestral origin information for individuals seeking information regarding their genealogy; provide a powerful intelligence tool that can be used for national security, military and in-combat efforts; and provide data for the educational and research studies of human anthropology. Overall, the resulting commercial impact of this transformational technology and the positive contribution it will have to society is immeasurable.

Kampachi Farms

Phase II Award No.: 1026645

Award Amount: $1,215,513.00

Start Date: September 15, 2010
End Date: August 31, 2014

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Sector: Biological Technologies

SBIR Phase II: Launching Velella: Testing the Commercial Potential of Mobile Offshore Fish Farming In Ocean Gyres

This Small Business Innovative Research (SBIR) Phase II project will catapult open ocean mariculture far offshore, away from the restrictions caused by competing user groups, site lease requirements and mooring restrictions, by developing the technology for Velella - an untethered, open ocean regional drifter cage. Since 2005, Kona Blue's open ocean mariculture operation has produced up to 500T per annum of Kona Kampachi, with negligible environmental impacts, from a 90 acre site. Growth and investment are constrained by site limitations. Mariculture expansion in U.S. waters is similarly limited by regulatory constraints for moored structures, and the technological challenges of operating further offshore. The Velella Project is developing essential technologies for drifter net-pens that can be entrained in regional ocean eddies. This will allow increased scale and reduced labor requirements, and greater farm profitability. Phase II will also expand eddy predictive capabilities, and launch a Velella beta-system maiden voyage.

The broader impacts of this research are to be accrued through benefits to the environment, coastal economies and public health. The oceans are in deep trouble; over 90% of the ocean's larger predator fish are gone, and over a quarter of fish stocks have "collapsed". Heavily exploited or overfished wild stocks cannot meet the growing global demand for healthful seafood. Still, increased seafood consumption is imperative for American consumers' health. Inshore and onshore aquaculture offer only limited expansion opportunities, or lower-value products. Open ocean mariculture can meet this burgeoning demand, improve product quality and reduce pressure on wild stocks. Overcoming the industry constraints requires highly-automated husbandry systems, and demonstration of a scalable production model for deep water that meets current regulations. This research could significantly expand sustainable, eco-friendly mariculture in U.S. waters, without environmental impacts or user-group conflicts associated with other site-constrained aquaculture. Increased automation can increase production volumes and improve profitability, fish health and worker safety offshore. Increased domestic mariculture could reduce America's $9 billion seafood trade deficit.

Lumiphore, Inc.

Phase II Award No.: 1152688

Award Amount: $499,674.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Biological Technologies

SBIR Phase II: Time-Resolved Fluorescence (TRF) Microscopy of Live Cells with Cell-Penetrating Peptides and Other Targeting Agents

This Small Business Innovation Research (SBIR) Phase II project addresses challenges found with the current methods of microscopic imaging of protein-protein interactions in living cells. These methods rely extensively on Förster Resonance Energy Transfer (FRET) between cyan (CFP) and yellow fluorescent proteins (YFP). These methods are problematic, due to the interference from background noise and the intrinsic photophysical properties of these fluorophores. We have developed a system that uses a lanthanide complex donor in combination with time resolved fluorescent microscopy, which overcomes these limitations. The research objectives of this project are to expand the capability of these luminescent probes, as well as scale-up in order to provide enough material to meet manufacturing needs for initial product sales. By the end of the project, we will have reagents for performing site directed time-resolved measurements in live cells and an operational prototype time-resolved imaging module.

The broader impact/commercial potential of this project, if successful, is the potential to develop a new class of cell imaging reagents and techniques. This innovation will improve the ability of researchers to follow protein-protein interaction pathways with quantitative accuracy that has not been available before. This will impact not only fundamental and applied research but also primary healthcare through the discovery of novel pharmaceutical targets and mechanisms to diagnose and treat disease. The design and use of novel probes to study structure and function at the molecular and subcellular level in living cells is a topic of great importance, with a growing need for new approaches and tools to visualize not only the distribution of molecular species in cells, but the manner in which they interact. Protein-protein interactions and other dynamic events within cells have been largely invisible, but will be increasingly observable with new imaging modalities. In particular, lanthanide probes, with the dramatic lowering of background achieved through time-gating can enable new microscopic imaging, if successfully coupled with cell penetration and molecular targeting and recognition. This new scientific capability is certain to have significant commercial appeal and adoption in the basic science and medical research markets.

MBMR Biolabs Inc.

Phase II Award No.: 1152557

Award Amount: $499,824.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Biological Technologies

SBIR Phase II: In vivo Fluorescence Imaging Kit for Cell Proliferation

This Small Business Innovation Research (SBIR) Phase II project proposes to develop an in vivo fluorescent imaging kit for cell proliferation that addresses the need to study cell growth processes in real time. Proof-of-concept has been demonstrated for a novel method of imaging DNA replication in vivo that is non-toxic and does not interfere with cellular metabolic processes. The method utilizes the unique specificity and high rate of reaction of bio-orthogonal ligation chemistry, and it has shown that in vivo labeling of DNA molecules with this novel bio-orthogonal mechanism yields fast, precise labeling of cell proliferation of cells in their natural environments. Most importantly, the method is minimally invasive, results in reliable incorporation of both the nucleotides and the label, and does not require cell lysis, DNA strand separations, or any of the abrasive treatments characteristic of cell proliferation assays currently on the market. The company plans to develop new methods for the usage of its technology with Fluorescently Activated Cell Sorting (FACS) protocols and testing different formats, such as tissues and different cell lines, for the applicability of this method.

The broader impact/commercial potential of this project, if successful, is a Fluorescent Imaging Kit that can be routinely used with such advanced techniques as high content screening, high throughput screening for drug-discovery, and ADME-TOX assays, as well as with more traditional cell biology and molecular biology settings. The unique advantage of the proposed product is that it allows cell monitoring over prolonged time periods, up to several days. The product will have applications in multiple scientific disciplines, from cancer biology to stem cell biology, and streamline experimental protocols. The proposed assays are especially tailored to be fully compatible with high content screening, one of the major technologies at the forefront of personalized medicine, most notably in the field of oncology, and as such it will directly contribute to the advancement of new therapies, better diagnostics, and more efficient treatment plans. The method also will allow cutting costs of reagents by eliminating the need to repeat experiments multiple times to monitor different markers, and by streamlining research aspects of early stage drug discovery.

Nanofiber Solutions

Phase II Award No.: 1152691

Award Amount: $499,983.00

Start Date: October 1, 2012
End Date: September 30, 2014

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Sector: Biological Technologies

STTR Phase II: High Throughput Aligned Nanofiber Multiwell Plates for Glioblastoma Research

This Small Business Technology Transfer Phase II project seeks to address the unmet need for high-throughput, cost effective tools to model the metastasis of brain cancer cells. The proposed Phase II work will achieve three key objectives necessary for broad adoption: 1) eliminating the use of adhesive during multiwell plate production, 2) implement FDA-approved sterilization procedures utilizing the Sterigenics gamma radiation facility, and 3) additional biological data providing both a head-to-head comparison of our products to those already on the market while also creating a market "pull" for the pharmaceutical application of this technology in clinical treatments of brain cancer. A supply of high-throughput cell culture migration assays will allow researchers to understand and treat cancer metastasis in ways never before possible. It is anticipated that a result of this project will be faster and more effective drug developments to treat brain cancer and other metastasizing cancers. Extension of this technology to other types of cancer and areas of tissue engineering is anticipated once production conditions are fully established.

The broader impact/commercial potential of this project is that it will provide improved, more accurate models of glioma migration having better predictive power and higher translational potential. Current surgical procedures for malignant brain tumors cannot remove all of the cells associated with the primary tumor and these cancer cells migrate into the surrounding tissue where they evade both detection and current chemotherapies, leading to secondary tumor formation and nearly 100% patient mortality. A multi-well plate in vitro migration assays will enable pharmaceutical research identifying key factors regulating glioma cell migration, potentially helping devise a broad range of effective therapies and drugs against these devastating tumors. If this initial form of high-throughput motility assay is successful, it will provide an innovative tool appropriate for researchers from a large variety of backgrounds beyond both glioma treatments and cancer. Additionally, strong commercial potential exists as the cell/tissue culture supplies market is expected to reach $4.97 billion globally by 2012; this market includes the proposed consumable research tool.

PhylloTech Inc.

Phase II Award No.: 1230075

Award Amount: $515,910.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Biological Technologies

SBIR Phase II: Targeted Production of Spider Silk Fibroins in Plant Trichomes

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a platform for the production of spider silk fibroins in plant trichomes. Synthetic spider silk has great potential as an environmentally-friendly biomaterial because it is very flexible yet has a tensile strength greater than steel. A great need exists for a scalable strategy for spider silk fibroin production in a renewable heterologous system that will allow efficient harvest and recovery. The platform is a natural mechanism for protein production and purification in the plant Nicotiana tabacum. The technological innovation is the targeted expression of spider silk fibroins within the gland cells of leaf surface structures called glandular secreting trichomes. The research objectives will be to optimize the production of spider silk fibroins and generate fibers from harvested proteins. The goal is to drive the expression of different spider silk fibroins in trichomes using patented promoters, and refine methods of fibroin recovery, so that fibers with differing physical properties can be generated and tested. This work will demonstrate further that spider silk fibroins can be produced by plant trichomes in a cost-effective manner, and will allow the large-scale, photosynthetic production of next-generation biomaterials.

The broader impact/commercial potential of this project, if successful, will be to demonstrate that a variety of synthetic spider silk fibroins can be produced in a plant-based system, and to better understanding the biosynthetic hardware of the specialized plant structures called glandular secreting trichomes. This work will allow the development of novel ways of achieving industrial biomaterial production without the use of toxic chemicals, and will thus have great societal impact by decreasing the necessity of utilizing large amounts of hazardous compounds in industrial processes. The commercial impact of this project will implement a platform for the photosynthetic production of environmentally-friendly biomaterials.

Actuated Medical, Inc.

Phase II Award No.: 0923861

Award Amount: $1,370,000.00

Start Date: August 15, 2009
End Date: June 30, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Active Device for Reliable Cleaning of Feeding Tubes

This Small Business Innovation Research Phase II project will continue development of the Tube-Clear(TM) device to clear clogged and sluggish feeding tubes, satisfying a critical medical need and reaching a viable commercial market. When compromised patients are unable to swallow food or medication, feeding tubes are used to administer medication and nutrition. A clog leaves the patient without medication or nutrition for hours, or even days, and is extremely frustrating to both patient and caregiver. Approximately 410,000 PEG (long-term) tubes and 5 million NG (short-term) tubes are placed each year in the U.S. Each type of tube presents specific challenges for feeding, clogging and cleaning. The Tube-Clear(TM) PEG prototype cleaned a clog of food and ground medication, in less than one minute, that could not be easily removed using any other available approach. Demonstration of the PEG alpha-prototype at four focus groups, for over 20 nurses from a variety of clinical settings, produced an overwhelmingly positive response toward the device. Phase II (following on Phase IB) will further develop both the PEG tube and NG tube cleaners to beta-prototypes, take the devices through clinical trials, and establish manufacturing protocols, all under a Food and Drug Administration compliant quality system.

The Tube-Clear will ease the burden on nursing staff and patients dealing with the frustration of clogged and sluggish feeding tubes. A structured financial and technical plan has been put in place using a combination of funds from SBIR (Phase I, IB, II and IIB), the State of Pennsylvania, Commercial Partners, and equity investment to reach specific milestones over a 2.5 year period. The NSF Phase I project kicked off this development effort with a highly successfully Alpha prototype for PEG tubes, which was tested in a series of nursing focus groups, resulting in extremely positive reviews. The Tube-Clear for PEG cleaning has an anticipated market launch date in 2010, followed by a NG tube cleaning device market launch in 2011. By 2013, Piezo Resonance Innovations (PRII) anticipates revenue for the Tube-Clear (TM) of $25-50 Million. Three commercial partners, with presence in the enteral feeding market, have indicated strong interest in the device and would provide access to their paths to market, marketing staff, and device development expertise. They have also expressed willingness to contribute financially, potentially as Phase IIB partners. PRII staff will also teach guest lectures on medical device design in the Penn State School of Nursing.

ADM Diagnostics, LLC

Phase II Award No.: 1256638

Award Amount: $500,000.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Early and Specific Dementia Diagnosis Using Imaging and Pattern Classification Software

This Small Business Innovation Research (SBIR) Phase II project addresses a critical need for accurate patient diagnosis in the development of effective therapeutics for Alzheimer's Disease and other dementias, and in patient treatment. The high variability of patients selected for dementia clinical trials, including misdiagnosis, has been a significant contributor to the high failure rates of these trials. The diagnostic under development in this grant would provide an important way to reduce misdiagnosis and patient variability. A main objective of Phase II is to expand the glucose metabolism dementia diagnostic developed in Phase I to be capable of analyzing amyloid PET images and structural magnetic resonance images (MRI), and to combine data from one or more of these imaging modalities into an optimal diagnostic and prognostic assessment. The research will include the development, refinement and testing of: single-modality analysis methods that identify the type of dementia that a patient has, single-modality analysis methods that place the patient along a scale of disease severity, methods that combine and optimize information from multiple imaging modalities, and automated software to conduct these analyses. In addition, reports will be further developed and refined with feedback from physicians and pharmaceutical partners to clearly communicate results.

The broader impact/commercial potential of this project is the ability to address a major barrier of patient variability in achieving successful clinical trials, thus increasing the opportunity to find effective therapeutics for Alzheimer's Disease and other dementias. More than 6 million persons in the U.S. alone are affected by these dementias, with a societal cost estimated at more than $400 billion. This population is rapidly growing as the population ages, and the need to effectively identify and treat patients is urgent. The use of the technology to screen patients for clinical trials and stratify them for analysis is expected to be of immense value to pharmaceutical companies and is an initial commercial opportunity. Already, the developments of Phase I are in use for projects with two such companies. The ability to accurately diagnose patients will help to address the need to correctly treat these patients. The project will result in job creation as the initial service model and subsequent product model are implemented. Finally, by allowing characterization of the subjects in clinical trials, this project will aid in the scientific understanding of the progression of disease and its relationship to symptoms and response to therapy.

Akonni Biosystems Inc.

Phase II Award No.: 1230152

Award Amount: $498,780.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Reel-to-Reel Assembly of Lab-on-a-Film Diagnostic Tests

This Small Business Innovation Research (SBIR) Phase II project is designed to investigate the feasibility of manufacturing a Lab-on-a-Film microarray device on a reel-to-reel assembly line. Reel-to-reel manufacturing has the potential to drastically reduce device cost because hundreds of parts per hour can be assembled. The goal of this project is to demonstrate the feasibility of manufacturing valve-less molecular lateral flow cells for gel drop microarrays using reel-to-reel assembly equipment. At the conclusion of this project, the goal is to demonstrate feasibility by positively identifying clinical samples for infectious disease on reel-to-reel manufactured Lab-on-a-Film assemblies.

The broader impact/commercial potential of this project is the potential to distribute quality diagnostics to an expanded population. With cost being such an important factor in today's healthcare system, the need to investigate new avenues for offering quality diagnostics arises with increasing urgency. This challenge may become a catalyst for a new multiplexing paradigm in molecular diagnostics. A range of possibilities apply to this paradigm such as infectious disease testing for multiple organisms, pathogenic genotyping, genetic testing, forensics, environmental screening, agriculture testing, and biodefense applications. Addressing not only the usability of the end test, but also the manufacturing process is a means to be competitive in a 50 billion dollar global diagnostics market space.

Alpha Universe LLC

Phase II Award No.: 1256561

Award Amount: $499,996.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Inexpensive and Effecient System for Signal Amplification

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a new signal amplification system that, while being inexpensive and simple to use, can be combined with antibodies or other probe molecules and can increase detection limits of conventional Enzyme-linked immunosorbent assay (ELISA) by 100 to 1000-fold. ELISA has been used both in science and diagnostic for more than 40 years. ELISA is simple, reliable, and inexpensive technique. However, because of the nature of enzymes used in this technique as signal-generating and amplifying device, it has a relatively low sensitivity. During Phase I, it was demonstrated that substitution of these enzymes with phages that can propagate and simultaneously generate light signal substantially increases the sensitivity of ELISA and simultaneously reduces cost of the assay without complicating its protocol. In Phase II, the goal is to further improve sensitivity and response time of the system and create two types of products: 1) components that can be plugged-in into conventional ELISA system, and 2) kits designed for detection of specific toxins and other pathogens.

The broader impact /commercial potential of this project is expected to impact the areas of basic research, biodefense, and medicine. The proposed system will allow very sensitive and inexpensive detection of antigens of choice. For those involved in basic research, the proposed immunoassay will allow a significantly more detailed analysis of biological processes, possibly even opening the doors to monitoring those processes and molecules previously undetectable. In biodefense and medical diagnostics, increased sensitivity will mean an increased security by allowing earlier detection of harmful pathogens, as well as pathological changes in the human organism.

Apama Medical, Inc.

Phase II Award No.: 1127549

Award Amount: $515,400.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Biomedical Technologies

SBIR Phase II: An innovative ablation device for treating atrial fibrillation

This Small Business Innovation Research Phase II project proposes to develop a novel ablation balloon catheter to perform radiofrequency ablation on atrial fibrillation patients. The intellectual merit of this project is in its use of an innovative approach to positioning, mapping, and ablation for atrial fibrillation patients, negating the need for excessive catheter rotations and/or serial point ablations. This new technology significantly reduces user variability, procedural time, and the resultant cost burden on the hospital, physician, insurance payer, and patient. The research objectives for this project are to design and develop an improved prototype that enables verification of balloon-to-tissue contact; design and develop a 2nd generation radiofrequency generator capable of powering 20 electrodes; refine catheter design to increase reliability/robustness and sheathing capability; and develop 2nd generation handle that allows for the balloon extension. All of these changes will be validated through in vitro and in vivo testing.

The broader impact/commercial potential of this project is an improvement in the treatment of atrial fibrillation, which is the most common heart rhythm disturbance encountered in clinical medicine, accounting for 1/3 of hospital admissions for cardiac rhythm disturbances. It is estimated that nearly 2.6 million individuals are currently afflicted with atrial fibrillation in the United States, with a projected increase to nearly 4.4 million people by the year 2030. Given the significant public health and economic impact of atrial fibrillation, there is an urgent need for practical and cost-effective approaches to treat atrial fibrillation. This technology aims to answer this need, providing an improved method of treatment for patients as well as highly-marketable technology that will save hospitals time and costs burdens.

BC Genesis

Phase II Award No.: 1026421

Award Amount: $1,041,700.00

Start Date: September 1, 2010
End Date: February 28, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Customizable Meniscus Implant Prepared by Dielectrophoretic Biofabrication

This Small Business Innovation Research Phase II project aims to develop a prototype meniscus implant of bacterial cellulose biomaterials fabricated by dielectrophoretic microweaving, an innovative biofabrication process. Nano-cellulose networks produced by the bacteria Acetobacter xylinum are biomaterials with unique hydrogel-like properties and biocompatibility that are ideal for cartilage tissue replacement. This technology is based on a new biofabrication process, in which bacterial motion is precisely controlled in an electric field to form nano-cellulose networks of desired morphology. Earlier feasibility studies have demonstrated bacterial cellulose deposition at the nanoscale during biaxial motion of bacteria in an electric field and the ability to control the assembly of cellulose layers into any desired three-dimensional architecture and control biomechanical properties. This Phase II project will develop a microweaver bioreactor for fabrication of customizable meniscus implants based on radiology images from patients. The structure and biomechanical properties will be evaluated in knee-model and compared with native meniscus. Biocompatibility and long term performance will be evaluated in large animal model studies.

The broader/commercial impact of this Phase II project, if successful, is the availability of meniscus implants that mimic the structure of the natural meniscus to address knee-joint failures, estimated to affect 15+ million people worldwide each year. Each year, in the US, more than 1 million people undergo meniscus surgery. Irreparable meniscus injuries often progress and lead to osteoarthritis. Currently, there is no satisfactory solution for irreparable meniscus injuries. The potential market for a meniscus implant is more than $3 billion. By developing a meniscus implant that can substitute for the injured native meniscus, it will be possible to prevent osteoarthritis and its related huge economic costs.

Biodesy LLC

Phase II Award No.: 1256619

Award Amount: $500,000.00

Start Date: April 1, 2013
End Date: March 31, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Development of an SHG Instrument, Artemis QuantTM, for measuring conformational change in real time

This Small Business Innovation Research (SBIR) Phase II project will build a real-time detection instrument for conformational change. Conformational change is a change in the structure of a biomolecule such as a protein. For a given protein, different structural changes produce different functionals effect in a biological cell, for example turning biochemical networks on or off. Virtually all biological processes, and all diseases, are mediated by a particular conformational change or the lack of one. Conformational change is thus a topic of enormous scientific and medical importance. In this Phase II project, multiple improvements will be made to the existing in-house prototype instrument, in software, mechanical and optical design, and fluidics handling, to produce an instrument with high precision and robustness. The research objective of this Phase II project is to create an instrument that can be used by scientists, an important milestone in the development of the technology.

The broader impact and commercial potential of this project is to create an instrument that will significantly increase scientists' basic understanding of how conformational changes work, and also enable scientists to discover better or new medicines for diseases. In particular, three-quarters of all proteins known to cause or contribute to disease, due to some mutation, cannot be addressed using conventional techniques. Thus, no effective medicines exist for many diseases. Cancer is one such example. The instrument will enable scientists to find better and new medicines for these diseases. Thus this innovation has great societal and scientific potential. Commercially, this Phase II project will play a critical role in the development of the innovation. It will enable to transition the technology funded by NSF from the current lab prototype to an instrument that will be robust, reproducible and comprehensive enough in its capabilities to enable scientists to use it independently. This important and necessary step is the first on the path to commercialize the innovation.

BioSentinel, Inc.

Phase II Award No.: 1127245

Award Amount: $516,313.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Biomedical Technologies

SBIR Phase II: De Novo Assays for Detection of the Proteolytic Activity in Botulinum Neurotoxin-Based Pharmaceuticals

This Small Business Innovation Research (SBIR) Phase II project proposes to complete development of a universal, in vitro assay for determining the enzymatic activity of botulinum neurotoxin (BoNT)-based pharmaceuticals. This assay, called BoTest Matrix A Assay, will enable standardized comparisons of different BoNT preparations, regardless of manufacturer. BoNTs are used in many different cosmetic and pharmaceutical applications due to their exquisite specificity for motor neurons and their long-lasting effects. Currently, the strength and quality of BoNT-based pharmaceuticals is assessed using a mouse bioassay where BoNT is injected into dozens of mice and a unit of activity depends on the rate or proportion of mouse deaths. Beyond the obvious concerns about animal testing, the variability of the mouse bioassay and the lack of suitable standards and uniform protocols among manufacturers put patient safety and clinical outcomes at risk. The proposed assay(s) will reduce the use of animals and will provide a method to uniformly assess the activity of BoNT-based pharmaceuticals, thus increasing patient safety and the likelihood of successful treatment.

The broader/commercial impacts of this research are improved procedures and protocols that would greatly increase patient safety while reducing animal testing. The BoTest Matrix Assay would be applicable to all stages of BoNT-based drug manufacturing, including quality control, quantification, stability testing, and decontamination testing at manufacturing sites- all applications that are currently performed with animal assays. In addition, the assay would be applicable for authenticity testing (against counterfeit drugs) at border control points and inoffice testing for high-dose procedures where toxin activity concentration is critical for clinical outcomes. The proposed technology would be also the first of its kind on the commercial market. Other commercially available assays for detecting BoNT activity are not suitable for assessing BoNT-based pharmaceuticals, because the stabilizers added to the pharmaceutical formulations interfere with those assays. The proposed technology could be further adapted for testing BoNT activity in highly complex matrices (e.g., blood, food, water). Thus, the assay's utility would extend into food, biodefense, and environmental testing.

Carmot Therapeutics, Inc.

Phase II Award No.: 1127154

Award Amount: $500,000.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: Biomedical Technologies

SBIR Phase II: A new drug discovery method to transform peptides to small molecules: proof of principle with p53-hdm2

This Small Business Innovation Research (SBIR) Phase II project creates a powerful drug discovery technology that uses an innovative fragment-based approach to identify small molecule inhibitors of difficult targets. Though many peptides can disrupt protein-protein interactions, conventional screening technologies are rarely successful at identifying small molecules that do so. In this project peptides are transformed into smallmolecule drugs through an iterative, systematic, empirical screening approach, whereby a small molecule can be evolved to harness key binding properties of peptide-based inhibitors. This proprietary technology, Chemotype Evolution, will be applied to the anticancer target p53-HDM2. The Phase I/IB grant demonstrated that peptides can be deconstructed into baits suitable for performing Chemotype Evolution. In Phase II, Chemotype Evolution will be used to convert these peptide-based baits into novel, potent, completely non-peptidic inhibitors of the p53-HDM2 interaction. Moreover, the flexibility of the technology will be increased by adding additional chemistries.

The broader impacts of this research are two-fold. First, the inhibitors discovered could lead to new drugs for treating cancer. Second, their identification will validate a drug discovery technology that can be applied generally to difficult targets. Routine transformation of peptides into small-molecule drugs would create a wealth of profitable opportunities. Scientifically, this technology will advance the field of molecular recognition and provide a rapid and cost effective method for creating chemical probes to investigate biological pathways. The societal impact will be substantial, as the technology will facilitate the discovery of drugs for unmet medical needs, particularly where conventional technologies have failed.

Chemica Technologies Inc

Phase II Award No.: 1152661

Award Amount: $495,138.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Innovative Green Technology for Advanced, Patient-Centered Home Hemodialysis

This Small Business Innovation Research (SBIR) Phase II project focuses on the further development of an advanced, mobile, easy-to-use, patient-oriented, advanced Home Hemodialysis (HHD) system that minimizes the use of water (less than 6 liters) and medical waste, and importantly, minimizes nutrient loss. End-stage renal disease (ESRD) is a devastating, disabling disease. Many ESRD patients and their family members are severely limited in the mobility and freedom due to the time and effort of having hemodialysis (HD) treatments at hospitals and dialysis centers. Our ultimate goal is to develop a next generation lightweight HD machine (~22 kg) equipped with high precision components and an innovative dialysate regeneration cartridge (DRC). This Phase II program focuses on the construction of a prototype HHD machine that is fully equipped with necessary functions and safety devices. The intellectual merits are based on both the highly efficient and selective DRC composed of a specifically functionalized sorbent, and the compact and highly efficient HD machine that allows for a well-configured and accurately controlled dialysis treatment. This development would greatly improve quality of life for ESRD patients and their families by allowing for effective and comfortable treatment at home, or even at work or school.

The broader impact/commercial potential of this project, if successful, is to reduce the economic burden of ESRD on both patients and Federal healthcare programs. As the number of HD patients approaches 3 million globally, it is becoming critical to decrease the cost and resource burden of treating these patients by drastically decreasing facility costs, use of water and energy in treatment. The second impact is to increase patients' quality of life by facilitating greater flexibility in the length and place of treatment (home, school, work). This system also allows for the personalized dialysis treatment of patients through selective adsorption of toxins. The proposed mobile, semi-portable HD machine offers many advantages over currently available dialysis systems, resulting in high commercial potential. The system will enhance the scientific and technical knowledge in the fields of bioengineering of dialysis and chemistry of sorbent technologies. Given the flexibility in dialysis treatment, the quality of life of dialysis patients will be greatly enhanced. Since this product achieves two goals simultaneously, namely improved treatment and reduced cost, it has a significant advantage over many of the competitive products available today.

Echelon Biosciences, Inc.

Phase II Award No.: 1127467

Award Amount: $527,812.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Biomedical Technologies

SBIR Phase II: Near Infrared Substrates for Imaging Autotaxin Activity In Vivo

This Small Business Innovation Research (SBIR) Phase II project aims to further develop ATX-Red, an in vivo imaging agent that becomes fluorescent in the presence of the enzyme autotaxin. Autotaxin and its product LPA are involved in numerous biological functions that generally involve cell movement, and their dysregulation is associated with many diseases including cancer, fibroses, cardiovascular disease, and others. In Phase I ATX-Red generated highly informative images in living organisms, essentially "lighting up" tumors. In Phase II ATX-Red metabolic stability will be improved and increased performance will be demonstrated. Then ATX-Red will be used to monitor progression and treatment of breast cancer and pulmonary fibrosis in mice.

The broader impacts of this research are improvements to basic research, drug discovery, clinical diagnosis and disease treatment, with the ultimate result being an improvement to human health. ATXRed will be an indispensible tool to the many basic research fields associated with autotaxin and LPA, where questions regarding autotaxin in vivo were essentially unanswerable prior to the development of this tool. In addition to its usage in the research arena, ATX-Red will aid development of therapeutics. Currently significant efforts are underway to develop drugs targeting autotaxin pathways. ATX-Red will likely be employed in the extensive in vivo experimentation needed to develop these compounds. Human patients also stands to benefit from this research, since ATX-Red could act as a companion diagnostic for pharmaceuticals targeting diseases associated with autotaxin dysregulation. Further clinical applications might include diagnosing disease and even directing surgical resection of tumors.

Echometrix, LLC

Phase II Award No.: 1152716

Award Amount: $493,860.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Acoustoelastic Tissue Property Evaluation of Selected Tissue Region in Dynamic Ultrasound Images

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a real-time ultrasound system for evaluating musculoskeletal soft tissue conditions by implementing the novel ultrasound post-processing software developed in Phase I into a programmable platform ultrasound system. Today, radiologists diagnose most musculoskeletal diseases by observing static MRI or conventional ultrasound images and considering key factors that support only qualitative, subjective assessments. Developing an efficient, real-time, quantitative method for diagnosing soft tissue (e.g., tendons and ligaments) injuries and monitoring healing can lead to more accurate diagnoses and reduce re-injury of incompletely healed tissues. The project will enhance the novel software technology's clinical utility and workflow efficiency. The original software will be enhanced by improving the software to automatically detect a region of interest with the ultrasound image. The registered regions of interest can be matched precisely from one patient visit to the next. Developing data mining software will further increase efficiency and accuracy by leveraging machine learning to assist with diagnostic decisions. These software improvements will be integrated with the platform ultrasound system to improve clinical workflow. The integrated product will both match the work flow efficiency of standard ultrasound and dramatically advance the utility of ultrasound within the musculoskeletal arena.

The broader impact/commercial potential of this project, if successful, will dramatically improve clinicians' ability to care for soft tissue injuries and will position the company to capitalize on (1) pressure to reduce medical imaging costs, (2) musculoskeletal specialists' growing interest in ultrasound, especially portable instruments, (3) a major ultrasound manufacturer's focus on the large and relatively untapped musculoskeletal ultrasound market, and (4) the recent emergence of quantitative ultrasound for non-musculoskeletal applications. This Phase II project will produce an efficient, real-time, quantitative method for diagnosing soft tissue injuries and monitoring healing. In the US alone, overuse injuries (strains, sprains) are the most frequently reported musculoskeletal injuries. Annually, 18.4 million such injuries cost approximately $92 B. Patients suffering from musculoskeletal injuries currently face three challenges at diagnosis, care, and outcome. First, current diagnostic methods, including MRI, ultrasound, or physical manipulation, rely on highly subjective and observer-dependent interpretation, so accuracy varies. Second, MRI is still the standard of care, but is far more costly than ultrasound. Substituting ultrasound for MRI, where appropriate for initially diagnosing musculoskeletal conditions, could save Medicare $736 M/year. Third, the lack of an objective monitoring method to determine when a patient can safely return to activity means patients risk missing unnecessary work time or re-injury.

Fyodor Biotechnologies, Inc

Phase II Award No.: 1230453

Award Amount: $476,862.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Broad-based Urine Test for the Diagnosis of Plasmodium falciparum and P. vivax Malaria In Febrile Patients

This Small Business Innovation Research (SBIR) Phase II project will develop and validate a broad-based non-invasive, single-step Urine Malaria Test (UMT-Pf/Pv) for the clinical diagnosis of Plasmodium falciparum (Pf) and P. vivax (Pv) malaria, which account for ~800,000 deaths a year. Since malaria deaths occur within 48 hours of onset of symptoms, the ability to manage malaria at home or in village settings where most cases occur would (i) facilitate prompt access to antimalarial treatment, (ii) target treatment to those who need it, and (iii) reduce malaria mortality. In this project, monoclonal antibodies (MAbs) to novel poly-asparagine protein fragments identified in the urine of febrile malaria patients will be used to develop a UMT-Pf/Pv dipstick. The four overlapping specific aims are to (1) perform a detailed characterization of the diagnostic utility of MAbs developed in Phase I; (2) develop, test and optimize a prototype to meet design input specifications; (3) implement preliminary performance evaluation studies to evaluate sensitivity/specificity, and; (4)undertake preliminary clinical testing. As a non-invasive alternative to blood-based tests, the UMT-Pf/Pv could facilitate the delivery of rapid malaria diagnosis in settings across all geographical areas where malaria is endemic, markedly impacting the way malaria is diagnosed and treated worldwide.

The broader impact/commercial potential of this project is the development of a broad-based one-step urine test for the home-based or point-of-care diagnosis of clinical Pf and/or Pv malaria in persons with fever. With the UMT-Pf/Pv dipstick, the number of steps that the operator is required to perform is significantly reduced, permitting greater utility, convenience and reliability in primary care settings. The test will also facilitate the effective integration of malaria RDTs into private sector malaria case management and encourage wider acceptability of clinical malaria diagnosis in endemic regions, especially in rural areas and in places where mixed infections frequently occur. Overall, the test has the potential to markedly impact the way over 95% of all clinical malaria is diagnosed and treated, and drive current global efforts toward home-based or point-of-care testing for malaria prior to treatment in all cases of fever, as mandated by the World Health Organization. Since it is based on the same platform as current RDTs, this test can be easily integrated into current healthcare structures to provide significant benefits to public health in most endemic countries. No such test is currently available.

Louisville Bioscience, Inc.

Phase II Award No.: 1026824

Award Amount: $499,826.00

Start Date: September 1, 2010
End Date: May 31, 2013

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Sector: Biomedical Technologies

SBIR Phase II: Plasma Thermograms for Disease Detection and Monitoring

This Small Business Innovation Research (SBIR) Phase II project will develop a powerful new diagnostic assay platform that will form the basis of a novel high-throughput diagnostic assay for detection and differential diagnosis of six autoimmune diseases: Lupus, Rheumatoid Arthritis, Multiple Sclerosis, Scleroderma, Polymyositis, and Lyme disease. Assay output is a differential scanning calorimetry (DSC) thermogram that is a characteristic signature for an individual's plasma or serum. The characteristic pattern provides a quantitative measure of the manifold components comprising an individual's plasma/serum, thereby providing an entirely new metric with which to analyze the fluids. The goal is completion of the necessary R&D objectives required to build a prototype diagnostic assay based on the plasma thermogram technology platform. Activities and experiments are directed at automating and optimizing laboratory assay capabilities; defining essential assay parameters and quantitative metrics; and testing and validating the prototype assay.

The broader impact/commercial potential of this project is the radical alteration of treatment paradigms, improved patient outcomes and reduced costs of patient care for complex diseases like autoimmune diseases. As many as 24 million people in the USA are affected by autoimmune disease. Convenient, quantitative and cost-effective diagnoses for numerous diseases, including targeted autoimmune diseases are not readily available. Early differential diagnosis between these diseases is an important unmet medical need and critical for timely and accurate treatment of disease and its complications. In addition, early accurate diagnosis potentially mitigates the costs and inconvenience associated with redundant administration of the current immunological, serological, clinical and pathological tests. Thus, a non-invasive blood assay like the plasma thermogram test that can differentially diagnose autoimmune diseases will be highly beneficial. The company will establish a CLIA (Clinical Laboratories Improvement Act) laboratory from which to market and sell the plasma thermogram test. A central laboratory offers a fast, low cost and high revenue business model for introducing new diagnostic tests into the marketplace. Commercialization of the thermogram technology platform represents a potential multi-million dollar market opportunity.

Lucigen Corporation

Phase II Award No.: 1058238

Award Amount: $1,032,000.00

Start Date: February 1, 2011
End Date: January 31, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Molecular Diagnostics and Biological Control of Disease in Farmed Channel Catfish

This Small Business Innovation Research (SBIR) Phase II project is aimed at developing an effective, inexpensive, safe means of controlling diseases in farm-raised catfish. One of the biggest problems in farm-raised catfish is disease that occurs in commercial ponds. Scientists at Auburn University discovered strains of natural bacteria that can be applied to fish feed to control the most common diseases. Lucigen is developing rapid, simple tests capable of detecting these diseases before the fish get sick. The goal is to combine these ideas to develop commercial products to rapidly diagnose and treat the most common catfish diseases.

The broader impacts of this research are 1) the preservation of an important industry in economically disadvantaged regions of the rural southeastern US and 2) protection of an increasingly important food source. Since yields of most wild-caught fish are declining, farmed fish are becoming an important food source and an important industry throughout the world. Fish diseases in aquaculture ponds cause losses of up to half the fish before harvest, costing billions of dollars worldwide, and there is no satisfactory means of controlling most of these outbreaks. Antibiotics, vaccines, chemicals or controlled feeding are all prohibitively expensive, harmful to human and environmental health and/or bad for yields. The detection and control of catfish diseases, the immediate focus of this project, addresses the $20-30M in annual losses caused by disease. Longer term, similar biological control systems should be applicable to other fish species in the US and the rest of the world.

Lumicell Diagnostics, Inc

Phase II Award No.: 1152489

Award Amount: $494,168.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Intraoperative Detection and Ablation of Microscopic Residual Cancer in the Tumor Bed

This Small Business Innovation Research (SBIR) Phase II project is aimed at developing a handheld system that a cancer surgeon uses to detect and eliminate microscopic residual cancer in the tumor bed after gross resection of the tumor. An integrated laser ablation system instantly removes the cancer cells identified by the imaging system during surgery, eliminating the need for repeat surgery. Effective resection of cancer is often difficult because of the need to spare essential tissue (blood vessels, nerves, brain) adjacent to the tumor and the lack of visual resolution of the tumor bed during manual resection. The integrated laser ablation system developed in Phase II will enhance the surgical technique by quickly and precisely eliminating residual cancer cells in the tumor bed. The objective of Phase II is to deliver a system ready for clinical trials, which includes: increasing the ablation speed, developing a larger field of view, and demonstrating efficacy in animal studies. After completion of this program, Lumicell will validate the performance of the novel system in human clinical trials.

The broader impact/commercial potential of this project stems from improvements in patient care and reduction of healthcare costs. Currently, around 50% of breast cancer patients and 35% of sarcoma patients require second tumor de-bulking surgeries because a final pathology report returns days after the initial surgery indicating that residual cancerous cells have been left within the patient. Furthermore, 25% of the final pathology reports do not detect residual cancer cells due to sampling errors fundamentally inherent in the process. Thus, most patients require subsequent medical therapy including additional radiation or chemotherapy treatment to prevent cancer recurrence and metastasis stemming from residual cancer cells. The system is designed to find and destroy residual cancer cells in real-time at a single cell level. Tumors adjacent to critical nerve or brain tissue are particularly difficult and a laser therapy guided by the proposed imaging system would allow the surgeon to thoroughly eradicate cancer cells with minimal added work and no adverse effect on surrounding tissue. Lumicell's novel single cell imaging device combined with focused laser ablative therapy will have a significant impact on preventing second surgeries and subsequent medical therapy resulting in significant healthcare cost savings and improved patient care.

Nano3D Biosciences, Inc.

Phase II Award No.: 1127551

Award Amount: $600,000.00

Start Date: August 15, 2011
End Date: January 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: In Vitro 3D Tissue Model for Toxicity Screening and Drug Discovery

This Small Business Innovation Research (SBIR) Phase II project will use in vitro three-dimensional (3D) cell culturing enabled by the magnetic levitation method (MLM) as an improved tool for toxicity testing. This work will probe the effects of common agents on the lung, liver and kidney, three organs that play a central role in drug metabolism and are predisposed to toxic injury. 2D cell culture, commonly utilized for testing the cytotoxic effects of drugs, displays limited accuracy in predicting toxicity in vivo due to fundamental differences in the cellular microenvironment. While better representations of the 3D architecture of in vivo tissue are provided by animal models, they fail to accurately reflect whether or not drugs will cause cellular damage in humans as a result of biological differences between species. Our preliminary data shows that magnetic levitation maintains cells in culture in an arrangement that allows the cells to develop and communicate in a manner that is much closer to the in vivo environment than other in vitro systems.

The broader impacts of this research are to improve assessment of drug toxicity and chemical hazards, reduce the use of animals, and advance the fields of in vitro toxicology testing and drug discovery. Commercial potential includes expansion of the device into high-throughput screening, generation of a prototype of a gas delivery system with capabilities to perform live cell microscopy, and development of a label-free viability assay for drug discovery and toxicity testing.

NovaScan LLC

Phase II Award No.: 1058413

Award Amount: $1,012,148.00

Start Date: February 1, 2011
End Date: April 30, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Electrical Property Detection of Residual Cancer in the Surgery Suite

This Small Business Innovation Research (SBIR) Phase II project aims to bring to market a hand-held probe used by the surgeon to ascertain that the surgical wound and regional lymph nodes are clear of cancer. This technology will provide a highly innovative, rapid and accurate device for detecting cancerous tissue by interrogating the electrical properties of the tissues. Currently, removal of affected tissue must be confirmed in the pathology laboratory resulting in delays of up to 36 hours. If the residual cancer is left undetected the patient may be subjected to multiple surgeries or worse, may have a re-occurrence of the disease. This innovative technology will provide surgeons with a tool to ensure all cancer is removed, assist pathologists to help identify malignancies, and provide better results for breast surgery patients to avoid second or third surgeries.

The broader impacts of this research will be the development and implementation of a novel, accurate, rapid, inexpensive, non-invasive, low power, hand-held probe that can assist the surgeon in the removal of all of the cancerous tissue and assist the pathologist in the diagnosis of specific tumor regions. Cancer is a major health problem in the US with over 1.4 million new cases and 560,000 deaths at a cost of $72 billion each year. In particular, the detection of breast cancer has serious drawbacks: cancer is hard to find in dense breast tissue, often depend on the use of invasive contrast agents, and advanced detection technologies are expensive and not available to the entire population. In addition, some types of tumors are not easily identifiable. Surgical procedures are safe only if all cancer is removed. Clearly, there is a pressing need for new technologies that would improve the detection of cancerous tissue.

Nuvogen Research

Phase II Award No.: 1127476

Award Amount: $380,588.00

Start Date: December 15, 2011
End Date: November 30, 2013

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Sector: Biomedical Technologies

SBIR Phase II: Gene Signature Screening for Pancreatic Cancer Therapeutics from Sonoran Desert Extracts

This Small Business Innovation Research (SBIR) Phase II project is to address the high lethality of pancreatic cancer. Screening has begun with Phase IB funding, of natural products from the Sonoran Desert that have produced other promising drug candidates, testing effects on human pancreatic cancer cells. The objective of Phase II is to develop a drug candidate that alters expression of selected pancreatic cancer-related genes and that kills pancreatic cancer cells that express those genes. The drug candidates will be developed using a personalized medicine approach. The gene expression profiles (or genomics patterns) for many different pancreatic cancer tumors will be matched to the effects on genomics produced by the drug. This personalized approach could translate directly to clinical trials to pre-select patients most likely to respond to the drug.

The broader impacts of this research are first to reduce deaths due to pancreatic cancer, which ranked fourth among the leading causes of cancer death with 35,240 deaths in the US in 2009. The 5-year survival rate for patients with metastatic disease is 1.8%. The societal impact and commercial value of targeting such a lethal disease are very high. Further, the personalized medicine approach to drug development will impact many oncology projects. The idea of matching each patient's genomics patterns with each drug that targets that pattern will be critical. Each kind of cancer is not one disease, but a wide spectrum of accumulated genomics changes that have to be addressed individually.

Puracath Medical Inc.

Phase II Award No.: 1230432

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Novel Peritoneal Dialysis Catheter to Reduce Infections

This Small Business Innovation Research (SBIR) Phase II project is aimed at improving the quality of life of dialysis patients through the development if a new disinfection process of the peritoneal dialysis (PD) catheter connection that will reduce infections related to PD. The prevalence of PD among dyaliss patients is increasing and infection rate has become a target for critical improvement. Since PD is a self-administered treatment, patient adherence to the set-up protocol is vital to ensure that sterility is observed. Unfortunately, this is not always the case - infection remains a pressing concern. The objective of this research is to circumvent the need to for complete patient compliance, and introduce a device that will decontaminate the interfaces of PD catheters that are at most risk of contamination. Research objectives focus on enhancing the device design in an effort to achieve a multifold logarithmic bacterial reduction on multiple pathogens, including bacterial and fungal. Other objectives of this project are to optimize product design, from both performance and usability standpoints. When implemented into the clinic, the disinfection device will allow peritoneal dialysis patients to safely receive the full benefit associated with this mode of treatment.

The broader impact/commercial potential of this project is to develop a new standard of care for all catheters suffering from catheter-related infections at ports. The total addressable market for dialysis, central venous, and peripheral venous lines is $13 Billion. Catheter-related infections still presents as a dangerous health hazard for many markets and as of yet, no disinfectant has emerged to successfully address this issue. The "No Pay" rule implemented in recent years prevents hospitals from being reimbursed from infection-related cases with catheters. The disinfection device will enable the decontamination of catheters and the prevention of luminal infections, thereby greatly reducing the risk of secondary infection. For peritoneal dialysis specifically, this technology allows for home dialysis to be a more attractive option compared to hemodialysis by adding safety, reducing patient morbidity and mortality, while permitting more patients to take advantage of the quality of life benefits that peritoneal dialysis provides.

Redwood Bioscience Inc

Phase II Award No.: 1151234

Award Amount: $461,368.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Biomedical Technologies

SBIR Phase II: Design And Production Of IgG Fc Carrier Scaffolds With Increased Payload Capacity

This Small Business Innovation Research (SBIR) II project outlines in vivo testing of semi-synthetic therapeutic protein conjugates. Low molecular weight peptide drugs have had limited therapeutic utility due to rapid clearance and, consequently must be injected very frequently. These drugs could be conjugated to a carrier protein. Attachment to large biomolecules, such as carrier proteins, improves the half-life profile of these peptides. Historically, many of these carrier proteins are recombinant genetic fusions with the peptide of interest. With fusion, the carrier's attachment to the peptide is limited to one site, the end terminus, and that limited placement can impact drug function and thus potency. As an alternative, chemical modification to carrier proteins with small molecule drugs can also render the drug more potent and longer lasting. The scientists at Redwood Bioscience have developed a technology platform that can universally modify proteins in a controlled, site-specific manner. They have generated carrier protein scaffolds, modified recombinant Fc domains that are homogeneous and easy to chemically elaborate with therapeutic peptides. Furthermore, optimized peptide conjugation to the Fc proteins improves conjugate activity in vitro. This technology is to be further validated through an initial in vivo analysis.

The broader impacts of this research are the development of best in class therapeutics and the generation of a robust protein modification platform. This work will change the utility of protein therapeutics by enabling optimization of therapeutic peptides that otherwise would not be useful as treatment for disease.

Remedium Technologies, Inc.

Phase II Award No.: 1256477

Award Amount: $500,000.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Sprayable Reversible Hemostat for Treatment of Non-Compressible Hemorrhage

This Small Business Innovation Research (SBIR) Phase II project aims to develop a sprayable foam hemostat for treatment of non-compressible hemorrhage, which is the leading cause of death (~90%) for bleeding-related trauma. The foam material is based on the biopolymer chitosan; a modification to this polymer with novel hydrophobic grafts allows the material to clot blood much more rapidly and adhere to tissue more strongly than the unmodified version. Also, a complementary cyclodextrin-based technology is able to reverse the hemostatic action of the modified chitosan on demand. The biopolymer is packaged into aluminum hand-held canisters with liquefied propellant and expelled via mechanical actuator creating a foam which is able to expand into irregularly shaped cavities. The desired outcome of the project is to develop a working prototype of the canister containing an optimized modified chitosan with respect to hydrophobic grafting density and hydrophobe length. Foam formulations will be tested for clotting and reversibility in vitro via dynamic and steady shear rheology studies in the presence of blood and in vivo using non-compressible bleeding models in pigs. Biocompatibility testing and tissue histology studies will be performed to determine the safety profile of the optimized formulations.

The broader impact/commercial potential of this project falls in the arena of battlefield and trauma medicine. Foams are the future of acute wound treatment on the battlefield and in emergency medical services. Severe bleeding, especially internal bleeding, is not easily treated with a spatially contained product, such as a bandage. Furthermore, correct bandage placement on an acute wound requires a great deal of skill and experience. However, a sprayable foam is very user friendly and allows potential for adequate self-application or application by an unskilled 'buddy' for a wide range of hemorrhage types. Thus, we envision our chitosan foam as a necessary supply in the soldier's backpack, the emergency room and the home first aid kit. This vision is a viable economic prospect because the material is low cost, lightweight and highly durable even in extreme ambient conditions. Additionally, the reversibility provided by the complementary cyclodextrin system provides a streamlining tool for the trauma surgeon. Removal of hemostatic material and precise indentification of the injury site are necessary tasks in the operating room which are made much easier by this unique technological feature.

Rochal Industries LLP

Phase II Award No.: 1228399

Award Amount: $467,234.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Correlation of Surface Free Energy and Cytocompatibility of Amphiphilic Biomaterials

This Small Business Innovation Research (SBIR) Phase II project pertains to the development of a spray-on polymer coating using a novel amphiphilic polymer in a non-stinging, volatile hydrophobic solvent for treatment of first and second degree burn wounds with reduction of scar formation, wherein a transparent, flexible substrate for human cell attachment, viability and proliferation is formed without any added exogenous biological components. No methods currently exist for treating burns that concurrently reduce pain upon treatment, are intimately conformal to regular and irregular (face, fingers) wound surfaces, provide a cell substrate for wound closure and healing, and do not require dressing removal, such as with the proposed spray-on polymer coating. This investigation will involve cytocompatibility and wound healing studies of these novel polymers, in conjunction with a determination of the polymers' physical and mechanical properties needed for spray-on characteristics. The success of this investigation will demonstrate that a sophisticated, yet inexpensive, easily applied, conformal polymer coating can be used for burn treatment with reduction of scarring.

The broader impact/commercial potential of this project pertains to the commercialization of a novel spray-on transparent polymer coating, delivered from a non-stinging, volatile hydrophobic solvent, to treat first and second degree burn injuries, with reduction of scar formation. Burn injuries constitute one of the most expensive aspects of health care. There are more than 40 million scar patients worldwide per year, at a treatment cost of $12 billion. Currently, no commercial burn care product or methodology provides for improved burn healing with reduced pain and reduced scar formation utilizing a patient and caregiver-friendly technique such as given by this investigation. Despite substantial research in tissue engineering for the preparation of scaffolds for topical wound care, the few commercialized products are costly in preparation, storage and use, and are subject to degradation and loss of activity. With the success of this project, a new technology will be developed that significantly improves burn treatment, is based upon readily synthesized, stable polymers in a commercially-available solvent, that provides a transparent, water-insoluble, oxygen- and water-vapor permeable coating suitable for use over large area burn wounds without forming a patch-work design, and which self-removes as the wound heals.

Sarentis Ophthalmic, Inc.

Phase II Award No.: 1152561

Award Amount: $449,696.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Regenerating Ocular Surface Wounds with Novel Biomaterial

This Small Business Innovation Research (SBIR) Phase II project will result in a bandage that accelerates wound healing to the surface of the eye. Eye wounds are extremely painful, can cause vision loss, and may fail to heal on their own. Trauma may occur due to household cleaning agents, traumatic impact from a falling object, or removal of a contact lens. Ocular surgeries, such as cataract and refractive surgeries, are also sources for corneal injury. Delays in healing may lead to scarring and permanent visual loss. This project will lead to the first biodegradable "green" corneal bandage that accelerates corneal healing. The bandage resembles a contact lens. When this bandage is placed on a wounded eye it reduces inflammation and stimulates the healing process. It is made of a novel biomaterial, which can be programmed to "dissolve" within hours to days providing patients with a tailored product. Completed work from Phase I demonstrated the corneal bandage significantly accelerated corneal healing rate. During Phase II further development will ready the product for human clinical trials. Results from Phase II will produce the final product design, quality system implementation, and initial development of a GMP manufacturing process.

The broader impact/commercial potential of this project will help the 2 million Americans that sustain traumatic injuries to the cornea each year, and the 4 million Americans that undergo surgery annually leaving the cornea wounded. Such corneal wounds cause intense pain and may lead to blindness depending on the severity. This new eye bandage accelerates corneal healing and adheres to the surface of the eye to aid in alleviating pain. The bandage is inexpensive and will result in a less expensive procedure for treating cornea trauma resulting in millions in savings to the American health care system, while allowing for the expansion of the point of care environments (i.e. clinic, home use, hostile environments). Production is fully scalable to large quantities, and can be easily packaged and distributed in a similar fashion as a contact lens. Furthermore, the eye bandage is an innovative technology, patented, and new to the medical device industry.

Stellar Biotechnologies, Inc.

Phase II Award No.: 0848952

Award Amount: $1,059,224.00

Start Date: March 15, 2009
End Date: August 31, 2013

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Sector: Biomedical Technologies

SBIR Phase II: Megathura Crenulata Post Larval Culture - Bottleneck for a Valuable Medical Resource

This Small Business Innovation Research (SBIR) Phase II project will develop methods for the control of larval settlement, metamorphosis and postlarval growth of Megathura crenulata (keyhole limpet) to support the production of commercial quantities of Keyhole Limpet Hemocyanin (KLH), a unique and medically valuable marine natural product. Unlike many other prospective medical products from marine organisms, KLH is already in extensive use in over 20 KLH-based therapeutic vaccine trials. Phase I research successfully identified a critical "cue" for settlement of M. crenulata larvae and demonstrated the feasibility of achieving the long-term commercial objectives of this research. Phase II studies will translate the results from Phase I studies into prototype designs for testing and optimization of systems, diets and aquaculture methods for cultivation of the age-specific developmental phases, from metamorphosis to fully developed adults for KLH production.

The broader impacts of this research are; 1) The elucidation of the underlying biochemical factors that promote settlement, metamorphosis and early postlarval survival of this carnivorous gastropod thus adding significantly to the body of scientific knowledge in this field and improving the potential for cultivation of other commercially important species with biomedical potential; 2) Providing sustainable commercial supplies of KLH for new, life-saving therapeutic vaccines for cancer, arthritis, hypertension, and other debilitating diseases, without continued dependence on the limited and threatened fishery, and; 3) Providing regulators and resource managers the opportunity to formulate management policies to protect the wild population without imposing limitations on KLH or the important KLH-based vaccines under development.

Stemina Biomarker Discovery

Phase II Award No.: 1058355

Award Amount: $599,285.00

Start Date: February 15, 2011
End Date: April 30, 2013

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Sector: Biomedical Technologies

SBIR Phase II: Metabolomics of Human Embryonic Stem Cells to Predict Teratogenicity: An Alternative Developmental Toxicity Model

This Small Business Innovation Research (SBIR) Phase II project will fund a continuation of breakthrough research, development and commercialization of an in vitro assay to help prevent birth defects. This innovative product is driven by a need to create a test for human developmental toxicity that is more accurate than current tests that use animals. False negative results from these animal assays have lead to unexpected cases of birth defects, such as observed with Thalidomide. This assay, performed on human embryonic stem cells, is more predictive of developmental toxicity than animal models (80% vs 60%) and unlike animal models, provides data about specific human biochemical pathways that are affected. This will fund research to 1) identify biomarkers of developmental toxicity present in three different human cell lines, 2) optimize automation systems, 3) create a web-based interface to be used by customers, 4) standardize and create quality control procedures and 5) take the initial steps required for validation of the assay by the European Centre for the Validation of Alternative Methods (ECVAM). Upon validation, the test will be required in Europe for assessing developmental toxicity of newly developed pharmaceuticals and may be further used for testing of environmental chemicals as well.

The broader impacts of this research include 1) a global reduction in drug and chemical induced human birth defects 2) significant cost savings (up to $70 million per drug) for pharmaceutical companies allowing greater confidence in drug candidate selection and 3) a major global reduction in animal testing.

TheraJect

Phase II Award No.: 1230127

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Dissolvable Microneedle Study for Migraine Therapy

This Small Business Innovation Research (SBIR) Phase II project aims to develop a new sumatriptan delivery method for effective migraine therapy that offers both rapid and sustained relief from pain. Triptans are the mainstay of treatment for acute migraine. Migraines are typically treated using tablets or nasal sprays that provide a slow drug release or via injection that provides the fastest drug release. However, the administration via injection is not accessible to patients at the moment of need. The proposed patent-protected drug delivery patch will target over nine million chronic migraine patients who are dissatisfied with currently available pain relief treatment options. The technology is based on the use of dissolvable microneedles that do not cause pain because of their small size. The method will provide a non-invasive, rapid release of migraine medication (e.g. sumatriptan) with minimal inconvenience to patients. It also incorporates a sustained mechanism of drug delivery. The Phase II project objectives are to further optimize the formulations for fabrication of the dissolvable microneedles, scale-up the manufacturing and validate the patch application in animal tests.

The broader impact/commercial potential of this project is as follows: The proposed dissolvable microneedle technology for painless drug delivery through the skin is generic and its use is envisioned for a wide variety of drugs. The microneedle technology will enable new ways for novel drug delivery for both small and large drug molecules through the skin. The total potential market size for this platform technology may include protein drugs ($27 billion, expanding rapidly due to advances in biotechnology and DNA recombinant technology), vaccine ($7 billion), and cosmetics ($8 billion). The delivery of migraine medication that is being developed under this project has a $5.0 billion market worldwide because there is an immediate customer need for non-invasive, immediate release pain-relief methods. The potential impact of the proposed technology is very broad, bringing migraine pain relief to about 10% of the adult population worldwide that suffer from moderate to severe chronic migraine pain.

Tymora Analytical Operations, LLC

Phase II Award No.: 1256600

Award Amount: $500,000.00

Start Date: February 15, 2013
End Date: January 13, 2015

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Sector: Biomedical Technologies

SBIR Phase II: Development of Novel Dendrimer-based Technologies for Phosphorylation Analyses

This Small Business Innovation Research (SBIR) Phase II project addresses the unmet needs for effective analysis of protein phosphorylation, a process where a phosphate group is added to a protein to change its function. Protein phosphorylation is a crucial modification of proteins; its abnormalities have been implicated in many diseases. Therefore, assessing the phosphorylation status of individual proteins or classes of proteins, qualitatively or quantitatively, has become a routine but extremely important step in the majority of life science research labs. Existing technologies have glaring deficiencies, including low reproducibility, poor recovery, high cost, reduced selectivity and prolonged experiment time. The platform technology to be developed during this Phase II project will greatly alleviate these shortcomings by providing lucrative, general approaches for phosphorylation analyses. The technologies will enable general phosphorylation detection, cost-effective cancer inhibitor screenings, and kinase/phosphatase activity quantitation for new drug discovery.

The broader impact/commercial potential of this project is the development of platform technology to improve a set of biochemical assays, thus enabling the discovery of new therapeutic targets and drugs. Protein phosphorylation and kinase inhibitors as drug targets are currently at the peak of research and development (R&D), responsible for over 30% of the total drug discovery expenses. These R&D activities could greatly benefit from the proposed technologies due to their innovative design and versatile features for optimum efficiency, and the ability to reproducibly explore phosphorylation events in unprecedented depth. These should provide invaluable tools and address needs of many bioscience research labs/facilities in academic and industrial settings.

Virogenomics, Inc.

Phase II Award No.: 1152483

Award Amount: $489,496.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Biomedical Technologies

SBIR Phase II: Electronic Allergy Diagnostics: Photo-Immobilization as a General Strategy for Attaching Structurally and Compositionally Diverse Ligands onto a Single Support

This Small Business Innovation Research (SBIR) Phase II project aims to create better diagnostic testing for drug, food, and environmental allergies. If successful, it would be transformative in the clinical diagnosis of allergy diseases by enabling rapid evaluation at the doctor's office in a format that is significantly preferable to skin-prick or challenge testing.

The broader impacts of this research are the development of next generation diagnostic devices. These devices will enable the diagnosis of many different conditions and diseases with just a small drop of blood, right in a doctor's office. Disease diagnosis from blood often requires that the blood sample, typically one or more test tubes full of blood, be taken from a vein in a patient's arm and sent to a clinical laboratory. This is uncomfortable for the patient, requires them to wait days for results, is expensive, and is less safe than the approach being developed by Virogenomics because a large amount of blood that must be transported and handled. The Virogenomics platform will use just a drop of blood and will provide results while the patient is still in the doctor's office. This diagnostic test works similar to the blood-glucose monitors diabetics use to monitor their blood sugar but is much more flexible in regards to the types of tests that can be done. In addition to allergy diagnosis, the proposed diagnostic platform would have application in many other fields that affect our health, such as diagnostics for autoimmune diseases, infectious disease and cancer.

Warwick Mills Inc

Phase II Award No.: 1152668

Award Amount: $499,480.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Biomedical Technologies

SBIR Phase II: Rapid Self-Decontaminating Textiles

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a stretchy, disposable, textile glove intended to prevent cross-contamination with 3-log reduction against bio-pathogens in under 90 seconds. Its chlorine coating lasts for three days and unlike nitrile, latex, and vinyl gloves, is breathable, reducing dermatitis associated with continual barrier glove use. Currently antiseptic test standards for textiles, hand wash and hand rubs, AATCC TM-100, BS EN 1499 and EN 1500 are inadequate to accurately evaluate project's goal of 3-log reduction in 30-90 seconds. We developed a new protocol appropriate to these faster times and that specifically measures contact transfer - the Contact Transfer Test Protocol - that measures cross-contaminating efficacy in seconds. This new protocol can be used in the evaluation of other biocidal systems aiming for short pathogen kill speeds.

The broader impact/commercial potential of this project, if successful, is an innovation in the field of cross-contamination control. While other attempts to make a self-decontaminating fabric have been made, their 3-log kill times are much longer than the 30-90 second goal of the BioTecT Glove. The new BioTecT Glove represents a significant contribution to the field of pathogen control, such as Vancomycin-resistant Staphylococcus Aureus (VRSA) and Methicillin-resistant staphylococcus Aureus (MRSA) that persist even where strong hand antiseptic and barrier glove programs are in place. While the largest demand for the introduction of an innovative solution intended to decrease the number of facility acquired infections (FAIs) may be in the healthcare field, many other markets such as hospitality facilities, the janitorial field, and correctional institutions can also benefit greatly from this technology. From a financial perspective, the cost of an infectious outbreak to a healthcare facility can be catastrophic. Moreover, the socio-political consequences and the impact on a facility's reputation can create long-term negative impressions that may remain in the public's conscience for extended periods of time. As a rapid, self-decontaminating garment, the BioTecT Glove provides an active, innovative solution to this common and serious problem in an affordable, easy-to-use, and effective manner.

Wasatch Photonics, Inc.

Phase II Award No.: 1256374

Award Amount: $498,325.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Program Director: Ruth M. Shuman

Sector: Biomedical Technologies

SBIR Phase II: High-speed Low-cost Spectral Domain Optical Coherence Tomography System for Intravascular Imaging Applications

This Small Business Innovation Research (SBIR) Phase II project proposes to develop an 840 nm spectral domain optical coherence tomography (OCT) system for intravascular imaging applications. The system will be designed to provide images equal to or better than what is currently clinically available, and will have higher imaging speeds with lower cost. Intravascular OCT is poised for clinical acceptance and commercial growth, but is still limited by availability and cost. Increasing system speed and reducing cost will accelerate clinical use of intravascular-OCT. The Phase II research will move the system toward commercial readiness by including in vivo imaging in a porcine animal model.

The broader impact/commercial potential of this project, if successful, will be the availability of a new imaging tool for the identification and treatment of coronary artery disease (CAD). CAD affects an estimated 16 million Americans and is the primary cause of heart attacks and strokes, which killed over 631,000 and 137,000 people, respectively, in the United States in 2006. Intravascular OCT provides detailed imaging information on plaque assessment, stent implantation, and stent monitoring over time. Identification and treatment of unstable plaques and other intravascular conditions will reduce the morbidity and mortality rate from CAD. Billions of dollars are spent on imaging and treatment of CAD. An OCT system with increased imaging capability and competitive cost will provide a significant improvement over the current state-of-the-art.

Absorbent Materials Company LLC

Phase II Award No.: 1230147

Award Amount: $489,173.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Development of Activated Swelling Organosilica-Metal Composites Filter Media in Bioretention Systems for Enhanced Remediation of Stormwater Runoff

This Small Business Innovation Research Phase II project will develop innovative Osorb bioretention systems for enhanced remediation of stormwater quality. PI, Dr. Hanbae Yang, is using novel engineered glass-metal hybrid materials developed by ABSMaterials, Inc. of Wooster, Ohio to remediate environmental pollutants. Runoff control is an immediate and growing concern in the US. Stormwater often laden with nutrients, hydrocarbons, herbicides, and pharmaceuticals, damaging surface water and carrying persistent chemicals impacting humans and ecosystems. Dr. Yang's innovations for controlling runoff pollutants using engineered glass (Osorb)-metal composites mixed into bioretention systems have demonstrated effectiveness on atrazine, estradiol, endocrine disruptors, BTEX, and nutrients. The Osorb-metal composites combine two advanced remediation materials: (1) a high-capacity organosilica sorbent, Osorb, and (2) reactive embedded metals. The composite materials absorb pollutants by removing them from the water and degrade the pollutants within the glass. The key technology developments to be achieved in Phase II include (1) formula optimization field testing with clients, (2) formulation performance improvements, and (3) development of commercial and modular bioretention packages. Compared to older bioretention systems, it is expected some of these systems will see orders-of-magnitude improvement in effective stormwater pollutant remediation and set new standards for best management practice.

The broader impact/commercial potential of this project conducted by Dr. Yang and ABSMaterials will include: (1) providing an entirely new tool for resolving combined sewer overflow challenges with green infrastructure for dozens of cities, (2) substantial reduction of environmental pollution with lower treatment cost for contaminated stormwater, (3) improvement of aquatic and human health, and (4) facilitation of green stormwater reuse. The EPA and state governments are mandating many stormwater programs control non-point-source/CSO pollution. The tools for runoff treatment are often lacking to meet stricter regulations. Developing economical and effective Osorb-based stormwater solutions will substantially reduce negative effects of runoff pollutants on human and aquatic health. Seattle estimates economic impact of uncontrolled stormwater runoff at $113M and plans to build 12,000 bioretention systems to reduce urban runoff by 16,000,000 gallons annually. Other cities, including Cleveland, Philadelphia, Baltimore, and New York, are developing similar green infrastructure strategies. ABSMaterials is further developing an integrated curriculum for science courses at high schools and colleges and providing internships and training experiences involving advanced materials and water remediation. The company expects to create 6 new full-time positions working directly on the commercial activities during the period of this grant.

ARZEDA Corp.

Phase II Award No.: 1256625

Award Amount: $499,999.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: High-yield Fermentation of Sugars to Levulinic Acid

This Small Business Innovation Research Phase II project focuses on the development of a high-yield fermentation route for the production of levulinic acid (LA). LA is one of the best-suited C5 building blocks for bio-refinery production due to higher value, broad applications, and likely quick adoption by the chemical industry. During Phase I, this project has designed and experimentally validated the concept of a novel fermentation pathway for the production of LA. The focus of this Phase II work will be to transition from this technical proof-of-concept to the development of a lab-scale fermentation process. The limiting enzymatic steps in the designed pathway will first be optimized to reach levels of activity consistent with the flux/yield required for economical production. Variants of the designed pathway incorporating the original and optimized enzymes will subsequently be cloned into suitable fermentation organism(s). Using computational and experimental metabolic engineering tools, knock-out and knock-down mutations will be performed to further optimize flux/yield in the pathway while optimizing for host cell growth. This work represents the first commercial application of enzyme design to rationally engineer novel metabolic pathway that do not have any natural counterpart, bringing us closer to the dream of designer cell factories.

The broader impact/commercial potential of this project is the advancement of a U.S. green chemistry industry and to allow America to take the lead in the commercial production of a new renewable chemical building block. The lack of a high-yield alternative to costly thermo-chemical processes has been preventing widespread adoption of levulinic acid (LA). Because LA can be converted, chemically or biochemically, to synthetic rubber (through isoprene and butenes), bio-fuels (such as kerosene and HMF), polymers (for instance, nylons) and polymer additives (for changing polymer characteristics), the addressable market is in excess of $20B annually. When considered as the end product, LA trades at a considerable higher price than ethanol, the current product of most commercial bio-refineries, and thus can help diversify their product offering and considerably increase their margins.

ATRP Solutions, Inc.

Phase II Award No.: 1026575

Award Amount: $882,501.00

Start Date: August 15, 2010
End Date: October 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Adapting ATRP to Industrial Scale Production

This SBIR Phase II project will scale up the atom transfer radical polymerization (ATRP) synthetic method to a 200 L scale from a 1 L scale that was developed in the Phase I work. This ATRP synthetic process is a highly controlled method for synthesizing polymers and copolymers specifically with highly tailored architectures including molecular structure and molecular weight distribution which can affect the properties of the material significantly.

The broader impact/commercial potential of the project will be to create a commercially viable option for producing specialty polymers that might not otherwise be feasible to produce on a large scale. This SBIR Phase II project will allow straightforward scale-up of ATRP process and bring it much closer to the broad market of commercial products. More importantly, the successful validation of the new "feeding" method for ATRP will allow, in the near future, a significant decrease in the consumption of energy and generation of chemical waste for all companies, which will utilize the ATRP technology for the synthesis of new well-defined and better performing materials.

Boulder Ionics Corporation

Phase II Award No.: 1152040

Award Amount: $1,089,972.00

Start Date: April 1, 2012
End Date: March 31, 2016

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Novel Synthesis Method for Ionic Liquids

This Small Business Innovation Research Phase II project is targeted at the development of a novel, low-cost continuous method for the production of ionic liquids. Ionic liquids are a class of industrial chemicals with broad applications in energy, pharmaceutical, biomass and solar fields. Ionic liquids are leading candidates for electrolytes in advanced batteries and capacitors where they enable non-flammable, longer-lived batteries that store more energy than current models. While the potential of ionic liquids is significant, the current cost is prohibitive. Boulder Ionics Corporation proposes to develop a novel, cost-effective method for producing ionic liquids in industrial volumes. The highly flexible technique enables continuous production of ionic liquids with low capital cost. It eliminates the use of solvents in the synthesis process, and produces a very high purity product. In Phase II the company will develop the novel synthesis process, demonstrate low-cost ways of making key precursors, and develop techniques for purifying and measuring the purity of the products. Successful completion of the program will result in low-cost, high-performance electrolytes for advanced energy storage.

The broader impact/commercial potential of this project is to make ionic liquids cost-effective in a wide range of industries. Ionic liquids can replace volatile organic solvents in a vast range of industrial processes, are leading candidates for biomass processing, and have broad applications in electrochemistry, advanced batteries, supercapacitors/ultracapacitors and as heat transfer fluids in advanced concentrating solar plants. In addition, our innovative synthesis technique has broad application across the chemical industry. Cost-effective ionic liquids are critical elements of the new energy economy, with applications in biomass, solar power, and grid-scale energy storage. Techniques developed in this research will enhance scientific understanding of novel chemical reactors, leading to a new generation of more efficient and less-polluting chemical plants. Knowledge gained in this program will enable technologies that will enhance U.S. energy security, and strengthen the emerging U.S. battery industry.

Cambrian Innovation Inc

Phase II Award No.: 1152409

Award Amount: $1,008,000.00

Start Date: June 15, 2012
End Date: May 31, 2016

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Exogen: Enhanced Anaerobic Digestion of Wastewater Using Bio-electrodes

This Small Business Innovation Research (SBIR) Phase II project will optimize and pilot test the patent-pending Exogen system for the generation of biogas during wastewater treatment. Based on a newly discovered process called electromethanogenesis, ExogenTM uses applied voltages and bio-electrodes to increase wastewater treatment rates and methane fraction compared to competing fixed-film anaerobic digestion processes. Phase I R&D demonstrated (1) 30% - 50% increase in chemical oxygen demand removal rate, (2) 30%-60% increase in biogas production, (3) 5 - 18% increase in methane concentrations with both artificial and real-world wastewater, resulting in a payback period of 1.7 - 3.7 years. Further benefits include reduction in start-up time and the potential for real-time automation via direct electrical feedback. During Phase II R&D Cambrian Innovation will optimize the technology and build a scaled demonstration plant at a customer site

The broader impact/commercial potential of this project is to help alleviate the conflicting demands for water and energy in the United States and across the industrialized world by enhancing the process of generating energy from wastewater treatment. Anaerobic digestion can generate energy from wastewater. A recent AgSTAR report has highlighted the potential for this technology in the U.S., identifying over 8,000 livestock facilities and numerous industrial sites suitable for the technology. Cambrian's ExogenTM platform aims to decrease the costs and increase the benefit associated with deploying anaerobic digestion in key industry segments, resulting in faster diffusion. Eventually the technology could open up new industries for anaerobic digestion processes. Exogen further has the potential for carbon sequestration via the direct reduction of CO2 to CH4. As such, ExogenTM technology offers a broad range of applications with significant societal benefit.

Cambrian Innovation LLC

Phase II Award No.: 1127435

Award Amount: $508,000.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Energy Efficient COD Removal and De-nitrification for Re-circulating Aquaculture Facilities with a Combined Bio-electrochemical Process

This Small Business Innovation Research (SBIR) Phase II project will optimize and pilot test a novel, energy-positive approach to de-nitrification for the global aquaculture industry. Recirculating aquaculture systems suffer from high wastewater treatment costs. Leveraging recent advances in bio-electrochemical systems, Cambrian's de-nitrification technology is capable of simultaneously treating chemical oxygen demand (COD) at end of pipe and nitrates in culture tank water while generating electricity directly. Phase I R&D demonstrated the existence of exo-electrogenic microorganisms in aquaculture wastewater. A flow through reactor consistently treated nitrate to below EPA drinking water concentrations (10mg/L) while removing an average of 65% of end-of-pipe COD and generating over 96 Amps/m3. An economic analysis demonstrated potential operating savings of over 70%, and significant bio-security benefits, versus competing systems. Phase II R&D will focus on optimizing treatment rates and reactor parameters with partner firms, and piloting a scaled reactor at an Aquaculture farm.

The broader impacts of this research are to introduce technologies and strategies that solve water and energy problems for the recirculating aquaculture industry. With the collapse of fisheries globally, the aquaculture industry is poised to fill an important gap in our food production. However, recirculating systems in particular are under pressure to limit environmental harm caused by water intensity and pollution. Bio-electrochemical systems represent a novel approach to turn waste resources into energy, thereby increasing farmer's bottom line and resolving the tension between economics and sustainability. Future research can broaden applications to other industries.

Cambrian Innovation LLC

Phase II Award No.: 1230363

Award Amount: $465,775.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: A low-cost real-time bio-electrochemical nitrate sensor for surface water monitoring

This Small Business Innovation Research (SBIR) Phase II project will continue the development of a low-cost real-time bio-electrochemical nitrate sensor for surface water monitoring initially funded as an NSF SBIR Phase I project. In Phase I, Cambrian Innovation demonstrated the feasibility of a bio-electrochemical sensor for measuring the level of nitrate in a water sample. Following the initial proof-of-principle, a microscale sensor prototype was developed and tested. The Phase II project will continue the development of the bio-electrochemical nitrate sensor to reach a detection level of less than 1 mg-N/L with a stable deployment of 6 months. Phase II development will optimize the sensor architecture and operational conditions for improved performance and develop a long-lasting substrate for microbial growth. Phase II will also include the design and construction of prototype electronic components, including the signal processing algorithm for interpreting the signal emitted by the bio-electrochemical cell. Finally, the sensor performance will be validated by extensive laboratory testing under controlled conditions followed by the initiation of field testing. Upon Phase II completion, Cambrian will be prepared for final development and testing of a first-generation nitrate sensor system in a Phase IIB project.

The broader impact/commercial potential of this project addresses environmental nitrogen management, one of the most pressing issues facing society in the 21st century. Nitrate contamination of waterways has become a high profile topic due to anoxic dead zones and drops in fish populations. A significant portion of this environmental impact has been attributed to agricultural run-off (USGS, DOI, 2000). The need for regulation, monitoring, enforcement, and remediation of nitrate pollution is limited by a lack of cost-effective technology for continuous monitoring of nitrate in the environment. Simultaneously, an increased thrust in precision agriculture has been fueled not only by environmental concerns but also by the dramatic improvements in crop yield and quality that can be obtained through careful control of nutrient addition. The development of a low-cost real-time nitrate sensor will transform the management of agricultural facilities, resulting in dramatic improvements in fertilizing efficiency and the environmental impact of the food production industry. Cambrian Innovation is developing a bioelectrochemical nitrate sensor to fill this unmet need and establish a new paradigm in environmental sensing.

Cool Energy, Inc.

Phase II Award No.: 0848689

Award Amount: $1,115,775.00

Start Date: January 15, 2009
End Date: June 30, 2013

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Sector: Chemical Technologies

SBIR Phase II: Solar Thermal Stirling Engine Combined Heat and Power System

This Small Business Innovation Research Phase II project advances the development of an integrated solar energy system which delivers heat and electrical energy to a building's occupants. At Cool Energy, development continues on the SolarFlowTM System, a solar thermal system for combined heating and electrical power generation from medium-temperature heat energy (100-300¡C) captured with evacuated-tube solar thermal collectors. The innovative system design integrates high-performance solar collectors with a novel advanced-materials Stirling engine and controller to use a single solar system to produce electricity and thermal energy for space and water heating. Economic value to the customer is maximized using an optimizing predictive control system to regulate the delivery of heat and electricity. Building on the successful Phase I program for selection of advanced engine components and the demonstration of significant electricity production from the engine prototype, the Phase II demonstration program encompasses system integration of the next-generation Stirling engine prototype with the system controller and solar collectors. The core intellectual merits are the advances in the Stirling engine design (with broader applications than solar power), the implementation of the predictive control system, the integration with the solar collectors for field testing, and the advanced engine and system design tools.

This project supports a technology demonstration that has enormous potential for helping to replace the world's depleting supply of highly polluting fossil fuels with cleaner, sustainable sources of energy. The costs of traditional energy are rising rapidly, causing significant hardship to much of the world's population, including in the US. Disproportionate effects are visited on the poor as the costs of heating fuels and electricity escalate. Rising carbon emissions threaten ecosystems and human populations worldwide over the coming centuries. Cost reduction of renewable energy technology is a main driver of this Phase II demonstration project, as only through lowered costs of clean energy will the US and the world be able to attain domestic energy security, economic stability, and environmental responsibility. Concentrating on market success to enable widespread adoption, Cool Energy has expended a great deal of effort on modeling the economics of the SolarFlow System in various regions of the US. Further, partnerships have been cultivated with potential customers, distribution partners, manufacturing partners, and investors to build a strong business foundation to foster rapid penetration of this technology into commercial channels upon its successful demonstration.

EcoHarvester, Inc

Phase II Award No.: 1127526

Award Amount: $499,734.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Low-Profile, Multi-Polar Energy Generator (MEG) for Small Scale Power Applications

This Small Business Innovation Research (SBIR) Phase II project proposes to create high performance energy harvesting products using EcoHarvester's Multi-Pole Energy Generator (MEG) technology. The novel platform technology will answer the need for power in the mili-watt to several watt ranges and will be possible to serve multiple markets. Phase II will focus on miniaturization of the MEG technology, system level integration of wireless light switches, and modification of the MEG technology for application to a user-actuated portable electronic device charger. The self-generated light switches will eliminated the cost and time spent on wiring or changing batteries. The user-actuated chargers will eliminate the need to buy disposable batteries for smart phone power back-up.

The broader impacts of this research are further investment in energy harvesting and accelerate the adoption of energy harvesting technologies to replace/supplement batteries. In addition to the great economic and performance advantages of our technology for end users, there are compelling motivations to promote this technology for reasons of sustainability and waste reduction. Locally generated power is highly desirable due to the inherent inefficiencies of transmission and storage. As our world becomes increasingly wired, the demand for environmentally burdensome batteries and copper wires has skyrocketed, creating problems related to material extraction, processing, and disposal. The limitations of batteries also constrict the useful life of many devices and limit some applications due to the need to be able to service and replace components.

Electrochemical Materials, LLC

Phase II Award No.: 1256154

Award Amount: $493,292.00

Start Date: February 15, 2013
End Date: January 31, 2015

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Sector: Chemical Technologies

SBIR Phase II: Engineered Solid Electrolyte Interphase Films for Silicon-Based Lithium Insertion Anodes

This Small Business Innovation Research Phase II project proposes to develop and commercialize surface-engineered silicon anodes for use in lithium-ion batteries. Silicon has a ten fold greater charge capacity than graphite but its practical use as an anode material is hindered due to the mechanical problems associated with lithiation cycles (cracking, pulverization) and unwanted chemical reactions at silicon surfaces. Electrochemical Materials (EM) has developed wet surface functionalization methods enabling silicon nanoparticles to be reversibly cycled without mechanical failure or deleterious side reactions. In this work, EM will develop the surface chemistry and integration methods to create anodes for tablet-size (4000mA·h) lithium- ion batteries. EM will develop a scalable manufacturing process and demonstrate batteries with surface-engineered silicon nanoparticles. The new anodes will allow batteries to reach capacities 30 to 40% higher than conventional lithium-ion batteries for more than 1000 cycles.

The broader impacts/commercial potential of this project is that higher capacity lithium-ion batteries will be quickly realized in portable electronics and electric vehicles. Lithium-ion batteries have revolutionized portable communications and electric vehicle power sources, yet their materials of construction have remained essentially unchanged since the mid 1980's. If successful, the commercialization of surface-engineered silicon nanoparticles in lithium-ion anodes would result in 30 to 40% capacity gains along with an approximately 20% drop in cost per watt. Cell phones, tablets, and laptop users could use portable devices for longer periods between charging intervals. Electric vehicles with lithium- ion batteries could increase driving ranges by 40% and improve their cost competitiveness with gasoline-powered vehicles. Electrochemical Materials has strong relationships with major specialty chemical manufacturers, battery materials providers and battery manufacturers and intends to use NSF research and development funds to commercialize their innovative capacity-enhancing anode material.

EN'URGA INC

Phase II Award No.: 0923865

Award Amount: $1,019,000.00

Start Date: August 1, 2009
End Date: July 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Line Scan X-Ray Tomography for In Cylinder Diagnosis

This Small Business Innovation Research (SBIR) Phase II project seeks to develop a sound and novel Line Scan X-ray instrument to characterize turbulent sprays and flames inside a windowless combustor. This project will develop and evaluate a prototype system that will be used by the automotive and gas turbine industries. The goal of the project is a commercially available diagnostic technique for obtaining detailed characteristics of flames and sprays inside windowless combustors.

The broader impact/commercial potential of this project is that it will enable industry to measure relevant information inside combustors, permitting stricter quality control and reduced pollution emission. Significant advances in the combustion process are required to enable quantum improvements in fuel efficiency. This diagnostic tool will provide the information critically needed to enable improvements in fuel efficiency and pollution reduction.

Endres Machining Innovations

Phase II Award No.: 1026686

Award Amount: $597,325.00

Start Date: September 15, 2010
End Date: February 28, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Cost- and Energy-Efficient Conversion of Cellulosic Biomass to Bio-Fuel Feedstock of Consistent and Preferred Geometry

This SBIR Phase II project will develop and commercialize a new energy efficient long-lifed cutting attachment for chipping cellulosic biomass into bio-fuel feedstock while achieving reduced specific energy, significantly longer knife-change intervals, and controllably-fine chips needed by various bio-fuel applications. The innovation involves an adaptation of advanced metal-cutting technology to replace traditional chipper knives.

The broader impact/commercial potential of the project will derive from creating technology to use inexpensive and readily accessible local feedstock for the production of bio-fuels, reducing the cost of feedstock processing upstream of enzymatic hydrolysis. Energy independence and sustainability along with environmental issues strongly motivate the inclusion of biomass to diversify the national and global energy portfolios. Cellulosic bio-fuels applications are poised to grow, but exhibit technical and economic challenges, one of which relates to the need for finer feedstock particles and the inefficiencies of increased chipping energy and knife wear that come with finer chipping.

Energetiq Technology, Inc.

Phase II Award No.: 1127205

Award Amount: $487,023.00

Start Date: October 15, 2011
End Date: September 30, 2013

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Sector: Chemical Technologies

SBIR Phase II: An Improved Open-Path FTIR Spectrometer for Remote Monitoring of Atmospheric Gases

This Small Business Innovation Research (SBIR) Phase II project will enable Energetiq Technology, Inc. to develop and commercialize an advanced Open-Path FTIR Spectrometer (OPFTIR) instrument for monitoring of atmospheric gases over extended distances. The Phase II technical goals will be the optimization of a high-brightness infrared source and optical subsystem that will enable long path instrument capabilities. For current FTIR instruments the infrared light source is a thermal blackbody, limited to operating temperatures of approximately 1000 C. For OP-FTIR instruments the consequences of relying on such low-brightness light sources are (a) bulky and expensive IR optics; (b) expensive IR detectors; and (c) limited monitoring range - typically less than a few hundred meters. The laser heated IR light source developed in Phase I has demonstrated greater than 2000C operation. Direct comparison with a standard GlobarTM source shows an improvement in signal amplitude of between 2 and 10 (depending on wavelength) and signal to noise measurements imply an improvement in detectability of from 1.5 to about 6.

The broader impacts of this research are in the area of environmental monitoring and potentially in Homeland Security applications. The cost and size of OP-FTIR instruments will be reduced and the range and sensitivity increased. With increased emphasis on monitoring total fluxes of atmospheric pollutants, including global warming gases such as CO2, OP-FTIR instruments will be even more widely used in the future.

Filter Sensing Technologies, Inc.

Phase II Award No.: 1230444

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Vibration-Based Cleaning for Ash Removal from Diesel Particulate Filters

This Small Business Innovation Research Phase II project will develop a vibration-based cleaning system, the AccelaCleanTM, to dislodge and remove contaminants accumulated on ceramic filters. The feasibility of the concept was demonstrated in Phase I, and diesel particulate filters (DPF) are targeted as a promising application. Nearly all new diesel engines are equipped with DPFs to meet stringent emissions limits. The DPF is a porous ceramic honeycomb mounted in the exhaust, and traps up to 99% of soot emissions. Over time, ash builds up, plugging the DPF channels, negatively impacting fuel economy, and limiting the filters life. Efficient removal of the ash is challenging, as it generally packs in plugs toward the end of the channels. Current cleaning systems are ineffective, resulting in added fuel and maintenance costs, and reducing the life of these expensive filters that may cost more than $5,000. This research will investigate the use of controlled vibrations to target and break-up hard-packed ash in the DPF. The Phase II work will build on the efforts of Phase I, specifically focusing on increasing ash removal rates through anharmonic excitation of the filter, and ensuring filter integrity is not compromised by the cleaning method.

The broader impact/commercial potential of this project will enable improved engine efficiency and extend DPF component life. Over 33% of DPFs can not be cleaned to acceptable levels using currently available technologies, and nearly all cleaning methods leave some amount of residual ash in the DPF. Despite their inefficiencies, commercial ash cleaning systems are expensive. More effective DPF ash cleaning can provide considerable annual fuel and maintenance cost savings to the end-user, and enables more effective emission control system operation. The US and European DPF cleaning service market is large and rapidly growing, due in part to increasingly stringent emissions regulations. FSTs proposed DPF cleaning technology provides a more effective, simpler, and less expensive DPF cleaning solution. It reduces DPF ash-related fuel economy impacts, extends filter cleaning intervals, and improves emission control system durability and performance. This technology is not limited to emission control applications, but a wide range of filtration applications where effective filter cleaning is required.

FiveFocal LLC

Phase II Award No.: 1127542

Award Amount: $452,469.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Real-time Camera Analysis and Process Tracking (ReCAPT)

This Small Business Innovation Research (SBIR) Phase II project will develop and test real-time process monitoring systems to support manufacturing of miniature digital cameras. Rapid growth in unit volume of digital cameras for cellphones and consumer goods has outpaced the industry's manufacturing process monitoring technology. Except for simple pass/fail outgoing quality tests, high volume camera manufacturers lack any system for in-line, real-time monitoring of production errors that cause low yields, high production costs, and delay new product introduction. The Real-time Camera Analysis and Process Tracking algorithm, ReCAPT, integrates with existing production equipment to identify manufacturing errors and trends before product quality is compromised. ReCAPT leverages outgoing QC data, along with novel design-aware algorithms to identify assembly and fabrication errors and improve the manufacturing process. The Phase II objectives include optimizing the data collection hardware and pre-processing software, automating and generalizing the algorithm initialization, and integrating ReCAPT into the production environment through improvements to the algorithm's robustness. With a key commercialization partner, ReCAPT will be tested multiple times in actual production environments with potential customers reviewing the results. The results will determine the achievable improvement in production efficiency, and quantify ReCAPT's economic value to manufacturers of digital cameras.

The broader impact/commercial potential of this project involves improving yields in the production of miniature camera lenses. Over one billion miniature digital cameras produced annually supply the explosive growth in cell phones and other mobile consumer electronics. The pursuit of cost reduction has led to development of wafer-level manufacturing where thousands of camera lenses are simultaneously fabricated, affixed to a wafer of image sensors and then diced - potentially eliminating the need for individual component assembly. By improving yields and lowering costs, ReCAPT will enable the rapid adoption of wafer-level and other automated, capital intensive camera manufacturing technologies. The broader impact is the development of manufacturing technologies that rely on automation and precision engineering instead of manual labor, enabling US companies to gain traction in the growing $15 Billion annual digital camera market. The statistical manufacturing process data supplied by ReCAPT enables real-time control of manufacturing, reduces new product risk, and allows more aggressive development of innovative camera technology. Sold as an enhancement to existing automated manufacturing equipment, the ReCAPT software product will increase profit for component manufacturers, improve product performance and performance consistency for consumer goods manufacturers.

Gate Fuels Incorporated

Phase II Award No.: 1256635

Award Amount: $437,163.00

Start Date: April 1, 2013
End Date: March 31, 2015

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Sector: Chemical Technologies

SBIR Phase II: One-step Production of Lactic Acid from Lignocellulosic Biomass by Recombinant Cellulolytic Bacillus subtilis

This Small Business Innovation Research Phase II project will further develop new proprietary cellulolytic Bacillus subtilis strains that can produce high-titer, optically- pure L-lactate in high yields from pretreated lignocellulosic biomass through consolidated bioprocessing (CBP) technology. Lactate, or equivalently, lactic acid, is the precursor of the biodegradable plastic polylactic acid (PLA). The following Phase I goals were achieved: (i) the creation of a cellulolytic B. subtilis strain with an enhanced cellulolytic ability, (ii) the demonstration of lactate production from pretreated biomass without the use of cellulases, and (iii) the secretion of large-size heterologous proteins in B. subtilis. This Phase II project will further engineer strains with enhanced cellulolytic ability, and will seek to increase product yield, productivity (i.e., its space time yield), titer, and purity using systems biology and synthetic biology tools. At completion of this project, the goal is to have industrially-ready CBP strains that can hydrolyze pretreated lignocellulosic biomass efficiently, with product yields of >90% based on mixed biomass sugars and >95% based on glucose, a titer of ~150 g/L, and a productivity of ~1 g/L/h. Such Bacillus strains will be ready for large-scale fermentation as a continuing commercialization phase.

The broader impact/commercial potential of this project is the production of a key building-block chemical from biomass. New proprietary recombinant cellulolytic B. subtilis strainsdeveloped in this project will provide an ultra-low-cost platform for producing L-lactate from the non-food biomass, with many advantages over other developing CBP microorganisms. Large-scale production of L-lactate from pretreated lignocellulosic biomass will enable the development of other CBP microorganisms that could produce PLA, biochemicals (e.g., succinate) and advanced drop-in biofuels (e.g., isobutanol, jet fuel) in the future.

GRT, Inc.

Phase II Award No.: 1152638

Award Amount: $500,000.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Chemical Technologies

SBIR Phase II: Enhanced materials for renewable fuel production and efficient emission reduction

This Small Business Innovation Research Phase II project will expand on the successful work from Phase I project on synthesis and characterization of metal oxide nanocomposite materials that can capture HBr and be regenerated to produce bromine. The capture and regeneration capabilities of these materials are integral to the economic viability of the GRT Gas-to-Fuels/ Chemicals rocess and the GRT Propane-to-Propylene Process. In the GRT Processes, natural gas alkanes are (1) reacted with bromine to form reactive lkyl bromides that are (2) reacted over catalysts to produce alkanes, aromatic compounds and olefins. The metal oxide nanocomposite was ound very efficient at sequestering HBr produced in the process as a metal bromide. The use of metal oxides allows for a very inexpensive eparation of HBr from the hydrocarbon products. Subsequent oxidation of the metal bromide produces bromine. Thus the bromine needed in 1) is generated in situ as necessary and is fully contained within the process. During Phase I, we identified metal oxide nanocomposite materials with favorable capacity and capture-regeneration cycle stability that makes industrial use economic. The proposed work is targeted at conducting further testing of these composite nanomaterials on a larger scale and in combination with other Process steps.

The broader impact/commercial potential of this project is that it can contribute to the urgent need for methods to economically produce renewable hydrocarbon fuels and high value chemicals that are more efficient than existing technologies. GRT is developing novel processes for the conversion of methane, ethane and propane into higher value hydrocarbons suitable for gasoline and jet fuel blend stocks, aromatic compounds or high value chemicals which can cost-effectively utilize stranded and/or small reserves of natural gas and shale gas. This upgrade of inexpensive natural gas to high value transportation fuels and chemicals at the source is very valuable because it eliminates the need for gas processing and pipeline transportation. The commercial viability of these technologies depends on energy efficiency and the capital cost of plant equipment. Improvement in the performance and stability of solid reactant/ metal oxide nanocomposite materials will make substantial improvements in both of these metrics and hence in the commercial viability of the GRT Processes.

Innovative Energy Solution

Phase II Award No.: 1127521

Award Amount: $448,771.00

Start Date: October 1, 2011
End Date: September 30, 2013

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Sector: Chemical Technologies

SBIR Phase II: Clean, Inexpensive, and Carbon-free Energy from a Toxic Waste

This Small Business Innovation Research (SBIR) Phase II project proposes to commercialize a new process to recycle petroleum toxic wastes to clean and inexpensive energy. This Phase II project will scale the improved process by modifying the company's pilot unit to incorporate the enhancements realized with the bench scale unit in Phase I. The basic SuperATR is a non-catalytic process that employs a cyclic flow reactor filled with an inert packed bed. In the cyclic flow reactor, the direction of oxidizer/fuel mixture is periodically reversed producing a high temperature volume. The modifications in the Phase I project effectively raised the temperature even higher to make the reactor even more efficient.

The broader impacts of this research are that deteriorating qualities of oils and gases is forcing the petroleum sector to incur very high cost for energy and waste disposal. For example, the benign disposal of hydrogen sulfide costs oil refineries and natural gas processing plants $5 billion a year. Present technologies only permit extracting the sulfur content while wasting the much more valuable hydrogen portion. In commercializing this technology, the value propositions are but not limited to:

• Obtain 9 billion kilowatt hours of carbon-free electricity and steam inexpensively.
• Lowering gasoline and diesel prices, even by 1 cent per gallon, would leave $2 billion in the hands of Americans.
• Eliminate 5 million tons of greenhouse gas along with 1.5 million tons of acid rain pollutants by helping refineries and natural gas plants exceed environmental standards.

Mango Materials

Phase II Award No.: 1256623

Award Amount: $498,417.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: A Novel Biodegradable Biopolymer from Waste Methane Gas

This Small Business Innovation Research Phase II project will use waste methane gas (biogas) as a feedstock to produce pellets of polyhydroxyalkanoate (PHA), a valuable polymer that is converted into a variety of high margin or high volume, eco-friendly plastic products such as childrens toys, electronic casings, water bottles, and food packaging containers. The current plastics market is dominated by petroleum-derived, non-biodegradable, energy-intensive plastics, which often persist in the environment upon disposal. Alternative plastics are derived from rapidly renewable biological resources (biobased) and consumed by microbes when no longer needed (biodegradable). Unfortunately, these alternative plastics are often costly to produce and their manufacturing process requires significant amounts of energy. Mango Materials has a novel, patented, energy-efficient method to produce a biodegradable, biobased polymer at a price competitive with petrochemical-based polymers. Phase II involves scaling the Mango Materials process to produce samples for customers to test while addressing associated challenges. Key goals are to optimize the production process and to verify that customers can process the product on existing manufacturing equipment. Key results include a more optimized process, customer validation of samples, a thorough understanding of polymer characteristics, and an updated cost and yield comparison.

The broader impact/commercial potential of this project will ultimately be the widespread production of low-cost bioplastics from waste biogas and the eventual displacement of petroleum-based plastics. Bioplastics have the potential to capture an increasing fraction of the plastics market, thereby giving consumers the choice to purchase affordable, environmentally friendly, bioplastic-based products. When products made from Mango Materials bioplastic are disposed in modern wastewater treatment plants or landfills, they biodegrade anaerobically (without oxygen) to methane. This methane can be cycled back and re-enter the process as feedstock to produce more PHA. Thus, the life cycle may be closed, creating a cradle to cradle system. This use of biogas will provide a strong economic incentive for facilities to capture their methane, rather than releasing or flaring it, which will reduce greenhouse-gas emissions and reduce corresponding impacts on global warming. The innovation will enhance scientific understanding by studying the production of bioplastic from waste biogas and by characterizing the microbial species responsible for this conversion. This project represents one of the first times that waste biogas will be used commercially as a feedstock for bacteria to produce a valuable product.

Materials & Systems Research Inc.

Phase II Award No.: 1230459

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Planar ZEBRA Battery Development

This Small Business Innovation Research Phase II project is to develop a planar, highly compact, sodium-beta rechargeable battery using sodium-ion conducting beta"- alumina solid electrolyte (Na-BASE) sandwiched between liquid sodium and nickel chloride-based salt, (a p-ZEBRA battery). The commercially available sodium-beta batteries are all constructed with BASE tubes having wall thickness of over 2 millimeters to maintain the battery mechanical integrity, thus leading to relatively low specific energy densities and large thermal masses that inhibit fast thermal cycling. The primary objective of this program is to overcome the limitations of the state-of-the-art sodium-beta battery technologies by the development of an advanced battery with a thin planar architecture. High performance Na-BASE discs possessing high strength and high resistance to moisture and CO2 attack will be developed and manufactured using the MSRI's patented vapor phase process. A unique battery design accompanying an advanced sealing technology development and degradation mitigation implementation will enable the p-ZEBRA battery integration and operation flexibility suitable for intermittent renewable energy storage applications (wind, solar power and geothermal) with high round-trip efficiencies. It also enables thermal integration with internal- combustion engines or solid oxide fuel cells for plug-in hybrid electric vehicle (PHEV) applications with extended driving range.

The broader impact/commercial potential of this project is to provide a low cost, highly reliable electrical energy storage system, which integrates a broad spectrum of power generation systems. It includes fast market penetration of renewable energy power systems that mitigate issues of grid transient and national energy dependency, and gasoline internal-combustion engines or advanced solid oxide fuel cells for PHEVs with extended driving distances. The successful development and deployment of the proposed p-ZEBRA battery technology will assist the US in building critical new industry and reinstating US leadership in large-scale electrical energy storage systems.

Membrane Technology & Research, Inc.

Phase II Award No.: 1127395

Award Amount: $503,000.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Carbon-Ceramic Composite Membranes for Olefin-Paraffin Separations

This Small Business Innovation Research Phase II project proposes to continue the development of carbon-ceramic membranes with excellent propylene/propane separation performance. The membranes serve as the enabling technology to be used in an environmentally benign and economically viable membrane process to separate propylene from propane for a variety of important petrochemical and refining processes. These composite membranes contain thin selective layers of a newly-developed microporous carbon material. The rigid structure of the material confers the membranes with exceptional resistance to plasticization. This allows the membranes to retain high mixed-gas selectivities at challenging industrial conditions. The mixed-gas propylene/propane selectivities and stability of the membranes achieved in Phase I work are far superior to those of previously examined polymer and facilitated transport membranes under industrially relevant conditions. In Phase II work, membranes developed in Phase I will be further optimized, and then used to produce prototype commercial-size modules for propylene/propane separations. In addition, this research is expected to increase general understanding of carbon-ceramic membranes and their potential for use in an array of other chemically and thermally challenging gas separations that are not possible with conventional polymeric membranes.

The broader impact/commercial potential of this project will be the use of the new carbon membranes for propylene recovery from polypropylene and propylene derivative reactor purge streams. This technology has important economic potential, considering the large volumes of propylene, polypropylene and other propylene derivatives produced annually in the petrochemical industry. With successful development and demonstration of the membrane-based processes, their potentially much larger applications include propylene/propane separations for monomer production at steam crackers and recovery of propylene from fluid catalytic cracker off-gases in refineries. The cost of making ceramic membranes is higher than that of polymeric membranes, but the savings from lower process energy requirements will easily outweigh the increased membrane costs. If successful, the new membranes will make membrane-based olefin/paraffin separations technically and economically attractive for use in conjunction with, or in place of, distillation.

Metal Oxygen Separation Technologies, Inc.

Phase II Award No.: 1322498

Award Amount: $499,993.00

Start Date: October 15, 2011
End Date: September 30, 2013

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Sector: Chemical Technologies

SBIR Phase II: High Efficiency BioMass Power Generation Using Liquid Tin Anode Fuel Cell

This Small Business Innovation Research Phase II project will continue the commercial development of the Liquid Tin Anode Solid Oxide Fuel Cell (LTA-SOFC) for direct conversion of biomass to electrical power. The LTA-SOFC is a transformational energy technology that dramatically increases the efficiency and simplicity of power generation from conventional fuels. In biopower, the LTA-SOFC provides a pathway to improve efficiency and capital cost and also enables smaller scale applications. Phase I successfully demonstrated the feasibility of direct biomass conversion to power, using biomass feed stocks which can have significant societal, environmental and economic impacts. Specifically in Phase I several different types of biomass including poplar and switchgrass were used to generate power in an actual LTA-SOFC cell. Post-test analysis indicated no ash fusion and near 100% fuel utilization (little residual carbon left). The Phase II effort will continue development of biopower applications for LTA-SOFC by demonstrating biomass fuel efficiency in a small stack assembly with continuous feeding. Also, evaluation of the fate of biomass-specific volatile components such as potassium will contribute to the understanding of LTA-SOFC longevity. Phase II will demonstrate additional LTA-SOFC biopower technical performance to reduce risk and increase the potential for commercialization of LTA-SOFC biopower.

The broader impact/commercial potential of this project will be increased use of renewable power. Currently biomass contributes only 1% of U.S. electric power despite available resources to provide over 20%. Increased use of biomass for electric power will reduce carbon emissions, increase energy security and create domestic jobs. Efficiencies lower than 20% and high capital cost of today's technology make conventional biomass power about twice as expensive as coal limiting market penetration to about 1%. LTA-SOFC Direct Biomass generators will reduce the cost of power and lower capital cost while reducing emissions and feedstock consumption by 2-3 times. The EIA predicts that by 2030, biomass will generate 4.5% of U.S electricity, representing an available market for LTA-SOFC of about $30 billion. The LTA-SOFC commercialization strategy starts with small devices. Growth into commercial markets will provide the maturity required for more demanding biomass power markets. In the biopower area military users have powerful adoption incentive that will encourage them to become early adopters. The US defense establishment has a goal to use renewable energy for 25% of the facility electrical consumption by 2025. This SBIR will reduce technical risk, providing confidence for integrator partners to co-invest in commercialization of LTA-SOFC biomass generators.

Mohawk Innovative Technology, Inc.

SBIR Phase II: Ultrahigh Speed Micromachining Spindle

Phase II Award No.: 1127346

Award Amount: $520,438.00

Start Date: November 1, 2011
End Date: April 30, 2014

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Sector: Chemical Technologies

This Small Business Innovation Research (SBIR) Phase II project is directed towards the development of an ultrahigh speed micro-spindle for micro-machining. The proposed spindle for micro-milling and micro-grinding at speeds near 500,000 rpm will be implemented with existing commercial micro-machining systems. Micro-manufacturing refers to the creation of high-precision three-dimensional (3D) products using a variety of materials and possessing features with sizes ranging from tens of micrometers to a few millimeters. While micro-scale technologies are well established in the semiconductor and microelectronics fields, the same cannot be said for manufacturing products involving complex 3D geometry and high accuracies in non-silicon materials. The trends in industrial and military products that demand miniaturization, design flexibility, reduced energy consumption, and high accuracy continue to accelerate -- especially in the medical, biotechnology, telecommunications, and energy fields. The principal advantages of the proposed micro-spindle include higher production rates and precision obtained through the implementation of ultrahigh speed machining that will decrease the cutting forces and tool vibrations. The prototype micro-spindle will be evaluated in a series of alpha and beta testing with commercial micro-machining systems. The objective of Phase II is to perform the necessary R&D to prepare the micro-spindle for marketing.

The broader impact/commercial potential of this project encompasses the following. The ultrahigh speed micro-spindle will enable the production of cost-effective micro-components and will positively impact the micro-fabrication industry. Since the underlying scientific principles of micromachining at such high speeds are not known, the availability of the proposed spindle will allow for basic studies to uncover the response of materials under these conditions. Such basic information could lead to new scientific discoveries and further extend the micromachining processes. The data and information generated will undoubtedly be used in future for training of graduate students. The broad impact of this research includes expansion of micromanufacturing research, and research opportunities for next-generation scientific researchers and technology developers to pursue micro machining and micro manufacturing related efforts in the broader fields of micro positioning devices, micro die-and-mold manufacturing, micro sensing and monitoring systems, and micro factory integrations and optimization. Commercialization of the proposed micro-milling spindle will be instrumental in the development of new businesses and industries, and high value added jobs.

Nanotek Instruments, Inc.

Phase II Award No.: 1127394

Award Amount: $463,406.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Ultra High Capacity and High Rate Anodes for Next Generation Lithium-Ion Batteries

This Small Business Innovation Research (SBIR) Phase II project aims to develop cost-effective and commercializable anode materials exhibiting large lithium storage capacity, high rate capability, and long cycle life for next generation lithium-ion batteries. Silicon-based anode materials hold great potential to meet the high energy density requirements for advanced lithium ion batteries. However, the intrinsic low electrical conductivity and huge volume change of silicon during lithium insertion and extraction lead to quick electrode failure, and thus hindering their practical applications. The proposed Si nanocomposites are expected to effectively prevent the crumbling of Si particles, maintain the integrity of the electron-conducting network, and allow the electrolyte solution to easily access the active sites. This phase II project will develop and optimize the nanocomposite compositions and related synthesis and processing procedure to accelerate industrial scale manufacturing of anode materials in the US.

The broader impact/commercial potential of this project is the development of a new anode technology capable of exploiting a dramatic improvement in lithium ion battery performance, which will speed the deployment of advanced lithium ion batteries for plug-in hybrid electric vehicles and all electric vehicles.

NextCAT Inc.

Phase II Award No.: 1127280

Award Amount: $514,830.00

Start Date: August 15, 2011
End Date: July 31, 2014

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Sector: Chemical Technologies

SBIR Phase II: Heterogeneous Catalyst Technology for the Economical Production of Biodiesel from High FFA Feedstocks

This Small Business Innovation Research (SBIR) Phase II project proposes a potentially viable solution for many financially stressed biodiesel producers. Industry estimates that 75% of the installed base of 173 U.S. producers is currently idle. In order become economically viable, they must be able to use less costly, and therefore, less refined agricultural source oils as their feedstock. The R&D presented here builds on a successful NSF Phase I SBIR grant focused on discovering new acidified heterogeneous catalyst formulations capable of refining lower cost feedstocks without adding substantial process costs. Phase II will use these catalysts along with reaction kinetics developed in the subsequent SBIR Phase IB to assemble and demonstrate a pilot-scale biodiesel reactor that will continuously produce FAME from high FFA feedstock (>15% FFA) with a yield greater than 90% for a minimum of six months.

The broader impacts of this research are the ability to simultaneously use low cost feedstock and to greatly simplify the biodiesel production process to achieve total cost saving of ~$1.00/gal. With these savings, retrofitted, currently idled facilities will be able to produce biodiesel fuel that will be cost competitive with petroleum diesel and help meet anticipated global market demand of ~8 billion gallons of biodiesel by 2015. These markets would add employment to economically depressed areas of the United States and bring the nation closer to energy independence.

Nextech Materials LLC

Phase II Award No.: 1256525

Award Amount: $500,000.00

Start Date: February 15, 2013
End Date: January 31, 2015

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Selective Catalytic Oxidation of Ammonia to Nitrogen for Hot Exhaust Treatment

This Small Business Innovation Research Phase II project investigates a new series of low-cost non- precious metal catalysts for selective catalytic reduction (SCO) of NH_3 to N_2. Selective catalytic reduction (SCR) of NO with urea is widely applied for abating NOx emissions in diesel engine vehicles. A common problem of using the SCR technology is ammonia slip. Under conditions of incomplete NO conversion or exhaust temperature upswings, NH_3 will be released from the exhaust, resulting in a number of environmental problems. This SCO technology can convert the toxic ammonia to nitrogen and water on NexTech's proposed catalysts at low temperatures. The proposed non-precious metal catalysts have proven to be highly active and tolerant to SO_2 and H_2O in Phase I. 100% NH_3 conversion and above 90% N_2 selectivity were achieved at $\geq 225^{o}$ C. The catalysts exhibited comparable NH_3 conversion but higher N_2 selectivity (i.e., less NO and N_2O formation) as compared to a conventional Pt-based catalyst. In Phase II, catalyst formulation will further be refined to improve SCO performance, and long term stability testing will be conducted. After that, the focus will be shifted to catalyst scale-up, washcoating on monoliths and evaluation under real diesel engine exhaust conditions.

The broader impact/commercial potential of this project is to solve the NH_3 slip problem existing in the SCR system, allowing its application in the diesel engine exhaust treatment. This SCO technology can also help reduce NO_X emissions by greater than 90% when stoichiometric or excess amount of urea is used in the SCR process, providing an excellent approach for reaching aggressive NO_X abatement goals. As compared to conventional Platinum containing catalysts, the substitution of the proposed non-precious metal catalysts could drastically reduce the cost of diesel engine after-treatment system. The generated information can provide new insights in understanding activation process of small molecules, such as NH_3, NO, NO_2 and O_2, on the oxide surface with acid and redox sites, enabling development of better catalysts for further emission reduction in the future.

NOHMS Technologies

Phase II Award No.: 1256436

Award Amount: $500,000.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Sulfur-infused carbon nanostructures for High Energy Density Secondary Batteries

This proposed Small Business Innovation Research Phase II project will develop a novel nano- scale process for synthesizing sulfur-infused carbon composite cathode materials to produce high- energy density lithium-sulfur (Li-S) secondary batteries with a high rate of charge/discharge and extraordinarily long cycle life. Lithium-sulfur batteries with a long cycle-life are a potentially disruptive technology in the $11-$13 billion lithium-ion battery market because of their three to fourfold energy density advantage over existing chemistry platforms. The technical objectives of this Phase II proposal include the optimization of the electrochemical performance of Sulfur-Carbon composite materials as well developing and implementing scalable unit processes for materials and cell manufacturing. This project will assemble and test pouch cells in sufficient quantities to demonstrate >600Wh/kg operation for 700 cycles with minimal product-to-product variability and reliable performance. Success in Phase II will provide an important pathway to receiving institutional venture funding and building joint-development partnerships to successfully transition NOHMs unique Li-S battery technology to commercial markets.

The broader impact/commercial potential of this project is significant. Secondary lithium-sulfur batteries employing sulfur as the cathode and metallic lithium as the anode offers the highest energy storage potential of any two solid elements. They offer more than twice the specific energy of currently deployed lithium ion battery technology with half the weight. Li-ion batteries currently have a $14 billion market and are expected to reach $44 billion by 2020. They account for close to 75% of all secondary (rechargeable) batteries used in portable electronics. If the potential of these batteries can be harnessed and scaled economically, they are expected to disrupt current lithium ion cell technology because of their higher energy density and the low cost and wide-spread availability of sulfur. Li-S batteries could transform the mobile device market, the electric vehicle market, and energy storage market, enabling greater efficiency and power in all those sectors.

Northern Technologies International Corporation

Phase II Award No.: 1127552

Award Amount: $500,000.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Chemical Technologies

STTR Phase II: Advanced Poly(lactide) (PLA) Materials for Extruded and Molding Applications

This Small Business Technology Transfer Research (STTR) Phase II project proposes to formulate and engineer chemically modified bio-based and biodegradable Poly(Lactide) based compounds, to generate a new class of materials that are, high strength, lightweight, multifunctional, environmentally friendly & cost-effective as an alternative to petroleum based polymers. NTIC has successfully commercialized a portfolio of reactive blended bio-based and/or biodegradable resins for extrusion, molding, and coating applications. However, it faces a major hurdle due to poor mechanical properties, high prices, and higher densities of current PLA materials. NTIC successfully developed novel chemistries of compatibilization to create advanced PLA bio-resins that offer improved toughness in Phase I of this work. The newly synthesized materials were applied in four different processing platforms to provide extruded films, injection molded cutlery, extrusion coated paper, and extrusion blow molded bottles. Phase II funding will allow NTIC to build on the success of the initial trials and build an improved, broader portfolio of high strength and economically viable PLA based products.

The broader impacts of this research are technical, environmental, and economical. This work will (1) widen the window of performance of PLA based applications; (2) further fundamental understanding of PLA and its chemistries (3) greatly increase the use of biobased products in larger industrial and packaging markets implying environmental preservation of fossil fuel resources; and (4) create new jobs for sales, manufacturing, technical support of newly developed Natur-Tec¨ products.

Omega Optics, Inc.

Phase II Award No.: 1127251

Award Amount: $690,000.00

Start Date: October 15, 2011
End Date: September 30, 2014

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Sector: Chemical Technologies

SBIR Phase II: Low Cost On-Chip Photonic Crystal Slot Waveguide Absorption Spectrometer for Highly Sensitive, Continuous,In-Situ,Remote Specific Detection of Multiple VOC in Water

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a low cost packaged near-infrared on-chip silicon absorption spectrometer for simultaneous and specific detection of multiple volatile organic compounds in water (ground water, waste water and drinking water). In phase I, the volatile organic compound xylene was successfully detected in water at 100 parts per billion through near-infrared absorption signatures, on chip with 300 micron long photonic crystal slot waveguides which represents the best results in device sensitivity and in miniaturization. The device combines slow light effect in photonic crystal waveguides with highly concentrated optical field intensity in a low index slot at the center of the photonic crystal waveguide. The photonic crystal slot waveguide proposed herein provides a factor of 1000 reduction in interaction length compared to conventional waveguides leading to enhanced optical absorption by analytes in the optical path. Transmission is measured from multiple waveguides covering the entire near-infrared wavelength range, and absorbance determined by measuring transmission differences in the presence and the absence of any volatile organic compound analytes of interest. The miniature spectrometer will enable massively parallel identification and high throughput analysis.

The broader impacts of this research are the enabling of continuous, remote, in-situ monitoring and unique identification of multiple volatile organic compounds (VOCs) in groundwater, drinking water, and waste water, with high sensitivity and specificity, a facility that is not available commercially at present. The integrated silicon platform ensures low cost production in high volume. From commercial standpoint, the United Nations Environment Program estimates the global water market to expand to $660 billion from the current $250 billion by 2020. The proposed photonic crystal slot waveguide device can be expected to occupy a significant position in this market. The generalized design of the proposed versatile technology implies possible implementation in multiple areas of in-situ analyte sensing, detection, and spectroscopy such as control of food, air, and water quality and health, in a lab-on-chip platform with low cost of ownership. Through continuous, in-situ and remote monitoring, the prototype developed from this research will eliminate the lag time that currently exists in industrial water monitoring, sometimes extending to few months as in VOC monitoring of rivers and lakes, thereby enabling early warning of spurious leaks and spills instead of after-the-fact damage control and mediation and thus enhance environmental and national security.

Pearlhill Technologies, LLC

Phase II Award No.: 1127187

Award Amount: $529,859.00

Start Date: August 15, 2011
End Date: January 31, 2014

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Sector: Chemical Technologies

SBIR Phase II: NIFUT Technology for Recycling Fluorides from Uranium Tetrafluoride

This Small Business Innovation Research (SBIR) Phase II project proposes to significantly expand the number of marketable compounds that can be converted from depleted uranium tetrafluoride (DUF4). DUF4 is produced by the reduction of depleted hexafluoride (DUF6), the largest and one of the most toxic waste components of the entire nuclear fuel cycle. Current technology can convert DUF4 into metallic fluorides. Pearlhill Technologies has developed new, environmentally and economically sound processes for the production of nonmetallic inorganic fluorides from uranium tetrafluoride (NIFUT). In Phase I, Pearlhill proved the feasibility of three NIFUT processes to produce commercially viable fluoride products; sulfur tetrafluoride (SF4) gas, sulfur hexafluoride (SF6) gas, and nitrogen trifluoride (NF3) gas. In Phase II, the company will design and develop prototype reactors and conduct field tests for three processes: (1) a scalable batch process to produce SF4; (2) a continuous process to produce SF6 gas by direct fluorination of SF4 in a stationary bed of cobalt trifluoride (CoF3); and (3) a continuous process for the direct fluorination of trimethylsilylamines at a low temperature liquid phase continuous process, in order to produce NF3 gas.

The broader impacts of this research are that, for the first time, a company has created nonmetallic inorganic fluoride products from DUF6. The Department of Energy (DOE) currently has as much as 700,000 tons of DUF6 in its inventory. Meanwhile, four companies are planning to build new uranium enrichment plants. When these facilities are operational, an additional 27,000 tons of DUF6 waste will be added annually to the inventory. DOE's 1999 roadmap for decommissioning DUF6 discussed the need to create new processes for the commercial production of high-value fluorine products from DUF6/DUF4 including a variety of metallic and non-metallic inorganic fluoride compounds, which can be absorbed into current markets. A mix of high-value fluoride products is needed to minimize flooding any single fluoride market. Market research suggests that the market demand for metallic fluoride products can absorb only about ten percent of the potential metallic fluoride gas products that could be created from the annual ongoing enrichment process; hence there is a pressing need to increase the number of markets for fluoride products created from DUF6. The innovative NIFUT process will address this need. The Phase I research has proven that three fluoride products - SF4, SF6, and NF3 - can be produced at a significant cost advantage in the current marketplace.

PH Matter, LLC

Phase II Award No.: 1230320

Award Amount: $500,000.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Chemical Technologies

SBIR Phase II: Mixed Oxide Sulfur-Tolerant Water Gas Shift Catalysts

This Small Business Innovation Research Phase II project will focus on the refinement of catalyst compositions identified during the Phase I program for production of fuels from biomass. New catalyst materials are needed to make liquid fuels and hydrogen from biomass more economical and efficient. In this Phase II project a scalable synthesis method will be utilized to prepare 1kg/day batches of high surface area catalysts with proprietary additives to improve low temperature shift activity. During the Phase II research, pH Matter will demonstrate the performance of the novel catalyst compositions under additional customer-specific gas feed environments and demonstrate a method for scaling up the catalyst synthesis process for delivery to BTL system developers and commercial catalyst manufacturers. The end goal is production of catalysts and generation of performance data demonstrating that the catalyst can operate in the full range of contaminants found in biomass sources,reducing the cost and improving the efficiency of fuel production from biomass.

The broader impact/commercial potential of this project is potentially quite large. The production of energy and liquid fuels from biomass will have a number of beneficial societal impacts. Biomass gasification processes are carbon neutral, since it uses C0 2 that was captured from plants; therefore, biomass gasification will replace energy production from fossil fuels, thus reducing greenhouse gas emissions. Unlike fuel crops, biomass can be garnered from second generation sources like waste products that have no use for human consumption, so the technology does not compete with food sources. Further,using biomass as a source of liquid fuel will reduce the dependence of our nation on foreign sources of energy. The technology developed and refined during the Phase II NSF SBIR program could have application to a wide range of other catalytic reactions as well. Potential applications include: lean burn diesel engine exhaust treatment,hydrocarbon reforming for fuel cells, electrode materials in fuel cells,and gas-to-liquid processes. Overall,the project will contribute novel results to the body of literature in catalysis and materials development.

Phage Biocontrol Research, LLC

Phase II Award No.: 1230441

Award Amount: $485,747.00

Start Date: August 1, 2012
End Date: July 31, 2014

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Sector: Chemical Technologies

SBIR Phase II: Improvement of the Biofuel Fermentation Process by the Phage-mediated Reduction of Contaminating Lactic Acid Bacteria

This Small Business Innovation Research Phase II project is focused on improving biofuel fermentation processes by developing phage products designed to inhibit bacteria that reduce biofuel fermentation efficiencies. This product will improve biomass conversion efficiencies in the biorefinery. One of the most significant challenges to commercial biofuel fermentation is the presence of lactic acid bacteria (LAB) that compete for the feedstock, produce undesirable organic acids, and inhibit the growth of the fermentative microorganism. Antibiotics are commonly applied to control LAB, which may lead to the emergence of antibiotic resistant strains. Furthermore, antibiotic residues in distillers grains can lower the value of this important ethanol co-product, further weakening the economics of biofuel production. Despite antibiotic applications, most facilities are still impacted by LAB-associated fermentation upsets, reducing ethanol yields and increasing costs. Ecolyse is proposing to develop an entirely new approach for controlling LAB during fuel ethanol fermentation, based on LAB terminating phage formulations. Phages are natural, highly host-specific bacteriolytic agents. Ecolyse is pioneering the development of phage products designed to mitigate bacterial problems during industrial activities. The dynamics of LAB contamination during biofuel fermentation is particularly well suited for phage-based mitigation.

The broader impact/commercial potential of this project is to develop a product that not only improves biofuel ethanol fermentation efficiencies but will also reduces the non-medical use of antibiotics. Current control practices for LAB contamination in fermentation facilities include rigorous clean in place policies, adjusting physical parameters, and through the application of chemical biocides and antibiotics. Antibiotics are often the most effective control measure. Regulations designed to reduce antibiotic use fail to encourage viable alternatives. Phage formulations could potentially fill this void for a myriad of industrial applications, including biofuel fermentation. While phage products are being developed for medical and agricultural purposes, Ecolyse is unique in seeking industrial targets. An advantage that phage share with antibiotics over chemical biocides is capacity to specifically kill target bacteria without interacting other microorganisms, including the fermentative yeast. In contrast, chemical biocides are much less selective and doses effective against bacteria may adversely modulate yeast growth. Thus, the innovative application of phage to control LAB in the fuel ethanol fermentation industry will lead to both immediate economic and long-term socio/economic impacts. The phage products will be marketed to the almost 200 ethanol fermentation facilities in the U.S. alone.

Phycal LLC

Phase II Award No.: 1152497

Award Amount: $495,763.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Magnetic technologies for improved microalgal biofuels production

This Small Business Innovation Research Phase II project develops novel technologies for separation and concentration of intrinsically magnetically susceptible algae for production of biofuels and biochemicals. Phase II builds on the feasibility demonstrated in Phase I using a model alga. During Phase II, an algal strain used for production of renewable biofuel feedstock will be utilized. Novel transformation vectors and tools developed for a production strain, Auxenochlorella protothecoides, will be used to make the algae magnetically susceptible. These traits provided an advantage vs. wild-type strains in growth in low iron medium for the model alga. Phase II will test modified algal strains at lab- and subpilot-scale to determine their performance in growth, and competition with wild-type and weedy algal strains. Additionally, strains will be tested for their ability to be separated or harvested magnetically. This separation will be modeled to determine cost efficacy for primary or secondary dewatering. The specificity of this separation will also be evaluated in relation to downstream use in a heterotrophic bioreactor. The OSU collaboration allows use of these strains in novel rare earth magnetic separators. The endpoint will be novel technologies to improve the overall cost structure for the production of algae-derived biofuels and biochemicals.

The broader impact/commercial potential of this Phase 2 research project will be to provide improvements in the economics of producing renewable biofuels using algae as the production system. It directly addresses one of the major issues with algal biofuels, cost effective dewatering. It also provides a potential selective advantage of the modified strains by improving its ability to compete for iron in an open environment (such as open raceways or photobioreactors). The nation has a critical need to improve its energy security and reduce its dependence on fossil fuels. This research will help address both of these needs. The overall purpose of this research project is business related and focused on commercialization of this technology through integration in a biofuel production process. This research project focuses on a high cost portion of the production process, dewatering, as well as a critical unit process, the heterotrophic bioreactor. The collaboration with OSU and the Cleveland Clinic will result in training of students in this area. The company plans to publish the results of this project once proper control of the intellectual property generated is accomplished.

PlastiPure, Inc.

Phase II Award No.: 1127553

Award Amount: $491,236.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Flexible Plastic Packaging Without Estrogenic Activity (EA)

This Small Business Innovation Research (SBIR) Phase II project will use resins, additives, and process aids shown by PlastiPure to be free of estrogenic and anti-estrogenic activity (EA**) to create innovative and novel flexible plastic films and products for the preparation and storage of food and beverages that leach no chemicals having EA**. These films and products should remain free of EA** when extracted by common solvents and food simulants, and remain EA**-free after the stresses of manufacturing and exposure to common-use stresses (microwaving, thermal cycling, and UV light). PlastiPure also proposes to produce prototype products which would be specifically targeted for pregnant women, infants, and young children, whom are particularly vulnerable to the potentially adverse health effects of EA**. These highly desirable end products are already being sought by PlastiPure licensees and interested retailers.

The broader impacts of this research are development and commercialization of food and beverage packaging that are significantly safer, especially for pregnant women, infants, and young children. Fetal or juvenile mammals, including humans, are especially sensitive to effects of chemicals having EA** at very low dosages and hence should not indiscriminately ingest such chemicals. EA** has been strongly linked to higher rates of certain cancers, birth and learning disorders, obesity, and reproductive issues. PlastiPure's data show that the vast majority of plastic food packaging leaches chemicals with EA**, including those advertised as BPA-free. This NSF SBIR grant should facilitate a comprehensive reduction of risks to public health and reduced environmental impact from chemicals having EA.

Polnox Corporation

Phase II Award No.: 1138520

Award Amount: $500,000.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Novel Antioxidants to Improve Thermo-Oxidative Stability of Biolubricants and Biodiesel

This Small Business Innovation Research (SBIR) Phase II project proposes to develop and commercialize cost-effective high performance macromolecular antioxidants based on Polnox's proprietary "dual type moiety per molecule" (DT-mPM) technology for sustainable-alternate bio-oils. Oxidative stability presents a key issue for industrial bio-oils. These oils, which are derived from bio-resources, have inferior stability compared those derived from fossil fuels. In particular, fuels and lubricants derived from plant-based polyunsaturated fatty acids are especially prone to severe oxidation. It has been demonstrated in Phase I that the DT-mPM antioxidants are significantly more effective in combating degradation of these bio-oils vs. state-of-the-art commercial antioxidants. The current, state-of-the-art, commercial antioxidants do not meet the challenges posed by plant-derived bio-oils. Current antioxidants were developed to protect petroleum lubricants and are simply not capable of meeting the stability issues posed by bio-lubricants. This proposal addresses the key steps involved in the product development of antioxidants for bio-lubricants; namely, (a) molecular design optimization, (b) cost-effective process scale up, (c) preparation of pound scale of lead antioxidants identified in Phase I, and (d) product storage stability.

The broader impact/commercial potential of this project is to play an important role in reducing the nation's dependence on foreign oil and providing a cleaner environment by reducing the pollution of air, soil, water, and the ecosystem. Societal benefits from the increased use of bio-lubricants include less potential for environmental pollution (e.g., from loss during use or improper disposal of waste lubricants, accidental oil spillage during industrial use, or off-shore drilling) as well as reduced dependence on imported petroleum as a raw material. However, as oils are developed from renewable alternate energy resources, there are some inherent issues to be addressed: (1) thermo-oxidative stability, and (2) pour-point properties. By addressing the thermo-oxidative stability problem of bio-oils through the development and commercialization of new high performance antioxidants, this will enable the production of higher quality alternate oils that are biodegradable and environmentally safe.

Proton Energy Systems, Inc.

Phase II Award No.: 1230199

Award Amount: $499,960.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: High Efficiency Electrochemical Compressor Cell to Enable Cost Effective Small-Scale Hydrogen Fuel Production and Recycling

This Small Business Innovation Research Phase II project addresses current limitations in hydrogen compression and enables reduction in hydrogen requirements for several applications through recycling of exhaust hydrogen containing water and other benign impurities. In Phase 1, feasibility of operating a proton exchange membrane (PEM)-based device as a high efficiency electrochemical compressor/purifier was demonstrated at up to 3 A/cm2. In Phase 2, refinement of the microporous plate will be performed for optimal water distribution, which will enable more uniform fluid distribution and high current densities. Poison-tolerant catalysts will also be developed to enable a broader range of applications. The objectives of this phase also include additional test stand modifications to enable a broader range of test conditions, demonstration of gas purity through analysis to determine the separation efficiency, and development of system schematics and product requirements. The anticipated result will be an improved hydrogen recycler which will enable substantial reduction in hydrogen production cost and new market opportunities.

The broader impact/commercial potential of this project includes applications ranging from power plants to heat treating to backup power and fueling. For example, over 16,000 power plants worldwide use hydrogen as a cooling fluid in the turbine windings. Currently, increases in dew point cause significant decreases in cooling efficiency and increase windage losses by several percent, requiring purging of the hydrogen chamber and increased production to backfill. Thus, significant energy waste is generated. Current solutions for hydrogen compression are also noisy, bulky, and inefficient. In applications where hydrogen is being evaluated as an alternative fuel, high pressure storage is needed. Having a mechanical compressor that represents half of the size and material cost of a home fueling or backup power device is not commercially feasible. The device proposed has the opportunity to decrease the energy required to produce pure hydrogen by 75% over generating additional hydrogen from water, and to compress the hydrogen with as little as 200 mV of overpotential even at high current density. Advances in these areas would find immediate commercial interest, and address key strategic areas on the government agenda related to energy savings and green technology.

Selenium, Ltd.

Phase II Award No.: 1256598

Award Amount: $499,999.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Sector: Chemical Technologies

SBIR Phase II: Selenium Biopolymer Spacers to Prevent Biofouling of Reverse Osmosis Modules

This Small Business Innovation Research Phase II project will build upon the data compiled during Phase I in which Selenium Ltd. worked with university and commercial partners to develop a novel anti-biofouling technology to be deployed in water filtration membranes and membrane spacers. The technology explores the use of organo-selenium compounds and their ability to generate reactive oxygen species (ROS) while being covalently bound to a substrate. As biofouling remains one of the largest problems to be solved in water filtration, the integration of the proposed technology into numerous filtration components at the point of manufacture emphasizes the technology's flexibility and capability to mitigate this problem in a commercially viable and economic way. The objectives in this Phase II project will be to optimize integration strategy specific to the manufacturing parameters of each filtration component (i.e. feed spacers, polyamide reverse osmosis and polysulfone ultrafiltration membranes, etc.). Further objectives will be to integrate organo-selenium compounds into pilot scale modules, developing a data set measuring antifouling capabilities in real world scenarios with the help of commercial partners. Selenium anticipates the results of this project will concretely identify the technical integration strategy and added value for delivering produced water at reduced costs.

The broader impact/commercial potential of this project is based on the notion that mitigating the industry problem of biofouling will reduce energy and maintenance demand, thus decreasing the costs associated with water filtration and produced water. Furthermore, the technology has broad applicability to a number of other filtration markets such as pharmaceutical and oil and gas, which could benefit equally from the reduction in biofouling. As the necessity to produce drinkable water from a growing number of sources emerges as a leading societal need, the ability to reduce costs positions the technology to be deployed worldwide allowing for populations across the world to benefit. By increasing the efficiency to produce drinkable water from sources such seawater and wastewater, water producers may produce drinkable water at reduced costs with less cleaning. The ability to combat biofouling continues to be an ongoing area of development. While a broad spectrum of technologies have been employed to explore antifouling properties, few have had much success. Should the technology substantially reduced the problem of biofouling while proving viable in the commercial manufacturing of filtration equipment, it could be considered one of the most influential innovations the filtration market has seen in the past decade.

Serionix Inc.

Phase II Award No.: 1256639

Award Amount: $464,720.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: Chemical Technologies

SBIR Phase II: Ion-Exchange Fiber Composites for Rapid and Selective Removal of Perchlorate from Water

This Small Business Innovation Research Phase II project will result in the continuing development of novel ultrafast, highly selective, high permeability ion-exchange fiber composites (IXFCs) for removing perchlorate from drinking water. The proposed material removes perchlorate 10-100 times faster than the best available technology and employs a low-cost production method compatible with widely available manufacturing equipment. Rapid contaminant removal is made possible by the use of micron-scale mass transfer distances; whereas commonly used beads and granular media are limited to much larger sizes resulting in drawbacks such as difficult containment and enormous pressure drops. However, IXFCs display both high permeability and self-containment due to their permanently intertwined, self-supporting structure. Serionix demonstrated the feasibility of this technology in Phase I and will continue in the Phase II with the following key goals: 1) optimization of ultra-high capacity IXFCs for perchlorate removal; 2) design/build IXFC purification cartridges for evaluation by industrial partners; 3) identify and validate chemistries for complimentary IXFCs that are selective for heavy metals such as lead and mercury; and 4) produce IXFCs at a pilot scale and develop strategy for commercial production.

The broader impact/commercial potential of this research is the development and commercialization of a low-cost technology enabling regulatory compliance and improved protection of human health. The first targeted application is perchlorate, which the EPA is set to regulate in drinking water by 2014. This represents only the first commercial opportunity for a platform technology with the ultimate potential to transform the industrial and residential water treatment landscape. Future applications may include ultrahigh efficiency water deionization, softening, and industrial wastewater recycling, personal protective equipment and clothing, and high activity solid acid/base catalysts. Dissemination of data and interpretation will contribute to improved understanding of mass transfer characteristics in fibrous sorbent materials used in both water and air treatment.

Sigma Technologies Int'l Inc.

Phase II Award No.: 1127135

Award Amount: $494,796.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: Structural Multifunctional Composites with Energy Storage Properties

This Small Business Innovation Research (SBIR) Phase II project addresses the development of a multifunctional solid-state nanolaminate composite, which may function as a structural material while storing energy in the form of a rechargeable super-capacitor. A unique production process is used, where liquid monomer and aluminum wire are introduced into a process chamber that converts them into a multilayer composite with thousands of polymer and aluminum layers. Applications include storage devices for battery back-up and inverter circuits used in transportation and high energy density capacitors for extreme thermo-mechanical environments, such as aircraft, photovoltaics and aerospace. The Phase I development work demonstrated the production of large area (10sq.ft.) energy storage material. The nanolaminate material has mechanical properties that are close to a hard polymer laminate and energy densities which are an order of magnitude higher than conventional electrostatic capacitors and similar to those of electrochemical super-capacitors, with superior performance at temperatures below -20C and above +65C. The Phase II effort includes development work to optimize certain manufacturing methods, optimization of the polymer dielectric, packaging development, creation of specification sheets based on short and long term life tests and sampling potential customers that represent immediate and long term business opportunities.

The broader impact/commercial potential of this project is in the utilization of a new multifunctional material that can store energy. Such material may be integrated into a structure and save space and weight. It is a green product that requires no water or solvents to produce, it is recyclable and it does not involve the use or disposal of hazardous materials. Nanolaminate energy storage products will be based on mainly two materials, aluminum wire and acrylate monomers, which are commonly used to produce protective coatings for flooring, printing, furniture, window films, etc. Lightweight energy storage nanolaminates can replace double layer electrochemical super-capacitors that have severe temperature limitations and conventional electrostatic capacitors, in applications where volume, weight and thermomechanical constraints such as vibration and operating temperature are limiting factors. Capacitors produced using nanolaminate composites, are solid-state components that can electrically self-heal and have an open-circuit, or fuse-like safe failure mode, which is desirable in applications such as electric vehicles and aircraft, where safety of people in the proximity of a capacitor bank is of paramount importance. Multifunctional materials are expected to play a key role in the future in improving energy efficiencies and reducing dependency on fossil fuels.

SOLARNO

Phase II Award No.: 1127564

Award Amount: $534,953.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Chemical Technologies

STTR Phase II: High Energy and Power Density Supercapacitors Utilizing Electrodes Comprising Nanofibrous Carbon-Carbon Composites

This Small Business Technology Transfer (STTR) Phase II project will optimize the technology developed in Phase I for the fabrication of composite carbon nanofibers incorporating mesoporous high surface area carbon as an electrode material for supercapacitors utilizing ionic liquid electrolytes. The Phase I results showed that test devices incorporating our patent-pending carbon fibers have surpassed the performance of commercial supercapacitors and can provide energy densities approaching that of lead acid batteries with superior gravimetric power density. The technology is to be further developed and optimized using lower cost polymer precursors and carbon templates. Achievement of our Phase II goals of 30 Wh/kg at 10 kW/kg (packaged) with consistent performance up to 5x10^5 cycles means that this technology can become the material of choice for application to high-energy, high-power energy storage systems.

The broader impact/commercial potential of this project lies in greatly expanding the market for supercapacitors for existing products and enabling new technologies, especially in those areas requiring energy densities that are higher than those provided by current supercapacitors. Such supercapacitors will be well suited for application to the Hybrid Electric Vehicle (HEV) market, including rapid charging stations; frequency regulation for the electric grid; and load leveling for renewable energy sources. Direct societal benefits will come from improving the viability of HEV due to reductions in fossil fuel consumption, improvements in power grid reliability, reducing costs for renewable energy production, and in replacing lead acid batteries. The world demand for supercapacitors is expected to reach $1.2 billion by 2015.

Sustainable Innovations, LLC

Phase II Award No.: 1229945

Award Amount: $439,346.00

Start Date: September 15, 2012
End Date: August 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Efficient Separation of Hydrogen From Reformate

This Small Business Innovation Research (SBIR) Phase II project investigates the viability of an electrochemical device for separation and compression of hydrogen from low-pressure mixed gas streams that are critical for industrial gas and energy applications. Previous studies have shown that hydrogen derived from reformation of hydrocarbons produces a gas stream rich in CO2, CO and H2. It has been well- documented that low-temperature electrodes similar to those used in these devices are often contaminated by carbon monoxide, negatively affecting their operation. While state-of-the-art solutions rely upon implementation of advanced catalysts or high temperature membranes, these solutions are not viable for systems having significant levels of CO in the feed stream. Specifically the project will focus on solving electrode contamination issues through a series of design modifications; allowing the system to operate continually at high efficiency. Research efforts will leverage results from a fluids transport model to optimize the cell and system design. Laboratory cells will be constructed and evaluated over a range of operational parameters to develop a better understanding of the performance improvement associated with this approach. This program will culminate in the construction of a fully-integrated system package that will be tested and validated with real-world reformate chemistries.

The broader impact/commercial potential of this project relates to the fact that depletion of fossil fuel reserves and a global requirement for the development of a sustainable economy, the prospect of hydrogen-based energy is of growing importance. Production, purification and compression of hydrogen represent key technical challenges for the implementation of a hydrogen economy, especially in the transportation sector where new sources and modes of delivery of hydrogen are needed. These technologies must be robust, efficient, and cost effective in order to have value in meeting our energy needs. Since hydrogen energy markets are emerging, viable product solutions must meet near-term industrial needs as a commercial bridge toward low-cost energy products. The current market for hydrogen is large and growing, with the vast majority of hydrogen produced from hydrocarbon sources resulting in gas streams containing appreciable quantities of CO and CO2 and hydrogen. Current methods for separation and compression of hydrogen are very expensive and these costs are passed to the end-user. Successful development of the proposed technology will integrate the separation and compression functions, and expand the applicability of this device to separation of reformate and other mixed gas streams in a low-cost configuration which offers significant commercial appeal.

Symbios Technologies LLC

Phase II Award No.: 1256582

Award Amount: $401,026.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: Chemical Technologies

SBIR Phase II: Advancing a Novel Low-voltage Electric Arc Method to Oxidize Organic Material in Contaminated Water

This Small Business Innovation Research (SBIR) Phase II project will support the final development and commercialization of Symbios Technologies plasma treatment system to allow produced water in the oil and gas industry to be effectively treated, thereby allowing its safe discharge to surface waters or recycling to stimulate production in new wells, rather than being disposed of in injection wells. Produced water is the water brought to the surface, with or without hydraulic fracturing, along with the intended fuel products during extraction of oil, gas, and coal bed methane from formations underground. In general, produced water is contaminated with hydrocarbons, salts, and harmful microorganisms, meaning that it must be treated before it can be discharged or reused for agriculture and other purposes. This is an important environmental, public safety, and economic problem in the US. Research conducted during this project will be used to evaluate reactor improvements including process sensors and control systems, electrode geometries and surface coatings, degradation of contaminants in produced water, field testing, and techno-economic modeling. The anticipated technical results are that the Symbios plasma system will degrade hydrocarbon contaminants and kill microorganisms in frac flowback or produced water, leaving the waters suitable for safe reuse or discharge.

The broader impact/commercial potential of this project is that it will facilitate cleanup and reuse of a critical resource, water, in the oil and gas production industry, with crucial societal benefits for protecting the environment, guarding human safety, and keeping domestic energy costs down. The proposed technology is based on an innovative, low-voltage plasma discharge that creates powerful oxidizing species for destroying biological and chemical contaminants in produced water. Symbios Technologies has developed relationships and executed agreements with key companies in the produced water treatment field, which have identified numerous near-term business opportunities and provided crucial insights into preparing the technology for commercial success during Phase II. The customer-centered emphasis on solving water contamination problems in the oil and gas industry, which was estimated to have a global market size of $45 billion in 2010, will result in a high likelihood for commercial success. The Phase II R&D plan will enhance scientific and technical understanding as well as commercial impact by addressing reactor improvements pertaining to corrosion resistance and automated operation for a market-ready system, treatment of microbial and organic contaminants in produced water, on- site testing, and demonstration of economic competitiveness of the developed system.

Thule Group of Consultants Inc

Phase II Award No.: 1127180

Award Amount: $504,884.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: Chemical Technologies

SBIR Phase II: On-Farm Algae Production for Livestock Feed and Biofuel

This Small Business Innovation Research (SBIR) Phase II project plans to refine and test prototype facilities for commercialization of on-farm algae production and harvesting. Algae will be utilized initially for livestock feed and in future for bio-fuel. The project targets an emerging global market for construction of on-farm algae infrastructure. At the consumer level, the market is driven by favorable consumer response to Omega-3 health benefits in meat, milk, cheese and eggs.

The broader impacts of this research are: to increase scientific and technical knowledge of algae production for animal feed; to grow, harvest and utilize algae strains that might otherwise be overlooked; to improve consumer health, especially cardio-vascular health, and reduce obesity; to meet the demand for algae in livestock feed; and to construct algae facilities which will be able to expand into bio-fuel production when oil extraction technologies mature. On-farm algae production conserves energy and protects the environment by using less water, fuel, and fertilizer than land-based farming.

Torrey Hills Technologies LLC

Phase II Award No.: 1230135

Award Amount: $487,463.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Chemical Technologies

SBIR Phase II: Capture and Use of Coal Mine Ventilation Air Methane (VAM)

This Small Business Innovation Research Phase II project proposes to develop innovative technical solutions and products that reduce coal mine gas explosion. Methane explosion is the major cause of mining casualty and economic loss. The list of world coal mine explosion is a long and shocking one. Even today, 300 years after human's initial mining of coal, methane explosion still kills thousands of miners each year worldwide. Developed naturally within coal seams, methane is known for explosion hazard and chemical neutrality, which makes it highly dangerous but difficult to remove. Although modern technologies have been developed to pre-release methane or to dilute it by ventilation, it is practically impossible to eliminate the threat due to frequently occurred gas bursts and accumulation. Due to economic concern, mine owners and managers hesitate to take prompt action in response to each gas alarm. Sometime, their hesitation proved to be deadly. Torrey Hills invented a technology that can effectively capture methane from ambient atmosphere and convert it to safe chemicals, and thus can reduce explosion risk and operation shutdown loss to coal mine owners. The main features of the technology are room-temperature and room-pressure operation, complementary to ventilation, attendance free, and portable.

The broader impact/commercial potential of this project includes not only addition of economic value to coal mine owners and operators, but also contribution to the overall society wealth in a broader sense by reducing life loss and improving environmental protection. The world coal market is estimated to be $400-600 billion per year. According to World Coal Association, the direct economic loss caused by coal methane explosion is over $10 billion worldwide each year. Nevertheless, the broader indirect costs are difficult to measure, including loss of life, hardship on the affected families, disruption to the local business, legal burden on the companies, and associated costs to governments and the society.

Trillium FiberFuels, Inc.

Phase II Award No.: 1229948

Award Amount: $479,079.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Prakash Balan

Sector: Chemical Technologies

SBIR Phase II: Xylose Isomerase from Marine Bacteria for Cellulosic Ethanol

This Small Business Innovation Research (SBIR) Phase II project will develop the xylose isomerase (XI) enzyme from a marine bacterium as part of a process to convert biomass to ethanol. Xylose isomerase converts xylose, the second most common sugar in biomass, into xylulose. Xylose is not fermented to ethanol by brewing yeast, but xylulose is. Previous XI enzymes are unable to work in conjunction with fermentation due to incompatibilities in pH and inhibiting compounds. The successful Phase 1 proposal identified this marine XI as capable of performing Simultaneous Isomerization and Fermentation (SIF) of xylose to ethanol. High efficiency conversion of xylose to ethanol can improve overall process yield by 20-40%. The Phase II project will optimize the production of the enzyme in native and high-productivity heterologous hosts leading to a low cost source of the new enzyme. The optimized enzyme will be further characterized and then produced in a 200 liter bioreactor to demonstrate scalability leading to commercialization.

The broader impact/commercial potential of this project is to enable the cost-effective commercial production of cellulosic ethanol. Ethanol from local cellulosic biomass is a sustainable transportation fuel that reduces greenhouse gas emissions by an average of 87% according to the Argonne National Lab's GREET model. The toxicity of tailpipe emissions are also reduced relative to petroleum-based fuels. As a domestic source of fuel, cellulosic ethanol adds to U.S. energy security and strengthens our economy. By creating jobs and recycling dollars into the U.S. economy, cellulosic ethanol improves the trade deficit and lessens the dependence on foreign petroleum. By developing a low-cost enzyme that is added directly to the fermentation, difficulties with genetically modified fermentation organisms are avoided. This not only simplifies the ethanol production process, but also reduces the GMO content of co-products that may enter the food chain.

United Environment & Energy, LLC

STTR Phase II: Waste Cooking Oil and Fly Ash Based Bioasphalt

Phase II Award No.: 1127426

Award Amount: $463,638.00

Start Date: December 1, 2011
End Date: November 30, 2013

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Program Director: Prakash Balan

Sector: Chemical Technologies

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a high performance, environmentally benign, and low cost renewable bioasphalt from recycled agricultural byproduct. The availability issue of petroleum based asphalt, along with the high cost of petroleum and the fuel price to transport the asphalt from a centralized refinery plant to distribution sites, has increased the price of asphalt substantially. The use of the petroleum asphalt also generates hydrocarbon fumes, which irritate workers and create a nuisance for the surrounding community. Because of concerns over dependence on foreign oil, a high asphalt price and unstable supply, and air emissions, non-petroleum based bioasphalt made from renewable sources needs to be studied and developed. In this Phase II research, the bioasphalt production technology developed in Phase I will be scaled up to produce samples for evaluation in the field. The commercial viability of this technology will be demonstrated.

The broader impacts of this research are the use of a renewable and agricultural based product to reduce the use of petroleum asphalt, eliminate the odor and emissions associated with traditional petroleum asphalt, and improve the product performance.

DAST, LLC

Phase II Award No.: 1256634

Award Amount: $500,000.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Program Director: Jesus Soriano Molla

Sector: Environmental Technologies

SBIR Phase II: A Microbially-Based Process to Produce a High-Quality Soy Protein Concentrate for Complete Fish-Meal Replacement in Aquaculture Diets

This Small Business Innovation Research (SBIR) Phase I project will develop a process to produce high quality soy protein concentrate (HQSPC) as a fish meal replacer in aquaculture feeds, while providing a binding agent for extrusion and an immunoprophylactic for disease control. Increased demand for fish protein and reduced wild captured fish has facilitated rapid growth of aquaculture (9% per year). This has dramatically increased demand for fish meal (the primary component in aquaculture feeds), causing overexploitation of this resource and rapidly escalating prices. There is considerable market opportunity for a high quality, economical plant protein concentrate to completely replace fish meal in aquaculture feeds, thus providing broad impact. The proposed innovation is a microbially-based process to economically produce HQSPC by converting soybean carbohydrates into protein, yield an exopolysaccharide for pellet binding, and provide an immunoprophylactic. Phase II objectives include generating sufficient quantities of HQSPC for feeding trials with yellow perch to assess technical and economic feasibility. The HQSPC is anticipated to have >70% protein to replace fish meal, while providing desirable growth rates and conversion efficiencies. Bench-scale production costs should be less than current SPC ($0.30/lb), but with an intrinsic value closer to that of soy protein isolate ($1.50/lb).

The broader impact/commercial potential of this project is to improve the nation's second largest trade deficit for natural resources, fish protein, by providing a complete fish meal replacement. Soybean meal or soy protein concentrates (SPC) have been used to partially replace fish meal, however the solvent extraction process used to produce SPC is expensive, the separated oligosaccharides do not have a valuable use, and the quality of SPC (65% protein) is insufficient to permit complete replacement of fish meal. Soy protein isolate (90% protein) requires a more costly protein extraction method. The proposed microbial process converts soybean carbohydrates into additional protein, along with sufficient gum to serve as a binding agent, and a probiotic to induce an immunostimulant effect. Preliminary data shows the proposed microbe will metabolize the individual carbohydrates in soybeans, which will enhance scientific and technological understanding of this mechanism. To demonstrate technical and commercial feasibility, extrusion and enzymatic saccharification will be used to solubilize carbohydrates in soybean white flake, followed by incubation with the gum producing microbe, and recovery of solids for use in yellow perch feeding trials. International aquaculture feed manufacturers would be prospective customers for the HQSPC or the conversion process itself.

Dynamo Micropower

Phase II Award No.: 1256632

Award Amount: $500,000.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Program Director: Ruth M. Shuman

Sector: Environmental Technologies

SBIR Phase II: A Novel 10 kW Micro-turbine for Distributed Generation Applications

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a low-cost 10kW micro-turbine power generator that provides the basis for portability, fuel flexibility, and reduced maintenance of conventional turbo-machines at a cost that is competitive with reciprocating engines. Current micro-turbines have prohibitively high costs due to complicated geometry and materials, but the proposed research will develop a micro-turbine with significantly lower manufacturing costs using a novel layered stackable architecture for the core micro-turbine engine. The primary research objectives are 1) to optimize micro-turbine components within the framework of the new proposed geometry using a combination of in-house numerical analysis and computational fluid dynamics, 2) to design application-specific peripherals and user interface for power generation at oil and gas wells - the proposed entry market, and 3) to build and test a field-ready prototype to validate the engine design and benchmark engine performance. The result of the proposed project is a compact, and low-maintenance 10kW micro-turbine power generator that will be produced for lower than $500 per kW.

The broader impact/commercial potential of this project is greatly increased commercial viability of micro-turbine power generators. The primary advantages of micro-turbines are portability, fuel flexibility, and low maintenance. Micro-turbines do not have significant market share due to prohibitively high upfront costs, but the proposed technology will bring costs down and enable micro-turbines to gain significant traction in many markets, including emergency response, oil and gas well power generation, and other remote/distributed power generation applications. Due to their portability, micro-turbine generators can be deployed quickly in emergency situations. Due to their fuel flexibility, implementing micro-turbines can significantly reduce the costs associated with the fuel supply chain, for example, associated gases that would otherwise be flared at oil/gas wells can be used to power equipment onsite. Due to their low maintenance, microturbines can be adopted where operating costs can be prohibitive for reciprocating engines. Lastly, the proposed project will lead to reduced carbon footprint by efficiently using fuel that would be otherwise wasted (as in the case of flare gas), reduce other toxic emissions via more efficient combustion.

EnSolve Biosystems, Inc.

Phase II Award No.: 1152257

Award Amount: $445,278.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Environmental Technologies

SBIR Phase II: Biological Treatment of Hydrocarbons in Shipboard Exhaust Gas Cleaning Systems

This Small Business Innovation Research (SBIR) Phase II project will address new regulations being enacted in the shipping industry requiring Sulfur Oxides (SOx) reduction from engine emissions. Many commercial scrubber systems effectively remove SOx from engine emissions, yet none are designed to remove polycyclic aromatic hydrocarbons (PAHs). EnSolve's approach is to develop a combined biological and mechanical system that can remove PAHs from the scrubber system waste water. The results of the Phase I study confirmed the biomechanical approach was effective in reducing PAHs at rates exceeding 99%.

The broader impacts of this research will be to provide the maritime industry with a cost effective, reliable, and environmentally conscious treatment system for removing toxic substances from the world's oceans. Ships will be required to either install scrubbing equipment or they will need to switch to more costly low sulfur fuels. A switch to low sulfur fuel would increase current fuel costs by over 88%. A commercial ship owner could realize annual savings of $2 million per vessel in fuel costs using a scrubber system compared with purchasing low sulfur fuel. An estimated 35,000 ships will be impacted by these regulations, yielding a market opportunity for the proposed scrubber water treatment system exceeding $5 billion. Other technologies under development utilize pure physical separation methods that transfer the contaminants from the scrubber water to another medium (i.e., filters) for disposal. Conversely, the proposed biological approach is a regenerative process that would significantly reduce landfill disposal, consumable, labor, and liability costs.

Green Revolution Cooling, Inc

Phase II Award No.: 1127222

Award Amount: $460,695.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Environmental Technologies

SBIR Phase II: Fluid Submersion Cooling for Energy and Cost Efficient Data Centers

This Small Business Innovation Research Phase II project proposes to commercialize liquid submersion cooling for computer servers. Liquid submersion cooling involves submersion of heat-generating components in a non-electrically-conductive liquid, replacing air as the heat transfer medium. Liquid is significantly better than air to transfer heat, but historically has required cost-prohibitive capital expenditures due to the added complexity of previous liquid cooling architectures. The research objectives are to produce a system capable of being mass produced at low cost, and with compelling system features that drive customer demand.

The broader impact/commercial potential of this project includes lowering of one of the largest marginal contributors to US electricity use. The EPA estimates that data centers now use nearly 3% of US electricity, up from nearly 1% in 2000, with nearly half of power being driven by using air as the primary heat transfer medium. This high-efficiency system offers the potential to cut total energy use by nearly 50% by nearly eliminating energy for cooling and reducing server power through internal fan removal, while offering higher cooling performance and lower costs. Also, this new heat-recapture system offers the potential to eliminate nearly all server energy in many locales. Alternate cooling solutions that are cost effective only offer marginal improvements, and as computing becomes a larger part of the economy, the search for more energy and cost efficient technologies will become more critical.

MetaMateria Technologies LLC

Phase II Award No.: 1152676

Award Amount: $500,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Environmental Technologies

SBIR Phase II: Waste Water Phosphorus Removal Using Nano Enhanced Reactive Iron Media

This Small Business Innovation Research (SBIR) Phase II project will continue development and commercialization of a nano-engineered high capacity sorption media for removal and recovery of phosphorous from water. This media addresses issues caused by nutrient-related pollution, which significantly affects drinking water supplies, aquatic life and recreational water quality. Phosphorus comes primarily from agriculture and waste treatment sources, including on-site generated wastewater and is the limiting nutrient that usually controls eutrophication in temperate climates. Better, low maintenance/ lower cost approaches are needed to reduce discharge levels. In Phase I, the feasibility of a high performance phosphorous removal media was demonstrated, showing a sorption capacity that is significantly greater than other media reported in the literature. The feasibility of phosphorous recovery and media regeneration was also shown. In Phase II, the sorption of the media will be improved further and will be tested in both the laboratory and as add-on tertiary systems that will be designed, fabricated and operated in the field with the help of commercialization partners. Scale up of manufacturing and regeneration processes will be examined. Successful completion will lead to a superior phosphorous removal media and data required for commercial introduction of products that are needed for wide scale commercialization into the market.

The broader impacts of this research are that phosphorus originating from smaller on-site wastewater systems and water runoff from agricultural and other locations is becoming recognized as a major cause of impairment to streams and lakes and degradation of the water bodies like the Florida everglades. Efficient, low maintenance technologies are needed to reduce discharge levels and a lack of effective solutions exists today. Removing phosphorus is common at municipal wastewater treatment plants where chemical flocculation is available, but such approaches are impractical for dispersed sources of generated wastewater. Lower cost approaches are also desirable for these municipal treatment plants. This new media will have a much higher capacity and longer life. This will provide an economic alternative to mitigate the negative effects that phosphorous has on the environment and will offer ways for recovering the economic value of the phosphorous, a non-renewable resource that is necessary for food production and which is becoming limited in supply. Further development and optimization is warranted to move toward verification in field trials that will accelerate the commercial use of this new phosphorous removal technology.

NanoVoltaix, Inc.

Phase II Award No.: 1152665

Award Amount: $500,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Environmental Technologies

SBIR Phase II: Development of Nanoporous Geopolymer Composites as Adsorbent for Arsenic Removal

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of a novel, environment-friendly adsorbent material with low life-cycle cost for the removal of Arsenic from the water stream. The proposed material solution is based on a novel nanoporous geopolymer composite designed specifically for this application and manufactured via a patented, sustainable, and energy- and materials-efficient production process. During Phase II, the superior performance of the new media demonstrated at lab scale in Phase I will be further validated at the pilot scale. The anticipated results include 1) successful pilot production of the novel adsorbent to validate the cost advantages of materials; 2) successful validation of superior performance of the nanoporous composite at a pilot testing scale; and 3) further improvement of the product cost by using lower cost precursors.

The broader impacts of this research are (1) providing to the environmental remediation industry a new class of materials and novel platform technology that may be expanded to removing other water contaminants. The novel material will be offered to replace the existing sorbent media and will provide performance/cost benefits for residential and commercial systems with additional environmental advantages; (2) enabling the development of new fresh water sources currently unusable due to high Arsenic content in the US and developing countries; and (3) transforming the nanoporous materials production technology with a broad spectrum of critical clean tech applications, including energy efficiency (insulation and catalyst), energy generation, and energy storage.

Pearlhill Technologies, LLC

Phase II Award No.: 1151935

Award Amount: $475,946.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Ruth M. Shuman

Sector: Environmental Technologies

SBIR Phase II: Photochemical Reactor for CO2 Separation in Carbon Capture Process

This Small Business Innovation Research (SBIR) Phase II project will stimulate the acceptance of carbon capture by companies that own and operate coal-fired plants. The Department of Energy considers the amine absorption of carbon dioxide (CO2) from flue gas of coal-fired power plants as the most advanced, most well understood, and most successful method for carbon capture. In this process, monoethanolamine (MEA) solvent is used in a thermal process for desorption and carbon capture. Unfortunately, the thermal process is very inefficient, requiring a 30% increase in coal usage for to capture the CO2. The Phase I research proved the feasibility of replacing the inefficient thermal process with a new, innovative photolytic process that has the potential to dramatically cut the 30% increase in coal usage by more than half. The first part of the Phase II project will focus on developing an efficient photolytic prototype reactor that will dramatically reduce the costs of capturing CO2 as preparation for field tested at a power plant. The Phase II objectives will focus first on optimizing the reactor processes that affect desorption and capture. Then, using the resulting data, the team will design and build the prototype reactor.

The broader impacts of this research are that it has the potential to make carbon capture at coal fired power plants significantly more cost effective for the power producer. For example, by retrofitting the photolytic technology, a 100-500 MWe power plant could save as much as $17 MM annually. With this type of saving, an investment by a power plant in the photolytic technology is likely to produce a very high rate of return, whereby the cost of adding the photolytic reactor process could be recouped in approximately three years. The World Coal Institute reports that coal‟s share of global electricity generation is set to increase from 41% to 44% by 2030. In the United States, electricity generation accounts for approximately 40% of total CO2 emissions and more than 80% of these emissions come from coal fired power plants. Near-term CO2 capture technologies raise the cost of electricity (COE) produced at these plants by 60-90%, and impose a 25-35% parasitic coal-burning load. As the U.S. searches for ways to reduce CO2 emissions, maintaining coal as a viable source of low-cost electric power critically depends on finding more cost effective ways to capture the CO2 produced. The energy efficient photolytic process developed in this project has the potential of reducing the increase in the COE for carbon capture from the current 60-90% for the thermal process to less than 35%.

NSF SBIR/STTR

PHASE II GRANTEE CONFERENCE

ELECTRONICS, INFORMATION & COMMUNICATIONS TECHNOLOGY

RENAISSANCE BALTIMORE HARBORPLACE HOTEL • MAY 13-16, 2013

IMAGES AND CREDITS

Images from left:

Phase II # 0956630
Credit: ***QM Power Inc.****; Description: Commercial HVAC/Industrial Motor developed under the NSF SBIR Phase I and Phase II grants.*

Phase II # 0924010
Credit: ***Blendics, Inc.*** *purchased this photo from www.shutterstock.com to illustrate the challenges of operating electronic equipment in extreme cold. The photograph by ffolas is titled "Communication Mast in Winter" and is item #69970465; Description: Use of nanoscale digital systems in cold environments introduces new failure risks.*

Phase II # 1026435
Credit: iZotope, Inc. (courtesy of ***Imagine Research, Inc****.); Description: Computers are no longer deaf! iZotope MediaMined technology gives computers the power to listen and understand sound.*

Phase II # 1152467
Credit: Stephen Ambrose, ***Asius Technologies, LLC****; Description: This photo shows a hybrid in-ear monitor - hearing aid. This listening device was partially developed using NSF TECP funds and incorporates the Asius bubble technology that delivers superior comfort. The hybrid combines the high fidelity demanded by musicians with the health and safety aspects of a hearing aid. The hybrid in-ear monitor - hearing aid is a musical hearing aid – a device that provides hearing aid wearers the fidelity musicians require and the daily living benefits of a hearing aid with Ambrose Diaphonic Ear Lens.*

Agentsheets Inc.

Phase II Award No.: 1127398

Award Amount: $497,765.00

Start Date: August 15, 2011
End Date: July 31, 2013

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Sector: Education Applications

SBIR Phase II: A Collective Programming Environment for the Social Exploration of Computational Thinking through Games

This Small Business Innovation Research Phase II project seeks to build a system called CyberCollage as a Social Cyberlearning tool to support computational thinking in STEM education. CyberCollage will enable collective programming of educational games and STEM simulations through a unique combination of networked real-time collaboration mechanisms and Web-based social end-user programming. For example, multiple students can work together on a Frogger game. While one student may be programming the frog, a different student might be working on the turtles. Similarly, students can collaborate on science simulations that explore STEM related questions such as "can your frog live in my pond"? Phase I established technical feasibility, and showed that complex science simulations with tens of thousands of agents can both run efficiently and be created collaboratively by students working together, locally, in the same classroom, or separated by hundreds of miles. Phase II will establish CyberCollage as a scalable cloud-based implementation of a Social Cyberlearning tool, and will integrate embedded assessment mechanisms that make learning outcomes in computational thinking both measurable and predictable. These assessment mechanisms enable the investigation and study of computational thinking transfer evidence between game and STEM applications.

The 2010 PCAST report asserts that computational thinking is one of the fundamental concepts of networking and information technology. Fluency in computational thinking is needed to prepare today's students to be the next generation of innovators and professionals. The proposed combination of high accessibility through Web interfaces, increased motivational prospective through social interfaces, and tested curriculum integrated into required computer education middle school courses is likely to reach a vast audience and attract both women and underrepresented communities to information technology courses and fields. This reach is enhanced by the participation of the National Center of Women in Technology (NCWIT) and Google in the Phase II advisory board. Both organizations are already disseminating AgentSheets Inc. computational thinking resources, which is an extremely positive indicator of a high probability of broad impact and commercial success. The CyberCollage project has established access to disadvantaged communities that include inner city, remote rural, and Native American schools in Alaska, Colorado, South Dakota, Texas and Wyoming. These and other schools will serve as testbeds. A pledged investment by a third-party organization should establish a consumer-oriented extension of CyberCollage, making Social Cyberlearning of computational thinking relevant beyond its original scope of educational applications.

ApprenNet LLC

Phase II Award No.: 1229941

Award Amount: $500,000.00

Start Date: August 1, 2012
End Date: July 31, 2014

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Sector: Education Applications

SBIR Phase II: Crowd Sourcing Apprenticeship Learning: Law-Meets - A Web Platform for Teaching Entrepreneurial Lawyering

This Small Business Innovation Research (SBIR) Phase I project is directed to the development of LawMeets, a web-based platform for teaching lawyering skills through virtual apprenticeships. LawMeets use an innovative pedagogical method that combines performance-based learning, algorithm-based peer-to-peer review and expert video demonstrations to replicate the benefits of high-cost, one-on-one apprenticeship learning but at low-cost and at scale. The target market for LawMeets is the quarter million novice lawyers who need to develop practical skills to become valuable members of the profession. In beta tests with hundreds of students at dozens of different law schools, LawMeets have proven to be engaging, effective and easy to use.

The broader impact/commercial potential of this project lies in the role transactional lawyers play in society. Skilled "deal" lawyers are a critical ingredient in the entrepreneurial process and, therefore, essential to the economic growth that relies on a vibrant entrepreneurial eco-system. Both law schools and legal employers have long struggled with how to teach the lawyering skills that mark an entrepreneurial lawyer as a master. Law schools have launched various experiential learning initiatives, including clinical offerings and simulations. Law firms have experimented with similar training programs. While improving learning on the margin, none of these efforts has had a fundamental impact. All rely at their core on the traditional model of student-teacher interaction. Various on-line tools offer resources for acquiring substantive knowledge but lack the interactive component that leads to the development of the cognitive capacities that make up true expertise. None of the solutions offers a low-cost, scalable vehicle for tapping the reservoir of expertise found among the community of senior practitioners. The goal for LawMeets is to provide low cost "hands-on" learning at scale and to become the dominant vehicle for practical skills instruction in both law schools and law firms.

Arqball LLC

Phase II Award No.: 1256419

Award Amount: $489,660.00

Start Date: February 15, 2013
End Date: January 31, 2015

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Sector: Education Applications

SBIR Phase II: Interactive 3-D Technical Illustrations for Science and Engineering

The Small Business Innovation Research Phase II Project will develop tools for creating, displaying, and publishing interactive 3D content. The resulting technology will empower educators, students, publishers, and businesses to easily produce interactive 3D illustrations for digital books and online education materials. A unique approach to this long-standing content creation problem centers around the use of Image-Based Modeling and Rendering (IBMR), which enables the creation of highly realistic digital 3D models using commodity smartphones instead of the complex dedicated hardware systems traditionally required. Building on technology developed during the associated Phase I Project, this research aims to: develop new algorithms for creating interactive illustrations that place fewer assumptions on the hardware used to create them, develop algorithms for extracting 3D geometry from image sequences, and develop new methods for capturing unique panoramic image sets that can be used in an educational context. The resulting technology platform will make interactive 3D content widely-accessible by significantly reducing the expertise and cost currently required during its creation.

The broader/commercial impact of this project is to make user-generated 3D content part of the revolution in digital and online education by simplify the creation process and making it widely accessible to a non-technical audience. The core technology developed in this proposal has application areas spanning from education and cultural heritage to consumer marketing and advertising. This project also includes specific outreach activities that will benefit the local community while bringing the resulting technology to the attention of the wide audience that can benefit from user-generated 3D content.

Barobo, Inc.

Phase II Award No.: 1152678

Award Amount: $516,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Education Applications

SBIR Phase II: Commercial Development of An Intelligent Modular Robot Platform for Research and Education

This Small Business Innovation Research (SBIR) Phase II project will study the feasibility for commercialization of an intelligent reconfigurable modular robot system called iMobot, which was originally developed at the University of California, Davis. Robotics has grown beyond automation to encompass systems that are self-reliant, reconfigurable, mobile, intelligent, and aware of their environment. iMobot has four degrees of freedom capable of full mobility and assembly into clusters. Because of its flexibility, modularity, and reconfigurability iMobot is an ideal platform for many research and teaching programs at colleges and universities. iMobot allows researchers to study artificial intelligence, swarm technology, robot collaboration, mobile networking, sensor fusion, gait simulation, and programming for re-configurability. Each module has am open architecture, with a processor capable of embedded Linux. Users can customize software and accessories for their specific needs. Proposed product feasibility research includes adaptable connectivity between modules, intelligent plug-and-play sensors, a robust and lightweight chassis, along with re-configurability. In this proposed Phase II project, a professional design team will develop necessary technology related to assembling into clusters including mechanical design, electrical interface, sensors, algorithms, control and control software and customer interface.

The broader impact/commercial potential of this project is great. This proposed project will be one of the first attempts to scale up an intelligent reconfigurable modular robot for commercial deployment. The initial market for iMobot will be for university research and teaching. With a standardized hardware base using an open architecture users will be able to more widely share their work with each other, and create a valuable open educational resource. The future release of different iMobot versions will be for life-saving rescue and search operations in the first responder system, and for K-12 education. Robotics is an interdisciplinary field. The unique full mobility and reconfigurability of iMobot are very appealing. Modules can be used alone or in collaboration with others, making it a flexible and scalable educational tool. Because of the homogeneous nature of modular robotics, the cost of manufacturing is reduced through production of a large volume of similar parts. By introducing students to interesting robotic projects with affordable hardware platforms, which involve a variety of math, physics, information technology, and engineering principles, we can excite their imagination and give them confidence to pursue STEM careers, especially for underrepresented and economically disadvantaged groups.

Filament Games, LLC

SBIR Phase II: Game-enhanced Interactive Physical Science

Phase II Award No.: 1230463

Award Amount: $500,000.00

Start Date: September 15, 2012
End Date: August 31, 2014

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Program Director: Glenn H. Larsen

Sector: Education Applications

This Small Business Innovation Research (SBIR) Phase II project will produce a set of engaging educational video games and associated teaching compendiums for middle school physical science classrooms that are optimized for students with diverse sets of learning needs, including those with learning disabilities and reading difficulties, via the application of the Universal Design for Learning (UDL) framework. Educational video games are the next generation of technology-enhanced instruction, with a growing body of research suggesting that game-based learning helps students think systemically, collaboratively, and creatively about Science, Technology, Engineering, and Math (STEM), while creating interest and motivation toward these topics that extends beyond the classroom. The company targets middle school since this is the critical period when students may begin to disengage from STEM topics. The process of developing the games will include iterative input from educators and students from around the country, from focus groups to classroom observation. The efficacy of the resulting set of games will be evaluated in a formal field test. This test will also provide evidence of the value of UDL in designing educational technology tools. The resulting product will be available for purchase via the SBIR's web store and distributed through the nation's leading educational websites.

The broader impact/commercial potential of this project is the development of a cutting-edge solution to a urgent need for more effective tools for teaching STEM subjects. The President's Council of Advisors on Science and Technology recently noted (2010) that while the United States remains at the top in STEM research, we are on the cusp of a stark decline over the next generation. American students are falling behind other countries in both STEM-related abilities and desire to enter scientific careers. By creating a game-centered physical science curriculum, teachers gain the tools they need to make STEM-subjects accessible and appealing to all students, building the next-generation's STEM workforce, and promoting scientific literacy among all citizens. Using the UDL framework and commercial-level production values, GIPS represents an important innovative to engage and empower students, including those who are disenfranchised by traditional STEM education methods. Indeed, advocates for students with disabilities point to the potential of UDL-enhanced games to increase the accessibility of learning materials for all students. This game-based learning solution will encourage students to apply the kind of creative thinking and ingenuity to STEM that will be the driving force behind the next generation of American scientific innovation.

Independence Science, LLC

Phase II Award No.: 1127412

Award Amount: $700,000.00

Start Date: November 1, 2011
End Date: December 31, 2013

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Program Director: Glenn H. Larsen

Sector: Education Applications

SBIR Phase II: Promoting STEM Education for Students Who are Blind or Print Disabled through the Development of the First Talking Pocket Size Scientific Data Collection Device

The Phase II project will produce technology to provide students with print disabilities (i.e., blindness, low vision, and learning disabilities that inhibit processing of text), who are commonly relegated to being passive observers in science classrooms, the ability to directly participate in scientific data collection and analysis. Science education involves the collection, manipulation, and examination of data, most of which is in visually based textual form, which is problematic for students with print disabilities. Project goals involve the development of non-visually-based technology for the collection and manipulation of data. The LabQuest, a popular scientific data-collection device used in many mainstream classrooms, is currently not accessible by students with print disabilities because it is operated through a text-rich, visual touch-screen menu. The focus is on making all features of the LabQuest accessible to students with print disabilities through fully incorporating text-to-speech software (resulting in an enhanced version of the Talking LabQuest developed during Phase I), non-visual collection and manipulation of data, the development of software interfaces between the Talking LabQuest and peripheral devices such as Braille note-takers (non-visually-based computerized devices frequently used by individuals with visual impairments for storing and manipulating data) and embossers for producing tactile graphs. All features, functions, and interfaces developed will be field tested by individuals with print disabilities for ease of operability. it is anticipated that individuals with print disabilities will be able to independently operate the proposed technology.

The commercial potential of this project concerns the inclusion in science, technology, engineering, and mathematics education and professions of a population that has typically been disenfranchised from these fields. Persons with print disabilities are underrepresented in postsecondary studies and careers in STEM fields. Behavioral research suggests that self-belief in one's capacity to independently function in a particular field is an important determining factor in whether one chooses that field as a career path, and that hands-on experiences contribute to one's self-belief regarding the capacity to independently function. Data from Phase I are consistent with behavioral science research; specifically, it was demonstrated that the technology can be independently operated by students who are blind or visually impaired to collect and manipulate data. Findings also indicated that these hands-on science experiences were associated with increased beliefs in students' capacity to independently function in science activities, increased inclination to consider postsecondary studies and careers in STEM, and improved academic outcomes. These data suggest that wide commercial availability of the proposed enhanced technology will help increase the representation of individuals with print disabilities in STEM studies and professions. Persons with print disabilities will be able to work independently in science classrooms and laboratories, and will be able to choose educational and career paths based on aptitude and interest. Because individuals with disabilities are frequently unemployed or underemployed and receive government assistance, their increased entry into STEM fields may reduce taxpayer burden.

Institute for Disabilities Research and Training, Inc.

SBIR Phase II: ASL Literacy Support System

Phase II Award No.: 1118610

Award Amount: $549,632.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Education Applications

This Small Business Innovation Research Phase II project will result in a robust assistive technology, cost-wise accessible to deaf individuals and their families/service providers, as well as businesses, which functions as: an instructional tool to improve the literacy of deaf children and adults, and a real-time translation device (i.e., between American Sign Language and English). The technology will accommodate a variety of input and output options: Input: (1) typing, (2) scanning, (3) screen text transfer, (4) sensor-enabled glove (the AcceleGlove), (5) 3-D camera, (6) speech recognition; and Output: (1) text, (2) sign graphics, (3) sign video clips, (4) speech.

The Instant ASL Communication System, as it is called, has two access modes: DVD, Web or local server-based access. This hardware/software system also will enable the user to edit, print, select appropriate signs when more than one match the English word and vice versa, 'hide' signs when support is not wanted, retrieve sign graphics/videos through an index, and generate flashcards and sign/word matching worksheets. The product will include a translation lexicon of 24,000 English words/phrases and 8,000 signs. Many deaf children are challenged by reading since this process largely depends on auditory understanding. Teachers of the deaf frequently reinterpret text into ASL or enhance it with signs to render it more comprehensible to their students. Research has shown that incorporation of signs with text provides a multimodal approach to the development of early literacy skills that utilizes multiple intelligences and learning styles.

The broader impact/commercial potential of this project is largely reflected in its effect on the Deaf community and those who interact with them. ASL is a visual/gestural language distinct from English. Many deaf people who rely on sign language do not have good facility with English. Because English is an auditory mediated language that depends upon phonological code, reading achievement scores of deaf children usually fall far short of those found among hearing children of comparable abilities. An interesting aspect of the low reading skill levels displayed by deaf students is that while they may not understand a sentence in print, they may understand it perfectly presented in ASL. This product will be tremendously useful to teachers, business personnel, speech/language pathologists, etc. who have a need to support understanding of English text with ASL signs for purposes of literacy improvement, curriculum enhancement, or communication. This product will enable English users to type, scan text, or paste screens text and have output in text with ASL graphics and/or video support. Inversely, deaf users will be able to sign to it and obtain English text and audio output. As a server-based translation service, there will be considerable impact on the ability of deaf individuals to be integrated into society at large for employment, education, and social purposes. Improvements to the AcceleGlove will have implications to other fields of R&D, such as robotics, telemedicine, virtual reality, and defense. The gesture library will have utility to other gesture capture strategies (e.g., camera-based).

IntelligentSimulations LLC

Phase II Award No.: 1230418

Award Amount: $456,657.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Education Applications

SBIR Phase II: Serious Gaming Platform for Mastering the Physician-Patient Diagnostic Interview

This Small Business Innovation Research (SBIR) Phase II project will complete development of the Artificial Intelligent (AI) Patient platform. This immersive simulation platform helps medical students hone their listening and rapport-building skills by interacting with "virtual" patients. The student asks questions and the video clip response from the patient depends on the specific question asked, how that question is asked, and when it is asked in the interview. If the student asks the wrong question, or asks inappropriate questions, then the patient will respond in a way that will prevent a positive doctor-patient relationship from developing. Because it combines video clips and artificial intelligence and is web-based, we anticipate that this training platform will teach a medical school student (and other health professionals) how to really pay attention to their patients, and that it will do so more effectively than other training products already on the market. In Phase II, we will complete the platform build, incorporate additional artificial intelligence and speech recognition capabilities, create versions of the platform that will work on smart phones and tablets, and develop a set of six patient scenarios. This work will result in a platform that closely approximates a natural conversational experience.

The broader impact/commercial potential of this project will be to achieve a significant advancement over currently available computer-based training and other instructional tools. Medical schools are experiencing a transition from passive to active methods of teaching, as professors and students both have the desire to replace passive learning methods of PowerPoint slides, lectures, and instructional videos with more interactive methods of learning. The active experience provided by the AI Patient platform will help students learn to be more effective listeners and better health practitioners, which will result in better patient outcomes. The platform will also allow researchers to track and measure the effectiveness of using this kind of training tool. By working with our medical school teaming partners (West Virginia University School of Medicine and the West Virginia School of Osteopathic Medicine), we will develop a set of scenarios that we can license to other medical schools. Sales to the medical school community will support the development of more medical scenarios and enable us to expand into other sectors - such as law enforcement, HR training, and social work - where trust and rapport-building skills are critical.

MammaCare Corporation

Phase II Award No.: 1230447

Award Amount: $479,223.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Education Applications

SBIR Phase II: Novel Tactile Online Nursing Trainer for Clinical Breast Exams

This Small Business Innovation Research (SBIR) Phase I project is about a devastating medical error that affects millions of women, a breast cancer that can be felt by hand but remains unconfirmed and untreated for months or years. Known as missed, palpable breast cancer, the cause is plainly, lack of training and skill. The result is delayed diagnosis for millions of women and disease that is more extensive, painful, and costly. Poorly performed breast exams also result in unnecessarily high rates of false positive findings, which means "detecting" disease that is not truly present. MammaCare scientists developed and standardized training and certification for nurses and physicians to perform proficient and effective breast exams. This training is taught by expert instructors who teach practitioners how to reliably detect small, suspicious breast tumors, about the size of a pea. However, this training is costly and time consuming. It cannot reach the thousands of nursing and medical students and practitioners who perform these exams.

The broader impact/commercial potential of this project is to reduce the toll of breast cancer by giving all nurses who examine women the skill to detect the smallest, earliest signs of the disease. To do this we created a new skill-based teaching technology using high-fidelity breast models, computers and the Internet to provide practitioners with essential breast exam skills. The training is self-administered, inexpensive, and effective. Our colleagues at the Mayo Clinic found that nursing students and nurses were much more accurate in detecting breast tumors after the training than they were before receiving it. The potential benefits of this technology for millions of women are reduced medical errors, improved breast cancer screening accuracy, and a better chance for disease-free survival.

Numedeon, Inc.

Phase II Award No.: 1256641

Award Amount: $500,000.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Program Director: Glenn H. Larsen

Sector: Education Applications

SBIR Phase II: Building K-5 mathematical fluency through curriculum-based puzzle games within a collaborative virtual world

The innovation of this Phase II project lies in the use of graphical, collaborative games within a virtual world environment to support math learning for elementary school students. This Phase II project builds upon Phase I development of prototype puzzle-based math games as an extension of a K-5 mathematics curriculum developed with prior support from the National Science Foundation and currently in use in K-5 schools. The games leverage puzzle solving, collaborative play, as well as puzzle creation to build mathematical fluency. Teachers and students in classroom as well as casual users tested the Phase I games and provided feedback that will inform the Phase II project. The Phase II project will involve development of more puzzle-based games with collaborative and creative components. It will also include an evaluation of the effectiveness of these games for math learning, as well as their ease of incorporation into classroom instruction. Phase II will also extend existing tools for training and supporting teachers in the use of these games for classroom instruction.

The broader/commercial impact of this project is a new form of interactive learning that integrates formal classroom-based instruction with informal game-based learning within a social online environment. This new form of interactive learning keeps pace with how students interact with technology and engages them to develop deeper understanding and fluency in the subject matter at hand through games and puzzles, collaboration and competition, as well as content creation and sharing. While this Phase II SBIR focuses on the application of these methods on mathematics, the research results will be useful as a model for other subject areas as well. As the $8.2 billion textbook market in the US enters the digital age, this project will set a standard for integrating existing curriculum with digital medium that goes beyond rote memorization and drilling to building mental infrastructure and in-depth understanding. In addition, the visual nature of game-based instruction will reduce barriers to use for bilingual students and those with special needs. Finally, the market potential of this project will benefit significantly from the development of new mechanisms to measure student outcomes articulated with online tools for teachers that provide professional development and support.

Quantum Simulations Incorporated

Phase II Award No.: 1230187

Award Amount: $378,528.00

Start Date: October 1, 2012
End Date: September 30, 2014

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Sector: Education Applications

SBIR Phase II: Artificial Intelligence Software to Tutor Literary Braille to the Blind and Visually Impaired

This Small Business Innovation Research (SBIR) Phase II project focuses on developing the first artificial intelligence (AI) educational software to tutor literary Braille to blind/visually impaired students. Braille is the primary medium for written communication for persons who are blind and there has been a dramatic decline in Braille literacy, negatively impacting academic performance, ability to navigate the everyday world and employment opportunities. The ability to bring proven effective AI technology to the table, which is unprecedented in this area of special education, will make a meaningful difference in providing equitable education opportunities to all students, as this project speaks directly to issues of basic literacy. The proposed intervention is an Internet-based adaptive learning system that provides expert instruction on demand during general and special education at school and at home. The software is supplemental to existing curricula, uses standard accessibility technology and integrates directly with existing lessons. In addition to improving learning outcomes for students, this project also includes support for mainstream teachers and teachers of the visually impaired (TVIs). To ensure the product is effective in real-world settings, ongoing formative evaluations with teachers/TVIs will be conducted and student outcomes will be measured during a year two field study.

The broader impact/commercial potential of this project will be the first-ever Braille education software based on AI, delivered on-demand through the Internet. The anticipated impact is that students achieve literacy and are able to perform at a higher level (e.g. academics, daily living, employment) resulting in improved quality of life and increased societal contributions. To have an impact, the product must be affordable, effective for a heterogeneous population in diverse learning environments, easy to use and easily accessed at convenient times and locations in informal and formal educational settings. In SBIR research supported by NIH, Quantum has successfully created the first-ever AI-based educational software that is accessible to the blind (in chemistry and mathematics). Furthermore, Quantum has patented and commercialized unique AI technologies in chemistry and accounting using a business-to-business licensing model that provides educational companies with first-to-market and strong sustainable advantages. This model engages the entire spectrum of educational vendors, offering breakthrough technology that permits increased market share for customers and rapid dissemination to end users. For this project, Quantum will partner with organizations with established channels, who distribute the software as an online service, such as the American Printing House for the Blind, a partner on this project.

Second Avenue Software, Inc.

Phase II Award No.: 1230334

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Education Applications

SBIR Phase II: Martha Madison's Marvelous Machines

This Small Business Innovation Research (SBIR) Phase II project proposes the development, testing and commercialization of a collaborative educational game aimed at middle-school physical science students that will improve educational outcomes and increase interest in STEM (Science, Technology, Engineering and Math) fields across a broad spectrum of students. Martha Madison's Marvelous Machines, a serious game based on pedagogical best practices, correlated to curricular standards and supported by lesson plans, challenges students to work as a team to solve progressively harder physical science problems. Sophisticated scaffolding guides learners and helps them achieve full potential by encouraging exploration yet minimizing frustration without giving the answer away. By tracking play mechanics, the game will test for student engagement, enhancement of scientific inquiry skills and knowledge of physical science principles. The game will cover a full year of physical science curriculum.

The broader impact/commercial potential of this project addresses a need to ignite interest in STEM study and careers at a critical time in students' education. There is a current lack of research-based, efficacy proven innovative digital STEM teaching materials. Research shows that middle school is a pivotal time for encouraging students to pursue math and science related fields. If interest and engagement in science are not maintained through middle and high school, successful pursuit of STEM fields drops significantly. Math and science assessment test results show that U.S. students consistently perform lower than international counterparts. In addition, women are significantly underrepresented in STEM careers, filling only 24% of STEM jobs while they hold 48% of all jobs in the U.S. Educational games provide a goal-driven, social framework for thinking about relevant topics and practicing skills. Through play and experimentation, games can provoke curiosity, enthusiasm and creativity about content. While games' merits for increasing engagement are clear, their role in improving educational content is even more important. As a scalable solution to a persistent problem, Martha Madison's Marvelous Machines has the potential to significantly impact U.S. learning and achievement in science.

Sheepdog Sciences Inc

Phase II Award No.: 1256609

Award Amount: $499,996.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: Education Applications

SBIR Phase II: Development of a Learning Tool that Enhances Memory During Sleep

The innovation uses custom hardware and software for accurate sleep classification in a cost-effective and durable design, as well as mobile "apps" to achieve memory enhancement by modulated consolidation (memC). By utilizing computer learning algorithms and models of the biological process underlying sleep, the innovation reduces the complexity of comparable systems. The system is tightly integrated with cloud systems to improve system performance for memory enhancement and reduce user experience complexity.

The broader/commercial impact of the work is to develop tools and methods to optimize learning for students and adults of all ages. Particularly of interest is to provide a new approach for K-12 students diagnosed with attention deficit hyperactivity disorder (ADHD). Sheepdog Sciences is developing a commercial system to be used by students during study times and during sleep. By monitoring sleep and delivering the appropriate interventions, students using the device will improve the efficiency of sleep and study.

The Athena Group Inc.

SBIR Phase II: Green Engineering Magnet (GEM) Project

Phase II Award No.: 1127544

Award Amount: $478,552.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Sector: Education Applications

This Small Business Innovation Research (SBIR) Phase II project proposes to research and develop the Green Engineering Magnet (GEM) Project in response to a national need to promote Science, Technology, Engineering, and Math (STEM) studies at the middle and elementary school levels. The GEM Project answers the question: How can one actively moti-vate today's young scholars to pursue STEM studies in a meaningful and sustained manner? The GEM Project uses the natural youthful attraction of green studies as a magnet to draw students into meaningful and relevant STEM studies. The Phase II GEM Project will frame an expanded list of Phase I STEM core topics and studies in the context of green engineering activities, providing students with authentic experiences that support the learning of STEM concepts presented in class. To achieve this goal, Athena will fuse together three powerful learning technologies beginning with immersive, high-value 3-D STEM simulators. Next, requisite data collection, display, and analysis activities will be channeled through virtual instrument portals that mirror real-world data collection activities. Lastly, software-enabled scenario-based learning motifs will be used to integrate, deliver, assess, and remediate content as authentic STEM activities. As a result, GEM students will engage in green engineering challenges by making observations, measurements, calculations, and choices based on sound science and economic and environmental costs, just like a green engineer.

The broader impact/commercial potential of this project is its support for middle school general science, earth science, and similar curricular offerings. In addition, GEM products will support teachers with activities having a green engineering emphasis. GEM Project users will benefit by becoming more capable and motivated in their in-class STEM academic studies, as well as being better prepared and interested in pursuing STEM careers and becoming more STEM-literate citizens.

Advanced Cooling Technologies, Inc.

Phase II Award No.: 1127293

Award Amount: $484,138.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Electronic Components & Devices

SBIR Phase II: Two-Phase Microchannel Heat Sink with Porous Layers Lining Channel Inner Walls

This Small Business Innovation Research (SBIR) Phase II project will develop an advanced heat sink and a two-phase pumped loop for cooling high power laser diodes and other high heat flux devices. An advanced coating will be applied to the heat sink to enhance the boiling process, suppress flow instabilities and improve overall heat sink performance. The objectives of this Phase II project are to: (1) develop and validate a two-phase heat sink model, (2) develop a system-level model for a two-phase pumped loop, (3) design and fabricate the heat sink and pumped loop system and (4) test the prototype loop in the laboratory and on an actual system. The key benefits of the technology include high heat flux capability and isothermal cooling. The system will be compact and designed such that it can be integrated with high heat flux components.

The broader impact/ commercial potential of this project will be to provide a new cooling solution for dissipating high heat fluxes in products used in the electronics and optoelectronics industries including compact high-power lasers. The technology developed will be capable of handling higher heat fluxes than those that can be managed with state-of-the-art, commercially available single-phase coolers. Moreover, the technology will not use refrigerants that have high Global Warming Potential. This program will also be performed in close collaboration with researchers at an academic institution and aide in the technical training of students in basic and applied research and new product development. The results of this study will be disseminated in the heat transfer community through conference presentations and journal publications.

Aquatic Sensor Networks

Phase II Award No.: 1026790

Award Amount: $499,720.00

Start Date: September 1, 2010
End Date: May 31, 2013

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Sector: Electronic Components & Devices

SBIR Phase II: Developing a Real-time High-data-rate Multicarrier Underwater Acoustic Modem

This Small Business Innovation Research (SBIR) Phase II project aims to develop a real-time high-data-rate multicarrier underwater acoustic modem for aquatic applications. The modem to be developed will achieve a data rate that is more than one order of magnitude higher than all competing commercial products in challenging shallow water environments. It will have robust error performance in the presence of impulse-like noise and undesired disruptions. In addition, the modem will be power efficient to sustain long operation time, have a user-friendly interface, and maintain an easily-extendable architecture to facilitate advanced networking functionalities. Bringing the advanced multicarrier technology into the underwater modem market, this project solves one long-standing problem in the field, i.e., making multicarrier modulation work in underwater channels (earlier attempts all had only limited success). With one order of magnitude data rate increase, this project will significantly advance the state-of-the-art in underwater telemetry.

The broader impact/commercial potential of this project is that the high-data-rate multicarrier underwater acoustic modem will significantly improve the operation of a wide range of aquatic applications, such as underwater environmental observation for scientific exploration, commercial exploitation, and coastline-protection/target-detection in military or anti-terrorism. It will also directly facilitate the development of emerging and fast-developing underwater wireless sensor networks and autonomous underwater vehicle networks. The significantly enhanced monitoring capability of aquatic environments will help us better understand and exploit the earth, preserve and protect it for our future generations. As more than 85% of underwater applications are envisioned to be in shallow water, this project will have enormous commercial impact in multiple market sectors including environment, energy, fishing, tourism, and national defense, etc.

Asius Technologies, LLC

Phase II Award No.: 1152467

Award Amount: $639,000.00

Start Date: May 1, 2012
End Date: October 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: New Technology for Coupling Sound to the Ear in Communications Devices

This Small Business Innovation Research (SBIR) Phase II project focuses on coupling sound to the human ear for communications devices (MP3, Bluetooth, hearing aids, headsets, earbuds) with unprecedented comfort, safety and audio quality. A chip-like device, the diaphonic valve, for harvesting energy from audio communications for the purpose of inflating a coupling device (balloon) in the user's ear has been demonstrated. This inflatable ear coupling mitigates excessive sound pressure levels that often occur within-ear listening devices, such as ear-buds and hearing aids, and which are a cause of audio fatigue and potential hearing damage. Diaphonic valve design has been dramatically improved making it smaller and more effective at pumping air. In this project, production of the critical diaphonic valve-chip component will be increased to a small scale manufacturing level. Additionally, the pressure and power utilization management hardware and algorithms to integrate the diaphonic valve and inflatable ear coupling (bubble) into commercial headsets, and hearing aids will be developed. Finally, work will be done on a non-inflatable ear couple technology, discovered during Phase I of this project, which also improves audio quality and hearing safety.

The broader impact/commercial potential of this project centers on revolutionary new person-to-audio couplings, based on an inflatable ear-piece, with applications in consumer audio, Bluetooth headsets, hearing aids, earbuds, and headsets for professional communications (pilots, law enforcement, military, etc.). This technology has the potential to improve peoples lives by reducing listener fatigue and hearing damage in the population using in-ear devices, as well as making hearing aids more comfortable and better sounding for people who already have hearing loss. Published results from Phase I have shown how existing ear coupling approaches can produce dangerous sound pressures in the ear canal and how the technologies of this project allow ear couplings that alleviate this problem. The first embodiment of this new technology to the market will be a basic version applied to consumer headsets (ear-buds). From there, more complex applications, such as hearing aids, will be addressed. The success of this project will create engineering and business sector jobs as well as manufacturing jobs. The project also includes funding for a high school student or college undergraduate to participate in the research and development activities.

Baker-Calling

Phase II Award No.: 1127487

Award Amount: $496,373.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Electronic Components & Devices

STTR Phase II: High Performance Piezoelectric MEMS Microphones

This Small Business Technology Transfer (STTR) Phase II project will develop a microphone for the test and measurement (T&M) market that utilizes piezoelectric microelectromechanical systems (MEMS) technology. During Phase I of this project, feasibility was demonstrated by building and testing a microphone with the necessary performance for this market. Specifically, this microphone has a noise floor that is 10 times lower than any piezoelectric MEMS microphone previously demonstrated. The unique device modeling and optimization that allowed for this significant performance improvement enables a new class of microphones. During Phase II of this project, the commercialization effort will be accelerated by partnering with a production foundry to develop a fabrication process, enabling the mass fabrication of these parts. Successful completion of this task requires the repeatable fabrication in a production foundry with yield exceeding 90%. This Phase II project also seeks to further develop self-calibration capabilities, building on a unique aspect of these microphones demonstrated during Phase I. Successful completion of this task will result in a microphone capable of determining its own sensitivity to within 1 dB of that determined by standard calibration methods.

The broader impact/commercial potential of this project is significant due to the widespread use of microphones in today's markets. This microphone's unique combination of device simplicity and high performance enables a new class of microphones that fills the gap between extremely low-cost microphones used in consumer electronics applications and extremely high-cost microphones used in laboratories and test facilities. Through discussions with manufacturers and end-users of microphones and related systems, the company have determined that a wide range of applications would benefit from such a device. These microphones will significantly reduce the cost of complex T&M systems such as arrays that can cost more than $1M and improve the accuracy of equipment used by noise control engineers, work safety inspectors, police officers, and many others. Further, this microphone technology not only has the potential to impact the T&M market, but provides advantages for the hearing aid and consumer electronics markets as well. The total addressable market for this technology is more than $2.5B.

Biorasis Inc.

Phase II Award No.: 1230148

Award Amount: $486,406.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Self Calibrating, Wireless, Needle Implantable Sensor for Continuous Glucose Monitoring

This Small Business Innovation Research (SBIR) Phase II project aims to develop a wireless, needle implantable miniaturized (0.5 x 0.5 x 5 mm) sensor for continuous glucose monitoring, with provisions for internal self-calibration that ultimately eliminates the need for frequent, external finger-pricking. As part of Phase I project, the internal calibration routine has been developed and its "proof-of-concept" has been demonstrated on an implantable glucose sensor unit operating in porcine serum for a period of 3 weeks. Along these lines, a proximity communicator (wrist-watch like unit) has also been developed which is in operable communication with the implantable unit. Phase II aims to further enhance the reliability of this calibration routine by demonstrating its efficacy in an in vivo environment (rat model) along with advancement of the proximity communicator unit in order to establish a two-way communication with a smartphone capable of real time data processing and implementation of the internal calibration routine. At the end of Phase-II, the completion of developmental activities for the self-calibrating glucose monitoring platform is envisioned, thereby, bringing it a step closer to commercialization in the pre-clinical animal research market (first market of Biorasis Inc.)

The broader/commercial impacts of this project are enormous considering that there is an urgent need for continuous glucose monitoring devices in view of the growing number of diabetic patients. Implantable glucose sensors that afford minimal user intervention present a viable alternative, although their "user-independent" nature is often undermined by the need for frequent external calibration via painful finger-pricking. The proposed project will result in a truly "user-independent" operation of implantable glucose sensors. The successful implementation of such an advanced glucose monitoring technology, which can also be adapted for the management of other disorders (such as obesity and cardiovascular complications) will pave way for new jobs in our Stare of Connecticut and neighboring regions in the sectors medical devices, wireless communication and biosensors. The project will be performed in the University of Connecticut (UConn) Technology Incubation Program (TIP) in partnership with UConn collaborators. This industrial/academic collaboration provides training for the graduate and undergraduate students in the field of biosensors, optical powering, chip design and wireless data communication and will motivate them to US industrial competitiveness.

Blendics, Inc.

Phase II Award No.: 0924010

Award Amount: $1,099,276.00

Start Date: September 1, 2009
End Date: June 30, 2014

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Sector: Electronic Components & Devices

STTR Phase II: Blended Clocked and Clockless Integrated Circuit Systems

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

This Small Business Technology Transfer (STTR) Phase II research project will develop and apply a principled design methodology to confront the serious problems associated with deep sub-micron, system-on-chip, integrated-circuit designs. The project will develop design services for companies wishing to market complex, proprietary, low-power integrated circuits through the development of a unique design tool, one which will apply a mathematically sound approach to the production of large, hazard-free, network-on-chip products. The goal for this tool is to reduce traditional design cycles by eliminating most of the global verification effort while improving the robustness of the design. New results in predicting the behavior of deep submicron arbiter circuits are essential to this work and will also be reported.

The broader impacts of this research are to reduce design costs, time-to-market and power consumption. More broadly this can: 1) significantly increase the productivity of integrated-circuit design engineers, 2) reduce power consumption of electronic control, communication and computational systems and 3) increase our competitiveness against off-shore system-on-chip designers particularly with respect to low volume products. Thus, successful completion of this project is important to the future of the national electronics marketplace because, without a major reduction in the time spent on global verification, the benefits of higher levels of integration, including reductions in time-to-market, conservation of power and increases in reliability, will not be available to many important electronics market sectors.

Bossa Nova Technologies LLC

Phase II Award No.: 1026525

Award Amount: $575,750.00

Start Date: August 15, 2010
End Date: July 31, 2013

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Sector: Electronic Components & Devices

SBIR Phase II: High Dynamic, Alignment Free Metrological Method for 3D Shape Measurement of Optical Surfaces Based on Polarization

This Small Business Innovation Research Phase II proposal aims at developing a new alignment-free metrological turn-key system dedicated to the measurement of optical surfaces with high measurement speed and high dynamic range. Next generation optical surfaces will need to be mass-produced with high departure from spherical shapes and high numerical aperture (Aspheric). Manufacturing these optical components is challenging because of today's limited metrology methods: contact sensors are too slow to be used in-process whereas interferometers and wavefront sensors have a small limited dynamic range and require careful alignment. The research objective is to design a prototype of a polarization based method and to evaluate its performances; speed, dynamic range, accuracy, insensitivity to alignment. The proposed approach combines an innovative polarization camera, a specific illumination, and a novel algorithm for automatic 3D shape extraction. The result of this research is to demonstrate that the proposed approach leads to very low sensitivity to alignment, fast measurement time, high dynamic range, and uncertainty smaller than current manufacturing tolerances. Preliminary simulations show that 2" diameter aspheric lens can be measured in 40 ms, with a resolution of 10,000 points, a dynamic range of 20 mm and an accuracy of 0.25 micron root-mean-square (RMS).

The broader impact/commercial potential of this project will address the growing manufacturing of aspheric optical components used for various applications: concentrating photovoltaics (CPV) for solar power generation, optical instruments, ophthalmic lenses and consumer electronics (cameras, phones). Controlling aspheric optical surfaces using current metrology tools is a time consuming process. Contact sensors are too slow and interferometers have tight alignment requirements and low dynamic range. The commercial potential of a system insensitive to alignment, performing fast measurements, with high dynamic range and good accuracy is extremely valuable for the following reasons. The system would allow mass production of high quality aspheric lenses with systematic inspection of each manufactured component. High numerical aperture lenses would also be measured easily in-process which will drastically increase productivity. This will translate into the faster deployment of cheaper, more efficient solar power production, lighter optical systems, and better corrected contact lenses. The present project will also have the broader impact of opening the door to a new kind of metrology based on polarization sensing, which could also be applied to many other industries such as plastics, steel, glass, automotive, robotics, surveillance and medical industries in the future.

Chiaro Technologies LLC

Phase II Award No.: 1127545

Award Amount: $508,000.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Program Director: Juan E. Figueroa

Sector: Electronic Components & Devices

SBIR Phase II: Ultra-high-speed 3-D imaging

This Small Business Innovation Research (SBIR) Phase II project will produce a commercial prototype of a new 3-dimensional (3-D) imaging technology capable of measuring 3-D surface profiles up to five orders of magnitude faster than existing techniques. 3-D imaging technology is increasingly used for many applications, but current approaches have slow acquisition speeds and cannot accurately measure certain types of objects and scenes. The proposed technology will dramatically advance the state of the art in 3-D imaging speeds from a few Megapixel frames per second up to MHz frame rates without sacrificing metrological precision. At the same time, this approach enables surface profilometry of objects and scenes that are difficult or impossible to measure with existing techniques. The approach uses an innovative projection system to illuminate a scene with patterned light and simultaneously acquire multiple images of the scene. The 3-D image is reconstructed from the acquired images using novel, robust, pixel-independent algorithms that improve accuracy for diverse illumination, object reflectivity characteristics, and minimize the number of images required for an object-independent reconstruction. This Phase II program will build on successful Phase I feasibility demonstrations to produce a complete system suitable for beta deployment at a customer site.

The broader impact/commercial potential of this project will emerge when the technology is used in applications that boost productivity, increase security, improve health, and advance the progress of science. Commercialization will initially target the research market, where scientists and engineers studying mechanics, aerodynamics, robotics, and ballistics require the ability to image dynamic systems in 3-D to validate models, to provide feedback in the design process, and to verify performance of prototype designs. A second target market is manufacturing, where trends towards 100% testing and increased use of 3-D measurements will drive the need for high-speed 3-D imaging capability to improve efficiency, quality, and yield. Beyond these markets, the proposed technology could serve a variety of other unmet needs for high-speed 3-D imaging, such as facial recognition, haptic vision for the blind, robotic navigation and object recognition, entertainment, and others. Because the proposed technology offers unprecedented measurement capabilities in terms of speed, resolution, and versatility, it holds the potential to reveal new phenomena that were previously inaccessible, giving researchers a new tool for understanding our dynamic 3-D world.

Chiral Photonics, Inc.

Phase II Award No.: 0849010

Award Amount: $1,099,988.00

Start Date: January 1, 2009
End Date: June 30, 2014

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Sector: Electronic Components & Devices

STTR Phase II: Chiral Long Period Grating Fiber Sensors

This Small Business Technology Transfer (STTR) Phase II project will develop a novel optical fiber sensor of temperature, pressure, extension, axial twist and various environmental factors, including liquid level, in harsh environments. The optical fiber sensor will be free of electromagnetic interference and of the hazard of igniting combustible fuels and will be capable of remotely monitoring temperatures up to and beyond 750 ¡C and of tolerating high-radiation levels. Conventional long period gratings fiber (LPGs) formed by exposing photosensitive doped optical fibers to patterned ultraviolet illumination cannot operate in harsh environments because of the fragility of the imprinted periodic structure. In contrast, the glass fiber in the dual-twist chiral fiber sensor (CFS) need not be photosensitive and will be chosen for its robustness. The chiral long-period grating (CLPG) structure of the CFS will be created in a glass-forming process in which signal and scaffolding optical fibers are twisted together to form a helix in the signal fiber as the fibers pass through a miniature oven. Transmission dips due to coupling of the light between the core and surrounding glass cladding by the chiral grating and their shift with environmental factors will be measured and calculated using an increasingly sophisticated sequence of perturbation theories.

The CFS based on the dual-twist CLPG structure overcomes the disadvantages of the LPG and of the CFS based on twisting single birefringent fibers. If successful it is ideally suited for demanding applications such as found in nuclear reactors, outer space, and oil wells, as well as in medical diagnostics and treatment and in the automotive and aerospace industries. The CFS may therefore become a pervasive part of modern technology and everyday life which relies increasingly on sensing and automated decision making. By substantially raising the operation temperature of optical fiber sensors, substantial savings can be realized. Conventional power generators could run at higher temperatures where they are substantially more efficient and the recovery rate in oil reservoirs can be increased considerably. The use of high-temperature and radiation-resistant CFSs in nuclear power plants can make these facilities more efficient and safe. The enhanced range of conditions in which the CFS can function relative to conventional electrical and optical sensors will have an impact across the economy and will make the CFS a rapidly growing segment of the multi-billion dollar sensor market. The novel glass forming fabrication methods and computational approaches may find use in diverse fields including photonics, microfluidics and medical diagnostics.

Dot Metrics Technologies, Inc.

Phase II Award No.: 0848759

Award Amount: $1,078,163.00

Start Date: February 1, 2009
End Date: June 30, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Ultraviolet Germicidal Optical Flow Cell

This Small Innovation Research (SBIR) project will bring to market a low power, point of use (PoU) water disinfection system designed to retrofit into existing passive (non-germicidal) filtration systems. This project will use ultraviolet light emitting diodes (UV LEDs) along with a novel and proprietary flow cell design, resulting in PoU water disinfection. Current ultraviolet PoU water disinfection is accomplished using discharge lamps, which requires high voltage, ballasts, and a relatively large form factor. The use of UV LEDs instead of discharge lamps will allow the light sources to reside inside a smaller form factor, and to function at lower overall electrical power, without line voltage and ballasts. Furthermore, the proprietary optical design of the flow cell will improve upon conventional flow cells by maximizing the ultraviolet dose received by microorganisms in the water, and increasing their residence time in the flow cell.

Currently, there are no PoU systems employing UV LEDs as the germicidal source. If successful, the product developed under the phase II program will be the first of its kind and provide a point of entry for UV LEDs into the large PoU water sterilization market. The low power aspect and small form factor of the flow cell will make the system potentially suitable for battery operated field applications where line voltage is not available. Such applications may include military or medical field operations. Overall societal impact should be significant, particularly in markets outside the United States where there is increasing concern about water sterility.

Energizing Solutions, Inc.

Phase II Award No.: 1230137

Award Amount: $499,982.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Proposal for Research into Low-Cost Distributed Wireless Sensing of Operational Condition in Industrial Electric Motors

This Small Business Innovation Research (SBIR) Phase II project will result in a commercially viable network of low cost wireless sensors that predict electric motor failure before failure occurs. American industries and manufacturers rely heavily on electric motors to power their equipment and processes. To minimize motor downtime costs, many use labor intensive preventative maintenance programs, manually inspecting motors on a fixed schedule. These inspections cost an average of $500 per motor per year, with 80% of that cost wasted. This waste can be eliminated through the use of sensors that monitor motor performance in real time, 24x7. Unfortunately, current systems cost thousands of dollars per motor on average. This is too expensive for most 1-150 HP motor applications, which comprise 98% of the motor market. This research will quantify and refine the performance of a low cost network of sensor nodes, and algorithms used by the nodes to predict motor failures, through controlled laboratory testing and field testing. It will also integrate vibration energy harvesting technology into the nodes. The result will be a network of sensor prototypes that are demonstrated to meet key performance and price metrics, and are commercially viable for use with 1-150 HP motors.

The broader impact/commercial potential of this project is that a prototype low cost sensor system will facilitate predictive maintenance of electric motors in US industrial and manufacturing facilities at a fraction of the cost of the current alternatives. As a result, tens of thousands of facilities around the US will be able to afford the initial investment to implement predictive maintenance on their motor systems, maximize up-time, and minimize motor maintenance costs. This will increase the competitiveness of these US industrial and manufacturing firms and ultimately help create and preserve American jobs. Additionally, the prototype system produced as a result of the research will provide an important proof-of-concept for low-cost, low-power wireless sensor nodes that should help spur future development and investment in this field, which is in turn instrumental for the development of "smart grids", "smart cities", and other intelligent infrastructure.

Hitron Technologies Inc.

Phase II Award No.: 1230389

Award Amount: $500,000.00

Start Date: October 1, 2012
End Date: September 30, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Liquid Crystal-based Next Generation e-paper Devices by Micro-engineered Surfaces

This Small Business Innovation Research (SBIR) Phase II project focuses on development of low power consumption, bistable memory nematic liquid crystal display (LCD) devices for e-book and mobile applications, based on the micro-engineered surface alignment (MESA) technology. The MESA-LCD innovatively implements new photoaligment materials and processes, combined with unique maskless UV pattern generator, to achieve bistability and performance requirements for portable devices. It is suitable for mass production and also on flexible substrates, also compatible with existing manufacturing infra-structure of LCDs. In Phase-I, the controlled weak anchoring have been successfully demonstrated, and the process has been developed to reduce the driving voltage by one order of magnitude. The main challenge in Phase-II is to reduce the driving voltage down to 0.1v/ìm. The main objectives and approaches in Phase-II are: (1) to develop a passive matrix MESA-LCD prototype (the first generation) for presenting to the potential investors; (2) to optimize the photoalignment process for driving voltage reduction, (3) to develop an active matrix MESA-LCD prototype (second generation) with the optimized photoalignment material and process, with establishment of large scale manufacturing processes. Anticipated Phase-II results would be the successful development of MESA-LCD prototypes for commercialization.

The broader impacts/commercial potential will be that the MESA-LCD related technologies will benefit from the low power, high contrast ratio and high resolution. Success of this project will enable a high performance and low cost MESA-LCD that have a significant market opportunity in mobile devices to bring users information and Entertainment, offer users a convergent display experience, with paper-like readability, significantly less power consumption, and video-rate response times. The most important market the MESA-LCD addresses is e-paper and e-book market. When the MESA-LCD based e-book and e-paper are fully developed, one device can hold tens or hundreds of books or content, decreasing the burden of students' backpacks, saving bookshelf space, and reducing shipping costs. Also huge amount of paper will be saved, which is a good contribution to the environment. Besides the e-book and e-paper market, MESA-LCD can also be used in various applications such as price tag and sale-announcement displays on shelves and throughout the retail stores, cell phones and other hand-hold devices, display products for security and hospitality, and display for industrial controls.

Imprint Energy, Inc.

Phase II Award No.: 1256631

Award Amount: $499,982.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Sector: Electronic Components & Devices

SBIR Phase II: Integration of Custom, Printable Batteries in Robotic Technologies

This Small Business Innovation Research Program (SBIR) Phase II project will expand the performance of a novel zinc battery chemistry which leverages a high conductivity polymer electrolyte, and further characterize the battery system to increase its commercial attractiveness to interested customers and partners, particularly for small portable and flexible electronics applications. The novel zinc battery chemistry is an ultrathin, flexible and rechargeable battery technology. This battery chemistry utilizes an air-stable, earth-abundant, robust, and non-lithium materials set that is manufacturable by print-based processing and is scalable to large dimensions with sheet or web manufacturing. The goals of this project are to increase understanding of this new battery chemistry, demonstrate and characterize its unique flexibility, scale the technology to pilot-level manufacturing, and improve its commercially relevant performance properties.

The broader impacts/commercial potential of this project are diverse. They include the establishment of new battery chemistry and manufacturing paradigm which can be disruptive to markets requiring novel device functionality and form factors. This technology also allows for significant reduction of the cost and environmental impact of batteries for growing and potentially ubiquitous application. Lastly, this new approach to battery manufacturing presents the opportunity to repurpose the printing industry to produce next generation batteries. Despite considerable prior work in the field of batteries, there is a large mismatch between available battery technologies and the performance, form factor, cost, and manufacturing requirements needed to serve as a platform battery system to power flexible and wearable electronics, robotics, sensors, energy harvesters, displays, and wireless electronics. The novel battery technology being developed in this project can alleviate these constraints and potentially revolutionize the portable electronic market to achieve new form factors, capabilities, and spur adoption into new application areas.

Iris AO, Inc.

Phase II Award No.: 1152710

Award Amount: $492,831.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: MEMS Deformable Mirrors for Laser Applications

This Small Business Innovation Research (SBIR) Phase II project will advance the state of the art in compact 360-degree camera systems, achieving sizes of about 1/8 of current systems, without compromising the quality or resolution of the optics. Convex mirror based optics has resulted in the realization of very high-resolution ultra-wide angle camera systems. A fundamental limitation in these systems has been the size of the optics in relation to the size of the imaging sensor. Mirror diameters in the range of 10 times the size of the sensor have been achieved. The objective of this research is to overcome the above limitation and achieve mirror diameters at the level of 3-5 times the size of the sensor, keeping ultra high resolution across the entire field of view. In this Phase II project, a miniature high-resolution 360-degree prototype system including optics and camera sensor will be built to demonstrate this capability.

The broader impact of this project will be will to increase the market reach of ultra-wide angle cameras for multiple applications, including video-conferencing, robotics and home surveillance. This new approach to designing optics will result in substantially reducing the form factor of high-resolution wide-angle optics. The high-resolution camera sensors available in the consumer market today can be better used in very small ultra-wide angle video cameras with the ability for multiple remote users to decide where they want to look independent of each other. This has the potential of transforming the market for pan-tilt-zoom cameras to "solid-state pan/tilt/zoom" cameras. The very low size, weight and power cameras that would result from this research can result in small wireless, battery powered systems that would increase the proliferation of cameras for a variety of different applications.

KWJ Engineering Incorporated

Phase II Award No.: 1058563

Award Amount: $1,204,511.00

Start Date: April 1, 2011
End Date: March 31, 2015

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Sector: Electronic Components & Devices

SBIR Phase II: Screen-Printed Gas Sensor using Nanoparticulate Catalyst

This Small Business Innovation Research (SBIR) Phase II project seeks to combine the technology for a high performance amperometric gas sensor, AGS, with the fabrication methods of printed electronics, first for sensing carbon monoxide (CO). In Phase I KWJ demonstrated a unique combination of technologies and fabricated a CO sensor that, in performance testing, was compared to commercial sensors 10-100 times larger and 10-100 times more expensive. The new unique geometry sensor response characteristics we as good or better than commercial sensors. The printed-AGS sensor provides a general platform for sensors that is both low cost and high performance. In Phase II, this novel Printed-CO-sensor and the process for fabrication will be optimized and innovative beta-prototypes designed and fabricated. The prototype sensors will be subjected to comprehensive testing and integrated with state-of-the-art electronics including tiny micro-powered RFID technology to demonstrate a fully compensated, high performance, yet low-cost, CO sensor and sensor system. This would represent the first major advancement of AGS technology in the USA in several decades, and the resulting product is potentially disruptive to the marketplace.

The broader impact/commercial potential of this project lies in the ability of this novel, inexpensive printed gas sensor to combine the high performance found in the AGS technology and the modern fabrication technology from the microelectronics industry. The innovative products from this NSF SBIR can open a new landscape for sensor use. Legislative trends are pointing to a need for a low cost, high performance CO sensor. The result of this work will be the next leap forward in the existing widely used AGSs for monitoring. Initial impacts will include: 1] improvements in CO sensors allowing high performance home CO alarms to better protect human health as well as property, 2] widespread monitoring capability in transportation and infrastructure applications, important to both safety and homeland security; and 3] the ability to integrate gas monitoring into consumer products and create instant worldwide networks to monitor and assess for improved health and safety as well as environmental protection. The printed AGS may not only replace millions of larger sensors now sold, reducing cost and material use by 10-100X, providing a greener footprint for sensors, but also enable evolution of high performance sensing capability into new and larger markets.

Mytek, LLC

Phase II Award No.: 0823022

Award Amount: $1,127,930.00

Start Date: August 1, 2008
End Date: July 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Extended Performance Red VCSELs

This Small Business Innovation Research (SBIR) Phase II project will demonstrate significantly improved output power, temperature range of operation, and reliability of red VCSELs. Commercialization of red VCSEL technology has been plagued by the limited temperature range and output power of the devices and unknown reliability characteristics. The Phase I project demonstrated the 1) feasibility of improving output power and temperature range through a number of techniques, 2) that the fundamental limit of the temperature range is at least as high as 125¡C, and 3) dramatically improved reliability. The Phase II approach proposed here breaks away from traditional models for fabricating VCSELs and consists of a variety of growth and fabrication methods allowing us to provide a high thermal conductivity path from the active region to the package. The goals and expected technical results are to demonstrate > 0.5mW single mode, and >1mW multi-mode useful output power at 670nm at 85¡C, and the same power output power objectives for 655nm at 65¡C on a reproducible basis. This project will also demonstrate greater than 10,000 hours device lifetime at 85¡C continuous operation. Project activities consist of design, wafer growth and fabrication, performance testing, and reliability testing.

To date, the only commercially available VCSELs have been at 780nm to 850nm, due to the substantial materials challenges at other wavelengths. This proposed effort is applicable to a variety of VCSEL wavelengths (similar thermal issues exist at 1310nm to 1550nm), as well as other optoelectronic devices. Commercially, a significant enhancement in red VCSEL performance can enable the migration of plastic fiber based home and auto networks to higher data rates, faster and higher quality laser printing, longer distance and more precise motion control sensing, new types of portable or wearable medical sensing, and improved robustness and cost of radiography equipment. The success of this project not only creates a significant business opportunity for a red VCSEL supplier, but also enhances the competitiveness of customers by making available a valuable new technology. The reduction in power consumption and improvement in medical technology costs address particularly important societal issues.

Nano Liquid Devices, Inc

Phase II Award No.: 1127563

Award Amount: $590,000.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Electronic Components & Devices

SBIR Phase II: Low Cost, High Bandwidth RF Switch

This Small Business Innovation Research Phase-II project is aimed at developing Micro Metal Sphere (MMS) fabrication technology for Radio-Frequency (RF) Micro-Electro-Mechanical-System (MEMS) switch. The target applications are high-bandwidth RF switches and digitally-tunable RF modules that can be used in wireless communication systems including cell phone. The MMS technology is distinguished from conventional cantilever or bridge type MEMS switches in that it does not have suspended element and no restoring force is involved in the switch actuation. In conventional MEMS switches, the restoring force is often not able to overcome interfacial forces over time and causes the infamous stiction that leads to permanent failure. Since the MMS switch is designed to switch with free body, it does not suffer from mechanical wear and possibly free from stiction. In addition, the MMS technology can provide an extremely cost effective packaging solution replacing commonly used labor intensive and costly wafer level packaging technology. Since the MMS technology is integration-friendly with conventional silicon CMOS technology, it can be placed on top of any CMOS IC. Therefore, anticipated benefit with the MMS technology extends to size reduction. Also the MMS technology is expected to lower the activation voltage below 10V.

Nano Liquid Devices (NLD) is the first U.S. company invented and developed RF-MMS process and cost effective packaging technologies that will enable mobile phone makers to design smaller, lower-cost smart phones, entry-level handsets and other mobile devices, which will accelerate the convergence of cell phones and computing for the next wave of mobile innovations. NLD's technology will enable lower-cost smart phones, which will complement and replace notebook PCs among mobile business people and students who access data and communications anywhere for work, study, social networking, and entertainment. About 1.5 billion cell phones will be produced in 2011, of which 67% will be multiband handsets, so the global impact will be enormous. NLD's RF-MMS technology will enable faster, better cell phone communications integrating voice, text and video for the average user worldwide.

Perpetua Power Source Technologies, Inc.

Phase II Award No.: 1058551

Award Amount: $999,834.00

Start Date: April 1, 2011
End Date: March 31, 2015

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Sector: Electronic Components & Devices

SBIR Phase II: Flexible Thin-Film Thermoelectric Wearable Energy Harvester

This Small Business Innovation Research (SBIR) Phase II project addresses the need for renewably powered and always available energy for powering personal medical and other location aware sensors. The project advances wearable thermoelectric generator (WTEG) technology. The system will yield new advances in terms of miniaturization, increases in WTEG power densities, application of advanced heat transfer materials, and integration with cutting edge locator system electronics. The research focuses on matching the thermal resistance of the thermoelectric generator with the thermal resistance of the skin to air interface, accomplished through the optimization of thermocouple geometries implemented in thin film semiconductors applied to a flexible polyimide substrate. The anticipated result of the research will be a fully functional wristband locator system that is lightweight, adjustable, waterproof, and renewably powered from the human body.

The broader impact/commercial potential of this project includes applications for location tracking of Alzheimer's patients, nursing home patients, and elderly home healthcare. As our population ages, achieving a balance between personal independence while providing for primary healthcare monitoring will be critical. Wearable thermoelectric generator technology can be used to power wireless sensors that monitor patient location and help facilities track "at risk" residents. Additionally, wireless sensors can help healthcare providers improve treatment, increase efficiency, and cut costs. A wide range of other follow-on medical applications include glucose monitoring for diabetic treatment and care, diagnosing sleep disorders, and the physiological monitoring of first responders, law enforcement, and soldiers. Each of these applications has been limited by finite and limited battery life. Harvesting body heat and converting to usable electrical energy opens up a new era of autonomous wearable devices.

Privatran

Phase II Award No.: 1127537

Award Amount: $390,810.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Electronic Components & Devices

SBIR Phase II: Massively Dense 3D Integrated Memory

This Small Business Innovation Research (SBIR) Phase II project will further develop a two-terminal, electronically-programmable, nonvolatile memory array using materials commonly found in integrated circuit (IC) manufacturing. Each element is smaller than a single transistor and is formed using standard IC layers. This results in a three-dimensional (3D) integrated memory (3DIM) architecture achieved using a single substrate without need to assemble multiple die or wafers together with advanced bonding techniques. The ON/OFF conductance ratio and switching speed of these devices exceed the performance of competing technologies. Current flows through nanometer-sized regions of the device, and, as a result, the memory elements will scale to smaller dimensions without reducing the current through the device, thereby resulting in a dense memory array architecture with improved signal-to-noise ratio for each subsequent IC technology. The proposed overall program will include integrating a passivation layer, connecting each element with an isolation diode, optimizing device architecture to minimize footprint, and implementing 3DIM control and drive interface electronics. The program proposed herein addresses the topic by providing material innovations for improved performance in electronics where nano-scale semiconducting filaments are fabricated within a dielectric material for commercial data storage applications.

The broader impact/commercial potential of this project are in the areas of microelectronics chip manufacturing for wireless, mobile internet and other portable devices using nonvolatile memory. Memristive device arrays impact numerous commercial markets including flash and embedded memory, and offer orders of magnitude more density as compared to conventional memory. By implementing massively dense 3D memory array architecture on a single substrate, there is no need to fabricate multiple substrates and bond them together, thereby simplifying the fabrication process, reducing manufacturing cost and increasing yield. In addition to portable devices, the proposed device may find applications in space-based earth sciences and astronomy since it is tolerant to x-ray and heavy ion radiation. Some recent approaches to achieve 3D memory on a single substrate have not been successful due to problems with external fields causing bit errors and low signal-to-noise ratio, or because device operation is based on thermal, ionic transport, or phase-change mechanisms that are inherently slow. The proposed memory elements are controlled using electrical signals rather than thermal or chemical energy, making them highly efficient and faster than competing technologies. Memory arrays will be fabricated in a commercial foundry and scaled to smaller dimensions throughout the Phase II project.

QuantTera

Phase II Award No.: 1127568

Award Amount: $558,596.00

Start Date: November 15, 2011
End Date: October 31, 2013

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Sector: Electronic Components & Devices

SBIR Phase II: Ultra Low Power InAsN Semiconductor Transistors

This Small Business Innovation Research (SBIR) Phase II project will demonstrate a new III-V nitride semiconductor alloy and bipolar transistor structure with the potential to enable ultra low power device operation in applications requiring both Radio Frequency (RF) and digital electronics. The problem to be solved is that for RF power amplifier increasing power efficiency has been a major issue for portable and high performance electronic devices. The research objectives is to demonstrate on a standard gallium arsenide (GaAs) transistor platform that the inclusion of our low band gap nitride semiconductor will significantly reduce the turn on voltage, thus increasing the battery life of the device. Our research will start from the development of a low bandgap material to the fabrication of transistor that will be compared to the specifications of cellular based RF amplifiers. This program will begin with device design and material synthesis and end with prototype demonstrations, with our commercial partners.

The broader impact/commercial potential of this project will have a huge impact on power consumption in the realm of high-performance personal communication electronics, as the requirement for greater functionality in cell phones rises. GaAs wafers dominate the market for amplifiers in wireless communication products. Transistors have advantages over existing standard GaAs-based devices with reduced power consumption could impact the entire electronics industry. As portable or wireless cellular devices continue to become ever more functional they will require significantly lower turn-on voltages so as to minimize power consumption while sustaining operation over longer periods of time. The overall structure of the project has been designed to provide enriching opportunities in the areas of teaching and training for both the graduate students and university researchers. The exchange ideas between industry and academia will ensure research candidates with an excellent technical background and a sophisticated understanding of the industrial environment.

Resensys, LLC

Phase II Award No.: 1026903

Award Amount: $736,334.00

Start Date: September 1, 2010
End Date: March 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: An RF Radiation Empowered Sensing Method for Low Cost Structural State Monitoring

This Small Business Innovation Research Phase II project addresses the deteriorating situation with respect to our nation's infrastructure system, particularly bridges. A solution is critically needed to monitor the structural integrity of such systems in order to identify potential failures - such as the Minneapolis I-35W Bridge collapse - before they occur. Existing solutions for structural state sensing are expensive, labor intensive, non-scalable, and unreliable. Phase I demonstrated the feasibility of an innovative, cost-effective, non-intrusive, and scalable structural monitoring technology known as Active RF Test (ART). The investigators developed a prototype of a thin, mechanically flexible, patch-like wireless sensor that can be easily attached to distributed points of a structure. ART sensors are batteryless, with their energy supplied through an in-network RF energy radiation mechanism. Based on the Phase I success, Phase II will (1) optimize the architecture and enhance the capabilities of the ART sensors; (2) develop cost effective processes for high-volume production of the sensors; (3) develop analytical tools that generate a map of installation locations for ART sensors on a structure; (4) develop detection/diagnostics models based on the sensors; and (5) conduct a field evaluation of the ART system on two highway bridges.

The broader impact/commercial potential of this project is protecting the US infrastructure against aging, structural malfunction, and failures. Aging infrastructure poses a significant societal challenge: recent reports indicate that the US transportation infrastructure has 601,027 bridges, of which 71,419 are structurally deficient. Unique features of the proposed ART technology - such as easy installation, low cost, scalability, energy self sufficiency, and durability - make it an ideal response to this challenge. The attachment of ART patch sensors will be non-intrusive to a structure, the installation effort will be minimal, and no drilling will be required. The mechanical flexibility of the ART patch sensors will allow adaption to complex geometries, including bearing plates, gusset plates, joints, support cables, and truss systems on a bridge. Finally, ART technology features a multipurpose solution that can be tailored to structural integrity monitoring needs of different types of structures, including bridges, pipelines, dams, airframes, and offshore platforms. The 71, 419 structurally deficient US bridges alone represent a commercial market of $2.8 billion. The potential to address other structures, along with the potential for international sales, would enhance the opportunity.

Shasta Crystals, Inc.

Phase II Award No.: 1026196

Award Amount: $819,727.00

Start Date: September 1, 2010
End Date: August 31, 2013

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Program Director: Juan E. Figueroa

Sector: Electronic Components & Devices

SBIR Phase II: Low Cost High Quality Nonlinear Optical Crystals for Laser Light Sources for Miniature Projectors

This Small Business Innovation Research (SBIR) Phase II project will demonstrate how to reduce the cost of manufacturing magnesium-doped lithium niobate (Mg:LiNbO3) crystals by more than an order of magnitude. Frequency-doubling crystals, such as Mg:LiNbO3 can convert 1064-nm light from an infrared laser to 532-nm (green) light. However, LiNbO3 crystals made by the conventional Czochralski technique typically cost $800 each, presenting an economic challenge for consumer applications. The approach is to grow crystals by the laser heated pedestal growth method with a novel afterheater and to pole them in situ. Phase II, enables the development of manufacturing capability for these crystals at a rate of 100,000 crystals per year at a cost of less than $22 each. In Phase III, The manufacturing capacity will be increased to 1,000,000 crystals per year and the manufacturing costs reduced below $8. The proposed cost reduction will enable manufacturers of picoprojectors to increase the brightness of their products by integrating lasers as the light sources instead of LEDs. The technical objectives are to optimize the density of Mg:LiNbO3 ceramic feedstock rods, to increase the manufacturing throughput by optimizing manufacturing yield and automating the growth apparatus.

The broader impact/commercial potential of this project is to enhance scientific and technical understanding by demonstrating a) a novel method of growing crystals with lower cost, higher speeds, and greater purity, and b) a way to pole LiNbO3 crystals in situ at lower cost. The project will generate a strong economic impact because many types of handheld consumer electronics devices (cell phones, PDAs, iPods, game terminals, etc.) contain digital data that require visual displays. Picoprojectors can display the content of handheld devices in large formats, but their LED illumination sources can't generate images with enough brightness to satisfy customers. Laser illumination sources can solve the brightness problem, but lasers are too expensive, primarily because of the cost of the frequency doubling crystals. This project will reduce the cost of these crystals and may thereby enable the picoprojector industry to realize its optimistic growth scenario ($3.6 billion in sales in 2014) rather than its conservative growth scenario ($901 million in sales in 2014). An intern, a science student who is a member of an under-represented group in the nation's science and engineering enterprise, will be hired to assist with Phase II research.

Spectral MD Inc

Phase II Award No.: 1058146

Award Amount: $1,259,446.00

Start Date: March 15, 2011
End Date: February 28, 2017

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Sector: Electronic Components & Devices

SBIR Phase II: 4-Dimensional Optical Tissue Imaging by Variable Digital Illumination

This Small Business Innovation Research (SBIR) Phase II project has as its main objective the development of a mobile physiological optical imaging hardware and software system to empower clinicians with the ability to deploy, capture, assess and distribute standards compliant image data characterizing deep wounds and cardiovascular conditions. The mobile system will allow clinicians to rapidly identify the presence of hidden wound conditions or problematic blood flow patterns thus allowing care facilities to provide more cost effective and informed care to their patients, while minimizing financial losses associated with wound related hospital acquired conditions. The intellectual merit of this project lies in its scientific pursuit to define, develop, and distribute a comprehensive systems platform that will significantly accelerate the deployment of suitable physiological optical imaging solutions into the market. The research includes linking illumination patterns to physiological conditions while implementing mapping transfer functions by way of digital signal processing. The research objectives include system definition, integration, algorithmic optimization, and clinical validations.

The broader impact/commercial potential of this project is to provide substantially affordable noninvasive imaging tools that may be used to assist in treatments that are more accessible to persons in remote areas or those having economic disadvantages. The portable device increases the ability of qualified clinicians to access patient wound care imaging diagnostics remotely, improving quality of care and accessibility to society. Broader commercial benefits include reductions in hospital visits and stays due to more thorough wound assessments and greater accessibility. The mobile system will enable care decisions that are more closely coupled with the state of the underlying tissue and related hemodynamics. It will also allow clinicians and patients to more effectively monitor the benefits of care decisions. The development of the novel and cost-effective optical system to facilitate the imaging of clinically and physiologically meaningful information will fill a void in the medical imaging industry for a point of care solution capable of providing quantitative visualization of physiological processes critical to wound care. The development of the mobile imaging technology will enhance scientific and technological understanding in the areas of optical-tissue image mapping, optoelectronic illumination systems, image processing, clinical applicability and real-time imaging scenarios.

Swamp Optics, LLC

Phase II Award No.: 1256253

Award Amount: $500,000.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: Electronic Components & Devices

SBIR Phase II: Simple Device for Measuring Nanosecond Laser Pulses

This Small Business Innovation Research Program Phase II project proposes to develop a simple, single-shot, inexpensive, and complete laser-pulse measurement device for ~100-picosecond to ~10-nanosecond pulses. Long (>10 nanosecond) pulses are easily measured, and recently developed techniques completely measure ultrashort pulses (<10 picosecond). But intermediate-length, ~1-nanosecond, pulses remain only partially, roughly, and expensively measurable, and so generally remain complex and unstable. This is unfortunate because most laser pulses are in this intermediate range. The proposed measurement device is based on frequency-resolved optical gating (FROG), a very successful technique for measuring the complete intensity and phase vs. time of femtosecond pulses. The main challenge in extending FROG to much longer pulses is the generation of a many-nanosecond delay range on a single pulse-currently an unsolved problem in general. The proposed innovation solves it by tilting the input pulse by a remarkable ~89.99¡ without distorting it in time. As a result, one side of a ~1cm-wide beam precedes the other by over a meter. The proposed nanosecond FROG can completely measure even complex pulses and will cost less than one tenth as much as the high-bandwidth oscilloscopes currently used to only partially measure such pulses.

The broader impact/commercial potential of this project follows from the fact that most pulsed lasers, from solid-state lasers to fiber lasers, emit pulses about a nanosecond long. They are the least stable lasers in the world, yet they have billions of dollars of applications, from materials processing to distance measurements to remote sensing to medical, military, and scientific uses. With the proposed device, nanosecond lasers will finally have a previously unavailable device to monitor their performance and to diagnose problems before expensive materials are ruined or patients are harmed. It will also be essential for combining pulses from multiple fiber lasers, generally regarded as the next important step in the development of compact and convenient high-power pulsed lasers. Finally, using this device, laser engineers in general will be better able to improve the quality of nanosecond laser pulses, thus greatly benefitting all pulsed-laser applications. If the spectacular progress in much-shorter-pulse lasers that occurred after analogous complete pulse-measurement technology was introduced there is any indication, such an inexpensive and simple device for measuring nanosecond pulses should make a huge difference in the generation of cleaner, more stable nanosecond pulses and consequently in the many fields that use such lasers.

Telescent Inc.

Phase II Award No.: 1057576

Award Amount: $585,086.00

Start Date: March 1, 2011
End Date: February 28, 2014

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Program Director: Juan E. Figueroa

Sector: Electronic Components & Devices

SBIR Phase II: Optical Detectors Based on Transparent Microwires and Nanowires

This Small Business Innovation Research (SBIR) Phase II project will develop a new type of optical power monitor utilizing transparent microwires and nanowires patterned within a multi-layer anti-reflection coating. These "wires" are nanometer to micron wide traces defined within a transparent indium tin oxide (ITO) conductive layer. ITO typically absorbs 1 to 10% at visible and infrared wavelengths, depending on its thickness, and optical intensities greater than 1 mW/mm2 produce measureable localized heating. This temperature change induces a proportional resistance change that can be measured electronically. By inserting this detector in-line between fiber optic cables, the optical power of the internal signals can be measured without degrading the signal strength. Moreover, by reducing the dimensions of the trace to the nanometer scale, the detector also has the potential for high-speed operation with a bandwidth approaching GHz.

The broader impact/commercial potential of this project includes new optical monitoring applications that were previously impossible or impractical. In one example, inexpensive and miniature optical monitors can now be integrated within the hundreds of millions of fiber optic interconnects produced annually for fiber optic communication systems. Advanced self-monitoring and self-diagnosing communication network architectures can be developed for Fiber-to-the-Home networks and data centers by transparently measuring the optical power through fiber optic junctions. This technology promises to reduce the cost to measure power within optical fibers by two orders of magnitude, and has the potential to be mass-produced and even inkjet printed on flexible plastic film, window glass, solar panels, mirrors, displays, or even on curved substrates such as light bulbs and lenses.

TestWorks, Inc.

Phase II Award No.: 1152453

Award Amount: $500,000.00

Start Date: May 1, 2012
End Date: April 30, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Integrated Circuit Yield and Quality Improvement thru Test Data Analysis

This Small Business Innovation Research (SBIR) Phase II project develops an automated, software-based analysis methodology that enables yield and quality improvement of integrated circuits (ICs) through information extraction from test measurement data. Deriving actionable information from test data is a challenging task due to lack of software that automatically correlates test measurement data obtained from failing ICs and their physical IC-design description (i.e., the layout). Maximizing knowledge extraction is accomplished by a new software-based diagnosis technique that uses in conjunction the logical and layout descriptions, in addition to the measured test data, to identify at the nanometer scale, the precise location and type of defects within non-working ICs. The project also develops software-based statistical methods that find commonalities among the defects characterized within failing ICs. The combination of improved diagnosis and commonality analyses means that the root-causes for failure can be quickly found and passed on to designers, process engineers, and test engineers to guide remedy selection and deployment.

The broader impact/commercial potential of this project centers on continuing the advancement of the US semiconductor industry which is vital to both Homeland Security and the general advancement of society as a whole. There is significant commercial opportunity in supplying test data analysis on a per-design basis to Integrated Circuit (IC) producers that enables rapid improvement in yield and quality through feedback from manufacturing testing. The potential impact is tremendous since specific, pertinent information is fed back to both designers and manufacturers about how and why ICs fail. Chip designers will use this information to improve design rules for producing high-yielding and ultra-reliable ICs. Chip manufacturers will use this information to fine-tune their fabrication processes to maximize yield and performance, and optimize their test methodologies to ensure quality meets customer demands. It is also anticipated that this technology will also spur further research and broaden the scope of research in universities.

Triune Systems

SBIR Phase II: Micro-Solar Powered Battery Charger Circuit

Phase II Award No.: 1230183

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Electronic Components & Devices

This Small Business Innovation Research (SBIR) Phase II project will address the efficiency issues with existing solar harvesting technology and the excessive power consumed by the power management circuitry. The proposed technology addresses the solar performance issues by including a low-power Maximum Power Point Tracking (MPPT) algorithm to maximize solar collection efficiency under variable lighting conditions. The patented technology reduces the power consumed in the charging electronics by 60x over existing products. The solar power solutions developed will minimize the charging time while meeting portable form-factor requirements in both indoor and outdoor lighting conditions. The first development phase will define specifications and develop system level implementations for portable charging and standalone off-grid applications. In the second phase, technologies used in the prototype systems will be integrated into a single device to further reduce overall size and system costs. The final product of this Phase II effort will be single-chip integrated power management devices for portable charging applications and standalone autonomous off-grid systems. These devices will deliver class-leading solar conversion efficiency both indoors and outdoors, and have revolutionary power dissipation levels that will enable new applications and markets that were not possible with products on the market today.

The broader impact/commercial potential of this project is to improve the environment, enable new markets, and provide opportunities, jobs, and tax revenue. In the past, solar energy harvesting was not taken seriously due to lack of flexibility and portability. Early solar panels and harvesting electronics were too inefficient and expensive to be useable, and remained a niche product. With advances in harvesting and charging technologies, solar power can be used effectively in many consumer standalone and portable applications. The proliferation of these efficient, cost-effective solar and low-power solutions can reduce a system's carbon footprint. Utilizing this proposal's technology and working closely with solar panel manufacturers, solar charging and energy harvesting becomes a viable alternative to replaceable batteries and grid-power. North American consumers use approximately 200,000 tons of cell batteries each year, 95% of which end up as waste. High-efficiency solar rechargeable systems can reduce the amount of toxic battery waste that ends up in neighborhood landfills. In addition to the positive environmental impact, the technology enables new markets and growth in existing markets which allows firms to grow and provide opportunities, jobs and more than an estimated $1.5 million in federal income tax revenue over the next 5 years.

United Science LLC

Phase II Award No.: 1256626

Award Amount: $499,869.00

Start Date: February 15, 2013
End Date: January 31, 2015

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Sector: Electronic Components & Devices

SBIR Phase II: In situ PFC Monitoring Sensors

This Small Business Innovation Research (SBIR) Phase II project addresses the analysis needs for monitoring perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) in water. PFOA and PFOS are ubiquitous environmental contaminants that have been found at low concentrations in waste water, drinking water, human blood, and in food. Because PFOA, PFOS and other perfluorochemicals are bio-accumulative, extremely persistent, and toxic, several states have established analytical methods and emission limits. Furthermore, there is a large effort surrounding remediation of PFOA and PFOS contaminated areas. Considering the impacts on both the environment and public health, there is a market need for rapid, selective, low cost, and field portable PFOA and PFOS sensing. This research aims at the development of a field deployable ion-selective electrode that permits selective and fast measurement of PFOA and PFOS with a low detection limit at low cost.

The broader impact of this research is to improve public health by rapid identification and screening of polluted areas. Moreover, the research will enable an economical PFOS/PFOA detection method for environmental monitoring, continued research, compliance and remediation efforts. Currently, research efforts are hampered by costly and time consuming liquid extractions coupled with liquid chromatography and mass spectrometry. This research aims to produce a device that will significantly lower the barriers to testing. Additional broader impacts include expanded application of the sensor to measure the contaminant in blood, soil and food. Most importantly, these efforts are important and instructive to direct and monitor remediation and enable in-field research. We view this effort as an integral part of a wider effort to understand and reduce sources and pathways by which the persistent substance has become widespread in the environment.

Zeno Semiconductor, Inc.

Phase II Award No.: 1230413

Award Amount: $493,721.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: A Novel Memory Having Both Volatile and Non-Volatile Modes For High Performance, Low Power Applications

This Small Business Innovation Research Phase II project seeks to continue the development of a novel one-transistor memory device, which has both volatile and non-volatile functionality, through collaboration with a commercial foundry partner. Such memory combines the non-volatile memory's ability to retain information in the absence of power (such as Flash memory) and the fast access speed and reliability of a volatile memory (such as Static Random Access Memory (SRAM)). In addition to the memory cell development and optimization, a memory block will also be developed to initiate commercialization effort of the memory technology.

The broader impact/commercial potential of this project is to enable power-efficient computing applications and mobile devices. For example, it can be used to reduce power consumptions in data centers. Data centers' annual energy consumption is estimated to be 150 billion kWh, about twice the capacity of the current US solar panel. A power-efficient memory such as the one proposed in this proposal can reduce the overall data centers' power consumption by up to 75%. Another application is to provide an integrated memory solution. Many electronic devices currently employ multiple types of memory, due to their own distinct characteristics. The proposed device will be able to combine the different types of memory into a single memory device, simplifying the manufacturing process for embedded memories.

Zikon Inc

Phase II Award No.: 1256578

Award Amount: $500,000.00

Start Date: January 1, 2013
End Date: December 31, 2014

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Sector: Electronic Components & Devices

SBIR Phase II: Low-Cost, Energy-Efficient Electronic Paper

This Small Business Innovation Research Program (SBIR) Phase II project advances a new electronic paper technology that offers paper-like viewability and high energy-efficiency at very low production costs. Central to the innovation is a reverse-emulsion electrophoretic display (REED) ink, combined with a paper-like nano-porous matrix that was developed in Phase I research. The research objectives for Phase II are: (1) to develop a controlled method for depositing the matrix layer, (2) to finalize critical product design parameters, (3) to develop scalable and high-yield fabrication methods, and (4) to conduct performance evaluation of advanced prototypes. Necessary tasks to achieve these objectives include developing matrix deposition hardware and characterizing layer quality, optimizing the combined formulation of porous matrix and ink, defining specific product geometry and functional specifications, performing process integration and assembly, interfacing with electronics and optimizing driving signals, conducting failure modes and effects analysis (FMEA), and identifying robust operating conditions. The anticipated results of this work is an advanced prototype display that meets performance requirements for electronic shelf label (ESL) applications, as well as a commercially-viable sequence of manufacturing processes for scalable production.

The broader impact/commercial potential of this project are to develop a core display technology that satisfies the readability, power, and cost requirements desired for electronic shelf labels (ESLs), opening new opportunities within the multi-billion dollar global electronic paper market. This project has important implications on society because it can mitigate some of the environmental impact associated with current thin-film display technologies, improve the energy efficiency of electronic displays, and can also lead to reduced paper consumption in a commercially viable way. Technology areas impacted by this innovation include electronic displays, printable electronics, and nanotechnology. Market sectors impacted include display manufacturing and retail. The innovation will further enhance scientific and technological understanding of the behavior of electrophoretic nano-droplets in thin nano-porous media. The enhanced scientific understanding that will be gained from the study of porous matrix and nano-droplet interactions has potential for synergies beyond the realm of electronic displays, with parallels encountered in other areas such as bioseparation and energy conversion processes. Another important aspect of this research is its impact on education, by engaging a university faculty member and a graduate student at one of the nation's minority serving institutions.

AccuStrata Incorporated

Phase II Award No.: 1026370

Award Amount: $902,266.00

Start Date: October 1, 2010
End Date: September 30, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Real Time Optical Control System for Thin Film Solar Cell Manufacturing

This Small Business Innovation Research (SBIR) Phase II project is directed at developing a real time process control system for improving manufacturing of thin film products such as thin film solar panels, solid state lighting, touch screen displays, optics and telecommunications. Photovoltaics are a vital component of the renewable energy mix but they need to be more efficient to be competitive against existing fossil fuel approaches. The system will be able to dynamically control and correct the film deposition process in order to keep each product within its targeted specification, reducing and even eliminating rejects. It allows manufacturing of more consistent and uniform solar panels resulting in higher solar conversion efficiency, reduced cost and increased manufacturing yield. The objective of this Phase II is to further develop and improve the prototype system developed under Phase I and IB and validate it for two most common thin film solar panel manufacturing configurations. This project will complete the hardware / software development and validation for monitoring film growth for amorphous silicon solar panel manufacturing. Phase II will remove technical risk allowing fast commercialization of the monitoring system. Additional development will be performed to finalize the control component of the system.

The broader impact/commercial potential of this project is to advance the scientific understanding of how thin films grow during deposition. It will help thin film solar panel manufacturers to develop higher quality products. The system will improve production accuracy, reduce production flaws and make the manufacturing process less susceptible to process parameter drifts and errors,especially for advanced thin-film products. The commercial impact of the project is that manufacturers will (i) increase solar panel efficiency and manufacturing yield, (ii) reduce manufacturing cost, and (iii) increase revenue and profit. The proposed technology provides an innovative platform solution that can be further improved in order to achieve waste-free thin film manufacturing with little human interaction. This system, if adopted by only 30% of the thin film manufacturers will result in roughly $1 billion in savings by 2015. The societal impact of the project is to help make solar panels a competitive source of energy against existing fossil fuel approaches. The system will allow manufacturers to meet the market demand for lower cost solar products which will accelerate PV adoption worldwide thus helping to reduce global warming and reduce our dependence on oil.

Active Spectrum

Phase II Award No.: 1058145

Award Amount: $616,000.00

Start Date: April 1, 2011
End Date: September 30, 2013

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Sector: Electronic Systems & Instruments

SBIR Phase II: Airborne Soot Sensor for Improving Fuel Efficiency and Reducing Pollutants

This Small Business Innovation Research Phase II project will result in the development of a miniature airborne soot sensor for automotive diesel engine exhaust sensing applications. Current government regulations mandate that by 2012, all diesel vehicles sold in the United States will be equipped with onboard NOx and airborne particulate matter sensors. The proposed particulate matter sensor is based on the principle of electron spin resonance (ESR) spectroscopy. This sensor technology will be miniaturized and hardened for use in an automotive application for airborne soot sensing. Design changes intended to meet aggressive cost-reduction goals are an important feature of the project. The end result will be an automotive-grade, low-cost airborne soot sensor that can ensure end-users' compliance with new diesel engine emissions standards.

The broader impact/commercial potential of this project is a reduction in airborne particulate matter emissions. Airborne particulate matter has been identified by the US government as one of six criteria pollutants with potentially serious health and environmental effects. Among the largest sources of airborne particulate matter (PM) are diesel vehicles and power plants. We propose a new, low-cost and highly specific airborne soot sensor based on a miniature electron spin resonance sensor technology. The upcoming government regulations for onboard vehicle diagnostics, combined with similar regulations abroad create a market for approximately 6.3 million airborne soot sensors per year worldwide. It is expected that the worldwide market size for onboard airborne soot sensors will grow to approximately $350M/year as a result of upcoming regulatory changes.

Adicep Technologies, Inc.

Phase II Award No.: 1152605

Award Amount: $515,999.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Compliant Nonlinear Quasi-Passive Orthotic Joint

This Small Business Innovation Research (SBIR) Phase II project aims to create a leg brace that addresses the underlying causes of mild/moderate walking dysfunction affecting 150 million people worldwide. Novel brace elements called Morphologically Switched Orthotic Joints combine field-adjustable, non-linear torsion springs with microprocessor controlled clutches to change the brace's mechanical state dynamically according to the user's gait. Internet updatable software, executing under a multi-processor, fault tolerant brace operating system, samples the brace's 40 sensors to monitor leg posture and activate clutch state transitions. Novel brace concepts include soft/flexible tissue interfaces that adapt to brace misalignment, a joint configuration that provides greater range of motion compared with existing braces, and a fitting scheme with potential for self-fitting capability. Three research objectives are planned: optimize the brace design for comfort level while minimizing interference with Activities of Daily Living (ADL); build/test five prototype braces; and conduct human subjects testing with disabled volunteers to assess brace safety and benefits. Primary biomechanical benefits include dynamically adapting to the user's leg strength to provide full support at all knee angles and reducing the total force across the knee joint by up to an order of magnitude during mobility activities.

The broader impact/commercial potential of this project stems from creating a brace that offers biomechanical benefits that substantially surpass those of existing devices without interfering with non-mobile ADL. Anticipated benefits include: allowing Knee Osteoarthritis (KOA) patients to walk with less pain; improving walking/stair-descent safety; adapting to the user's preferred step-length/walking-speed; reducing the effort needed to walk; and allowing a full day of mobile ADL (including a 20-mile walk) on a single battery charge. This will have a transformative effect on the existing leg brace market (120K offloading braces/yr alone) and improve Quality-of-Life for as much as 40% of the world's population suffering mobility dysfunction. The benefit for KOA patients includes a new treatment alternative for multicompartmental or obese KOA patients or for patients who cannot have knee replacement surgery. The benefit for walking/stair-descent safety includes potential for reducing the incidence of falls. Falling accounts for two thirds of accidental deaths and is the leading cause of restricted activity days amongst America's elderly; persons with leg weakness have a four- to fivefold increased risk for falls; directly addressing leg weakness therefore has potential to increase longevity and reduce healthcare spending.

Artaic LLC

Phase II Award No.: 1152564

Award Amount: $500,000.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Computer-Aided Mosaic Design and Construction

This Small Business Innovation Research (SBIR) Phase II project will develop a computer-aided mosaic design and robotic assembly system for automation of a centuries-old manual process. Despite their prominence in art and architecture, mosaics are arduous to design and assemble. Labor-intensive methods have stubbornly resisted automation, adding considerable cost and delay to projects. Artaic's Phase I research proved feasibility of computer-aided design software to create renderings and digital blueprints of artisanal mosaics by introducing a streamlined, procedural workflow for tile layout that closely mimicked the workflow of mosaic artists, and did so over 10x faster than manual methods. The goal of the Phase II research is to demonstrate the speed, effectiveness, utility, and artistic quality of this mosaic design and robotic assembly system. The key Phase II objectives are to: (1) demonstrate a prototype artisanal mosaic design system and; (2) demonstrate a robotic mosaic production system, that will be: (3) validated for accuracy, speed, and quality through user assessment, and; (4) evaluated for economic and commercial potential. Anticipated technical results will enable a revolutionary advancement from manual to automated processes in mosaic design and production, comparable to the displacement of film by digital camera technology.

The broader impact/commercial potential of this project lies in art, design, construction, and architecture. Software and robotic automation will lower the cost of mosaics and increase its traditional societal impact of adorning public, commercial, and residential spaces. Artists, designers, and builders will have a significantly faster method to produce artisanal mosaics without the high cost and time associated with manual design and production. The efficiencies made possible by this proposed computer-aided mosaic design and manufacturing system will enable Artaic to expand into the global multi-billion dollar tile market and develop a domestic workforce to compete against global manufacturers of handcrafted mosaic artwork. Additionally, the computational demands of the rendering algorithms developed during Phase II will give impetus to further development of advanced GPUs and CPUs -- with companies such as Intel, Nvidia, and AMD providing solutions for increasingly more advanced rendering algorithms. Perhaps the most significant societal benefit from the development of this technology is its potential to make artisanal mosaic design and production accessible and affordable to the general public, and because this research enables any Photoshop artist to become a mosaic artist, it also hold significant promise as an educational tool in our nation's schools.

Artaic LLC

Phase II Award No.: 1230364

Award Amount: $500,000.00

Start Date: October 1, 2012
End Date: September 30, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: High-Throughput Agile Robotic Manufacturing System for Tile Mosaics

This Small Business Innovation Research (SBIR) Phase II project will demonstrate a prototype of a high-throughput, agile, low-cost manufacturing system for tile mosaics. Mosaics have been a source of visual splendor for millennia, but they have always required arduous and painstaking hand assembly. Our Phase I proved the feasibility of a programmable, high-throughput robotic tile-assembly system to enhance the production of mosaic tilings. Phase II R&D will build upon Phase I success to further speed up, automate and scale the system, develop an effective agile manufacturing management system, and analyze the economic viability of robotic mosaic assembly for Phase III. We will accomplish this by enhancing the mechanical processes and reducing operator time - in addition to developing a productionflow information system. After Phase II system optimization, we will evaluate the commercial potential of the Artaic technology. The anticipated technical result will be providing a 5x faster manufacturing process with a 75% reduction in the price per square foot of customizable mosaic tilings produced. The intellectual merits of this SBIR project involve Artaic's disruptive robotic technology, which transforms mosaic installation from its current, time-consuming manual labor processes to a rapid, robotically directed customizable process.

The broader impact/commercial potential of this project expands the utilization of artisanal mosaic work while increasing the competitive advantage of U.S. manufacturing processes through increased automation and customization. Successful development of this technology will enable a breakthrough pricing structure that is 75% lower than the competition (based on manual and rudimentary automated processes), leading to broad market affordability and widespread commercial adoption. Our robotic system has the potential to revolutionize the $76B global tile industry, while creating numerous domestic job opportunities. Artaic expects that the 5x increase in manufacturing speed realized during Phase I will be maintained in Phase II during manufacturing scale-up without loss of placement accuracy. The increased understanding of robotic agile manufacturing-enabled mass customization processes will expand the scientific understanding of related robotic processes that utilize highthroughput flexible assemblies, such as for medical or pharmaceutical technologies, or for consumer products. In addition, classical mosaic techniques will become more accessible as an art form to all students, while undergraduate students will increase their understanding of STEM concepts through engineering courses utilizing this technology. Artists and designers will find the realization of their design work much more practical and affordable as a business enterprise.

Barrett Technology

Phase II Award No.: 1058474

Award Amount: $497,971.00

Start Date: March 15, 2011
End Date: May 31, 2013

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Sector: Electronic Systems & Instruments

SBIR Phase II: Force-Controlled Robotic Arm Capable of Sub-Millimeter Precision

This Small Business Innovation Research (SBIR) Phase II project proposes a portable, interactive Coordinate Measuring Machine (CMM) for geometric data collection consistent with statistical sampling of a series of parts. The innovation exploits a characteristic of cable drives that supports precise repeatability in an articulated arm. To optimize production and avoid scrap generation, manufacturing process corrections must occur promptly and yet must be based on adequate measurement data. Existing metrology systems inhibit these preferred statistical process control principles. Large motorized CMMs are either taught offline using computer-aided design (CAD) models or online using awkward joystick interfaces. Manual-only portable-arm CMMs are safe and convenient to use, but teach-and-playback is not supported. The proposed solution is a motorized articulated robot that combines the safety of a manual system with playback precision thereby supporting convenient statistical process control (SPC). The research objectives are to design and build a motorized CMM and develop the algorithms, tools, and procedures needed to create a successful product. The anticipated commercialized product will be a portable, user-friendly, cost-effective robotic arm that spreads the quality advantages of statistical process control across a broad range of products and manufacturers including non-traditional manufacturing such as medical surgery.

The broader impact/commercial potential of this project has four parts. The first is the direct impact on the US economy. US workers will assemble, test, and ship the products developed under this SBIR. Components will be sourced from local US fabricators and OEM suppliers, boosting the US economy and generating taxes; and some of these products will become exports, reducing the US imbalance of trade. Secondly, the shortcomings of metrology devices available today discourage the use of statistical process control, thereby undermining manufacturing quality. The proposed solution will improve manufacturing competitiveness in the metrology market sector through easier adoption of statistical process control, leading to higher quality and reduced scrap costs. Thirdly, the proposed solution invites production-line workers back into close physical contact with the process that they must ultimately understand and control. The worker strengthens intuition by teaching the device for each new part geometry, while the playback capability avoids tedium and repetitive stress. Corporations often automate these workers out of their skilled jobs who then join the unemployed while the company loses touch with the ability to understand and innovate processes. Finally, this SBIR will support formal internship programs with several universities in order to maintain diversity.

Barrett Technology Inc

Phase II Award No.: 1152562

Award Amount: $473,156.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Muralidharan S. Nair

Sector: Electronic Systems & Instruments

SBIR Phase II: A Resilient and Underactuated Robotic Hand Capable of Both Power and Precision Grasping

This Small Business Innovation Research Phase II project proposes a robotic hand based on a novel torque-switching mechanism and patented miniature motor controllers. The mechanism actively channels motor torque along different transmission paths and enables dependant and independent (time-discreet) control of both finger joints in a robotic hand to perform both power and pinch grasps. There is a growing need in industry for adaptable and flexible manufacturing capabilities in a dynamic environment. Industry generally uses single-axis grippers and end-effectors that are modified to pick up specific items in a highly-controlled environment. This requires exchanging multiple customized and expensive grippers via tool-changers. This project's goal is to produce a paradigm shift in the materials-handling industry by introducing a highly flexible, affordable, and lightweight robotic gripper that can grasp and manipulate objects of varying size, shape, and stiffness. The Phase-II project objectives are to design and develop a prototype 3-fingered gripper using a novel torque-switching mechanism, optimized motors, multiple feedback sensors, and miniature control electronics, and to test and evaluate the prototype gripper in an industrial setting. This program will result in a compact, lightweight, and affordable robotic hand capable of grasping and manipulating a large range of objects.

The broader impact/commercial potential of this project addresses the shortcomings of gripper devices available today which discourage the use of robotic systems, thereby undermining manufacturing productivity. The proposed solution improves manufacturing competitiveness by enabling easier adoption of robotic work cells in conventional markets such as light manufacturing and emerging markets such as the food and beverage industry. The societal impact will be felt in the field of education where robotics is recognized as a strategic motivator for children and young adults to enter into technical fields. Most robots are too large and dangerous to bring into a classroom. The proposed robotic hand will be very portable, safe, and exciting for both educators and students. A significant increase in gripper dexterity will make it an even more attractive motivator in the classroom and other secondary educational programs and workshops. A potential secondary application for this innovation is a more dexterous and lightweight hand prosthesis which could have a major societal impact. Finally, the ability to transmit torque through different paths in a miniature package and allow control of different functions with a single small actuator enables lightweight yet versatile machines and could have impacts beyond the field of robotics.

Blue River Technology Inc

Phase II Award No.: 1256596

Award Amount: $500,000.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Electronic Systems & Instruments

SBIR Phase II: Use of Machine Learning Techniques for Robust Crop and Weed Detection in Agricultural Fields

This Small Business Innovation Research (SBIR) Phase II project seeks to further develop a novel computer vision based plant identification system for commercialization in agricultural weed control. This system will provide a cost competitive alternative to chemical herbicides, a global $20B market. Existing computer vision based approaches can segment a 'splotch' of green vegetation from a brown background but are unable to provide the selectivity and precision necessary for mechanized, automated weeding. This project's objective is to create software algorithms that match the capability of the human eye and brain to quickly and reliably classify plants into crops and weeds in real-time. The project team will build a computer vision algorithm based on a hierarchical classifier. This classifier will utilize a field customized support vector machine (SVM) that uses point-of-interest rather than shape-based methods, a novel approach to visual object identification. The result of this research will be the creation of an algorithm integrated into an automated weeding system.

The broader impact/commercial potential of this project is significant, as the development of an alternative to chemical intensive agricultural weed control will impact technological understanding, create commercial opportunity, and positively impact society. Technologically, the project will advance the fields of computer vision and machine learning through development of a real-time, automated plant identification system based on point-of-interest and SVMs. Commercially, the system will offer conventional farmers an effective and chemical-free method to eliminate weeds, and it will offer organic farmers the first truly precise organic weed control method. The addressable market for weed control in food production is estimated to be $4B in the U.S. The system's ability to eliminate the use of chemical herbicides has a profound societal effect. U.S. farmers apply over 250M pounds of herbicide annually on corn and soybeans alone, with many unintended and detrimental side effects. Chemical concentrations in rivers, lakes and groundwater are rising, and the prevalence of herbicide resistant weeds is growing exponentially. An alternative to these chemicals limits society's exposure while protecting environmental integrity.

Bridger Photonics

Phase II Award No.: 1058583

Award Amount: $599,995.00

Start Date: March 15, 2011
End Date: August 31, 2013

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Sector: Electronic Systems & Instruments

SBIR Phase II: Fast and Accurate Laser Distance Metrology

This Small Business Innovation Research (SBIR) Phase II project will enhance and optimize the Precision Distance Measurement system developed during the Phase I effort. The technology is based on innovative ultra-precise control of frequency-swept lasers to determine absolute object distances and thicknesses. The system is capable of distance and thickness measurements with <10-nanometer precisions, >1 kHz update rates, volume measurement coverage of 1 m3 (<10-micron precision), and measurement ranges >>1 meter. This combination of features is needed for industrial metrology, target identification, and precision surveying applications. During the Phase II effort, a prototype system will be constructed and used to perform targeted experiments based on identified OEM customer needs and industry technology gaps. The prototype will include Doppler compensation, a software interface, and will be fully configured and tested for both in-house and on-site testing. The prototype will then be used to perform critical in-house and on-site demonstrations driven by OEM customer needs, which include spatial multiplexing and galvo steering for rendering rapid 3D images, precise measurement of large-angle and diffusely scattering surfaces for precise measurement of aspheric lenses, oddly shaped objects, and rough surfaces, and precise measurement of meter-level displacements for CMM and gauge block calibration.

The broader impact/commercial potential of this project will initially be to improve manufacturing efficiency, quality, and production throughput. The measurement system uniquely combines extremely high precision (<10 nm) with the ability to measure over extremely large ranges (>>1 m). Due to this combination of performance and flexibility, coupled with demonstrated high update rates, the technology will enable increased production throughput in the manufacturing process and enable rapid absolute positioning and scanning measurements. The system will therefore enable considerable growth in an industry driven by advanced and more accurate inspection. The project will also lead to important societal benefits. For example, the technology holds promise for penetration into severely degraded visual environments caused by blowing sand and dust as well as into smoke or fog. It is anticipated that a variety of military and civilian applications would benefit from this capability including navigation, fire safety, and inspection systems. The benefits include saved lives and reduced property damage and more efficient search and rescue in burning buildings. Moreover, the system provides unique scientific opportunities such as enabling advanced space-based measurements by formation flying sparse apertures for the exploration of extra-solar planets and for atmospheric turbulence mitigation and high resolution imaging of the earth from space.

Daylight Solutions, Inc.

Phase II Award No.: 1230424

Award Amount: $421,163.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Laser-Based Replacement for FTIR Microscopy

This Small Business Innovation Research (SBIR) Phase II project will realize the full potential of a new quantum cascade laser (QCL) infrared microscope for medical diagnostics. Infrared microscopy can be used for tissue identification without staining, potentially allowing quick, in situ diagnostics for diseases such as cancer. Present infrared microscopes based on Fourier transform infrared (FTIR) spectrometers and cooled detectors have a high cost and slow image acquisition speed that limits their usefulness in standard medical clinic settings. New QCL technology makes compact, broadly tunable laser light sources a reality for the mid-infrared region (3 to 12 um) where these microscopes operate. The high power of these lasers also makes it possible to use less sensitive (and lower cost) room temperature focal plane arrays for image acquisition. The Phase I research demonstrated that microscopy and imaging are indeed possible with coherent light sources like QCLs. The performance enhancements available with the rapid tuning and high intensity of QCLs will allow cancer screening via infrared tissue analysis at unprecedented speeds. The intellectual merit in the proposal is to create a useful product based on this new technology that can benefit cancer researchers and medical diagnostics.

The broader impact/commercial potential of this project is that infrared microscopes with increased capabilities and reduced cost can be developed and made available for medical diagnostics at the clinic level. Recent research demonstrates that infrared microscopy offers the resolution and tissue identification capabilities necessary for it to be used in automated algorithms for cancer screening. In spite of this potential usefulness, infrared microscopy has been confined to select labs. This is in part due to existing FTIR technology that does not allow the reduction in size and cost, nor increase in acquisition speed and resolution, necessary to make infrared microscopy a common analytical technique. The QCL microscope to be built in Phase II will revolutionize infrared microscopy instrumentation. Based on demonstrated performance of components in Phase I, it is estimated that the time to screen a tissue array for signs of cancer will be reduced from six days with a FTIR microscope, to just three minutes with a QCL microscope. This kind of performance is a game-changer for infrared microscopy, and will help drive larger adoption of the technique in clinical settings, and in automated systems that aid in rapid screening for disease.

Ekso Bionics, Inc.

Phase II Award No.: 0924037

Award Amount: $1,008,000.00

Start Date: August 1, 2009
End Date: July 31, 2013

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Sector: Electronic Systems & Instruments

STTR Phase II: In-Home Rehabilitation System for Post Stroke Patients

This Small Business Technology Transfer (STTR) Phase II project proposes to create an in-home gait training device that allows a post-stroke patient to undergo rehabilitation with little or no assistance. Approximately 500,000 Americans survive a stroke each year. Miraculously, most stroke survivors can relearn skills, such as walking, that are lost when part of the brain is damaged. They can relearn walking most effectively if they are aided in making the correct motions by a machine or a physical therapist while attempting to walk. This training is expensive and requires the patient to make regular visits to a stroke center or qualified physical therapy center. Berkeley Bionics proposes to create a lightweight robotic exoskeleton which cradles a patient's lower extremities and torso, and maneuvers their rehabilitating limbs for them.

The broader impacts of this research are immense. These devices could move most post-stroke rehabilitation out of the clinical setting thereby reducing labor costs dramatically. The gait training exoskeletons will be wearable, very unobtrusive, and allow patients to maneuver in the real world. Patients would therefore be able to wear such devices for most of the day, thus remaining mobile and gaining the therapeutic effects of physical therapy over the course of a day, rather than just a short session. Furthermore, creating such a device will also give clinicians an alternative to the wheelchair to assist patients who are unable to recover adequate mobility to function in their daily lives. This could potentially reduce unhealthy effects of wheelchair use for millions.

Ekso Bionics, Inc.

Phase II Award No.: 1026872

Award Amount: $1,000,000.00

Start Date: September 14, 2010
End Date: February 28, 2015

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Sector: Electronic Systems & Instruments

STTR Phase II: Integrated Powered Knee-Ankle Prosthetic System

This Small Business Technology Transfer (STTR) Phase II project proposes the development of an integrated powered knee-ankle prosthesis. The objective of this proposal is to investigate the use of integrated powered knee and ankle joints in trans-femoral prostheses that use sensory information from the ground and the wearer. The hypothesis is that a prosthesis with actively powered knee and ankle joints will significantly enhance the mobility of trans-femoral amputees while walking on level grounds, as well as stairs and slopes. The inability to deliver power to prosthetic systems has significantly impaired their ability to restore many locomotive functions. This proposal will derive a set of guidelines on design and control of an integrated powered knee and ankle prosthetic system which will improve locomotion function such as walking up stairs, walking up slopes, running, jumping, and as hypothesized in this proposal, even level walking. The proposed work will result in new theoretical frameworks for control and sensory systems, and the design of such systems. Major intellectual contributions will include the design of power systems; development of the sensory system to obtain information from the ground and from the user; the development of a control framework for the interactive control of prostheses; and the development of adaptive and robust controllers for impedance modulation during locomotion.

This project intends to create principles that provide significantly greater functional capabilities for above-knee amputees. Specifically, our work will enable more natural, stable, and adaptable prostheses. These research elements in this proposal will also form a foundation for powered orthotic systems. Additional significant benefits of this work include fostering a broader awareness and increased sensitivity of young engineers and educational institutions to disability issues. Limb loss is also afflicting a growing number of military personnel serving in recent conflicts, as well as a far larger number of veterans from previous wars. The recent Middle East conflicts have resulted in a number of young amputees, many of whom still shoulder the responsibility of raising families and anticipate a working life ahead of them. The integrated knee-ankle prosthetic proposed here will have a direct impact on the mobility of the trans-femoral amputees and their quality of life, and most likely alleviate the long-term consequences related to musculoskeletal health.

Energid Technologies

Phase II Award No.: 0848925

Award Amount: $1,249,200.00

Start Date: March 1, 2009
End Date: August 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Real-Time Roboting Grasping System

This Small Business Innovation Research (SBIR) Phase II research project will create an information-based robotic grasping framework to enable practical grasping of objects for any robotic manipulator and any robotic hand, or even multiple hands. Grasp algorithms are stored in an XML database organized in a tree structure that allows rapid access and uses intelligent caching for very large databases. When a new object is presented to the grasping system, best matches are found in the database and the corresponding algorithms are extrapolated to determine the best grasp for the new object. Shape, surface properties, and articulation are used for matching. The techniques support the grasping of moving objects that can be tracked with a vision-based system. For constructing the grasp database, human supervisors train new grasps by simply picking up objects and giving special cues. Collection devices, such as data gloves and machine vision systems, are used to collect the supervisor's hand position and contact forces, and a learning module finds new grasps by coupling supervisory input with simulation-based optimization, using high-fidelity dynamic modeling. For optimization, control and configuration parameters (in end-effector space) are perturbed iteratively using nonlinear numerical optimization techniques.

If successful the creation of a comprehensive grasping framework as proposed in this project will have broad impact to research, industry, and society. Traditional grasping systems require specialized coding for new tasks and new robots. The proposed system will facilitate specific instantiations of general grasping algorithms. Application to virtually any robot manipulator, any hand, and any object to be grasped will be possible. This unprecedented flexibility, coupled with advanced and innovative grasping algorithms will play a role in advancing general purpose robots (those that can do multiple tasks without reprogramming). Robots with the ability to grasp hold promise for industries with labor shortages. The agricultural industry, for instance, will use robotic grasping for harvesting. Grasping robots will work in dangerous environments. An example application is rescuing injured humans in dangerous situations. Next-generation robots will assist the disabled with intelligent manipulators that can open doors and pick up objects. Grasping robots will support manufacturing and warehouse businesses. The simulation capability that is part of this research will allow new grasping strategies to be tested safely in a virtual environment before being implemented and fielded.

FiveFocal LLC

Phase II Award No.: 1152720

Award Amount: $500,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Computational Low-cost Arrayed Infrared (CLAIR) Cameras

This Small Business Innovation Research (SBIR) Phase II project will develop a revolutionary approach to the lens and opto-mechanical design and fabrication process for long wave infrared (LWIR) imagers with the goal of reducing cost, size, and weight. To date, the high cost of sensors has made LWIR imagers accessible only in markets where performance -not cost - is the driving factor, allowing expensive and bulky optics to reign. New process improvements are significantly reducing the size and cost of LWIR microbolometer sensors, making optics the limiting factor for weight, size, and cost reduction. The research objectives are to extend the technology developed in Phase I and validate the final manufacturing and testing process for the optics and camera assembly to show that the final architecture can meet the market requirements for module volume, weight and price when scaled to high volume production. The development will scale the process to larger arrays and will take the necessary steps to evaluate the solutions mechanical reliability. The solution will be implemented and tested through arrangements with industry partners. The anticipated result is a demonstration of an LWIR camera that meets the needs of the infrared (IR) vision enhancement and thermography markets.

The broader impact/commercial potential of this project is to extend the sale of IR imagers into cost-sensitive commercial applications. Currently IR imagers are targeted for expensive military applications, but there is a large need for reduced cost systems in safety, security, and industrial markets where thermal imaging offers enhanced viewing over the visible spectrum. Thermal imagers provide visibility in complete darkness, which enables imaging in adverse conditions needed by automotive collision detection, search and rescue and security applications that require identification of humans in conditions of no light. In industrial use, LWIR thermography can improve energy efficiency by identifying thermal leaks and can predict imminent process faults. The impact to society is as ubiquitous as the commercial opportunities and constitutes an increase in emergency search effectiveness, city street safety, and energy conservation. The scientific and technological understanding cannot be understated: technological innovation occurs most rapidly near manufacturing capability. Already, labor costs are driving current labor-intensive IR lens fabrication overseas. The proposed innovations remove the labor-intensive component, bolstering the US as the dominant manufacturer in this emerging market while enhancing science in parallel process development, material property innovation, and IR sensor performance.

Gamma Dynamics LLC

Phase II Award No.: 1127463

Award Amount: $459,569.00

Start Date: December 15, 2011
End Date: November 30, 2013

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Sector: Electronic Systems & Instruments

SBIR Phase II: Active Visible and Infrared Management for More Energy Efficient Buildings

This Small Business Innovation Research (SBIR) Phase II program will develop electrofluidic smart window modules with unique capabilities for managing infrared as well as visible light. As a result, these windows will better manage solar heat gain by switching between infrared transmittance and reflectivity. The ultimate objective is to develop skylights, windows, and roofs that adapt to seasonal, regional, and diurnal changes in solar flux and heating and cooling requirements. These window modules change the optical properties of surfaces by moving pigment from a small area reservoir to full surface coverage in a similar manner to the way squids change their skin color. The Phase I program developed pigmented fluids with engineering infrared responses, and demonstrated proof-of-concept functioning devices operating with these fluids. The Phase II project will develop the designs, processing strategies, and materials for full smart windows modules. Windows modules will then be built, measured, and directly compared with status quo windows. The innovation in this work is the development and realization of entirely new materials and devices for managing near-infrared light over a large surface area.

The broader impact/commercial potential of this smart window technology is empowering buildings to actively manage solar heat gain to improve energy efficiency, which is a truly green solution. U.S. building energy consumption (40% of total U.S. Energy Consumption) can be reduced significantly with smart windows and smart skylights that maximize sunlight for lighting, while effectively managing solar heat gain, including near-infrared energy. Current passive technologies for windows do not readily adapt to seasonal, regional, and diurnal changes in solar flux and heating and cooling requirements. By empowering buildings to adapt solar heat gain to daily local needs, U.S. energy consumption could be reduced by as much as one quadrillion BTU per year, while adding minimal cost to building infrastructure. The commercialization path for this technology is through the Advanced Flat Glass segment of the Flat Glass market. In addition, this program will enhance scientific innovation at the Ohio Center for Microfluidic Innovation, a cluster for commercializing micro/electrofluidic technology.

Kapteyn-Murnane Laboratories, Inc.

Phase II Award No.: 1152265

Award Amount: $507,303.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Development of a Commercial Two-Dimensional Infrared (2D IR) Spectrometer for Characterization of Chemical Systems

This Small Business Innovation Research (SBIR) Phase II project is to develop a prototype for a commercial two-dimensional infrared (2D IR) spectrometer and its associated mid-infrared laser system. One of the most exciting developments in the field of ultrafast spectroscopy in the last decade has been the invention of 2D IR spectroscopy. It is now being used to study problems in material science, chemical dynamics, electron transfer, biophysics, polymer structure, solar energy, analytical diagnostics and others. But while it is now recognized as a valuable research tool, it is difficult to implement since it is only being utilized by a relatively small group of ultrafast spectroscopists that specialize in infrared spectroscopy. The research objectives of this project are to design and develop a 2D IR spectrometer, including an efficient mid-infrared laser source, which requires no technical skills to operate. It will utilize mid-infrared pulse shaping, a newly designed optical parametric amplifier, and a mid-IR pump laser. The system will be mechanically robust and computer automated so that it will be used by 2D IR experts and non-experts alike.

The broader impact/commercial potential of this project is the development of a commercial 2D IR spectrometer that will be used in academic, government, and industrial research laboratories worldwide with applications spanning the biological, chemical and physical sciences. 2D IR spectroscopy provides structural and dynamical information that is difficult to obtain with other techniques, such as at inorganic/organic interfaces that are important in solar cell research or membrane proteins associated with pharmaceutical targets. There are more than 15,000 research laboratories worldwide that utilize infrared spectroscopy of some type, and 2000 labs that utilize ultrafast spectroscopy. Thus, the commercial potential is substantial. The development of this laser technology has important societal implications due to the wide range of scientific and industrial topics that this technology can be applied.

Levant Power Corporation

Phase II Award No.: 1127397

Award Amount: $500,000.00

Start Date: November 15, 2011
End Date: October 31, 2013

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Sector: Electronic Systems & Instruments

SBIR Phase II: Integrated Hydraulic Suspension Energy Recovery System for Heavy Vehicles

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a fully functional turnkey regenerative semi-active shock absorber for heavy-duty transit buses and other commercial vehicles. An appreciable amount of energy is lost in a typical suspension as heat, especially in heavy vehicles. Existing technologies have been unable to efficiently capture this energy in a cost-effective manner. This project entails hydraulic and electronic model optimization, design of vehicle-ready prototypes, fabrication, lab testing, installation, and operational testing of a hydraulic adaptive damping energy harvesting system. The objective of the project is to demonstrate real-world benefits of an efficient, adjustable damping regenerative shock absorber on a transit bus in operation with a municipal transit agency. Emphasis will be on efficiency improvements, semi-active ride control, and application specific integration requirements to ensure seamless installation and operation. Work will culminate in a fully fielded pilot demonstration and quantification of regenerated energy (improved fuel efficiency) and ride improvement benefits using the regenerative semi-active shock absorber.

The broader impact/commercial potential of this project is significant if the challenges of inexpensively, reliably, and efficiently capturing suspension energy are overcome. The technology has the potential to save millions of dollars per year in fuel for large fleets, and significantly reduce carbon emissions in the United States and abroad. Effectively incorporating an aftermarket or OEM retrofit-able regenerative energy capture system may open doors to many new regenerative technologies in the transportation and automotive sector, facilitating significant reductions in waste energy. In addition, the research may lead to enabling technology for compact, sealed, and efficient hydraulic actuators and energy harvesters across several industrial applications. This may have applications in other fields such as off grid marine (hydrokinetic) energy, aerospace actuators, heavy machinery dampers, orthotics/prosthetics, and robotics.

Love Park Robotics, LLC

Phase II Award No.: 1256080

Award Amount: $500,000.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Electronic Systems & Instruments

SBIR Phase II: CoPilot - An Active Wheelchair Driving Aid for Independent Living

This Small Business Innovation Research (SBIR) Phase II project proposes to develop and commercialize an active driving aid that enables semi-autonomous, cooperative navigation of an electric-powered wheelchair (EPW) both indoors and in dynamic, outdoor environments. It uses intelligent sensing and drive control systems that work in cooperation with the driver to aid in negotiating changing terrain, avoiding obstacles/ collisions, and maintaining a straight path. Additionally, the system allows for higher-level path planning and the autonomous execution of non-linear routes of travel in a safe and efficient manner. The goal of the project is to enable active, safe, and independent living. The innovation is that as an individual begins to lose cognitive, perceptive, or motor function - due to age, injury, or disease - the system can augment that loss because it can interpret the user's intent and it can "see" out into the environment on their behalf. This exteroceptive sensing capability is enabled by leveraging the latest in 3D imaging technology. The team will exploit their experience in commercializing smart-EPW technologies (including acquiring FDA approval), and will apply the knowledge they have gained in developing autonomous driving solutions through their participation in the DARPA Urban Challenge.

The broader impact/commercial potential of this project will have significant impacts in the U.S. Socially, it will have a direct positive effect on the quality of life and independence of the elderly and disabled. Leveraging robotics for personal mobility can help Americans with disabilities to participate fully in basic activities such as employment, education, worship, recreation, and other activities of community life often taken for granted. Economically, a serious side effect of the rapidly growing elder population, to over 70 million by 2030, is that it will place unprecedented strains on the U.S. healthcare system. This impact can be moderated in part by enabling individuals to maintain their independence and live at home longer. It is estimated that adding a single month of independence and health to America's elder population would save $5 billion, while decreasing hospitalization and institutionalization 10% would save $50 billion annually. As a result, technology for home-centered approaches to healthcare, such as the proposed system, are necessary. In research terms, while the immediate focus is in the field of assistive robotics, this research will be extendable to general field and service robotics as much of the work is related to 3D perception.

Mad City Labs, Inc.

Phase II Award No.: 1152645

Award Amount: $500,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Real-time Active Image Stabilization for Microscopy

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize an integrated system to actively stabilize an optical microscope to the precision required by today's cutting-edge imaging methods. Microscopy in the biological sciences is undergoing radical advancement on several fronts. "Super-Resolution" (SR) techniques circumvent the diffraction limit on resolution once thought to be insurmountable, and promise the ability to image the structures and processes of cell biology at the molecular level. This will usher in profound advancements in the understanding of the inner-workings of the cell. However, significant interrelated barriers remain in the path towards widespread use of SR techniques: (1) they are technically challenging and (2) expensive to implement; and (3) they place physical demands on the microscope platform it was not designed to meet. Foremost of these demands is that SR methods require control over the movement of the biological sample and the stability of the microscope system with nanometer precision. This commercialized integrated system is designed specifically to address these issues and remove these barriers. It uses a 3-axis, piezo-driven nanopositioning stage to control sample motion and actively maintains the stability of the system using the image as the reference point for this stability.

The broader impact/commercial potential of this project lies in making SR methods routinely useful to working biologists. These "game-changing" tools will advance our understanding of the molecular bases of disease pathologies, and enable far more exacting methods aimed at their treatments. The new insights will range from those in molecular virology and the development of safer and more effective vaccines, to the molecular mechanisms of neuronal signaling and learning and memory. In fact, it is hard to imagine an area of cell biology that will not be impacted by these emerging SR techniques. One of the pioneers of these methods has likened them to the Hubble telescope: they enable people to see things they simply could not see before. This analogy goes further: there is only one Hubble telescope, and currently very few SR-capable imaging systems, due to both the technical and economic barriers to their routine use. And while SR methods expose the physical limitations of microscopes in an acute manner, their stability and image acquisition requirements are not unique. Thus, this commercial system will be much more broadly useful: it will also enable focal-stability and molecular tracking at the nanometer-scale for any long-term imaging experiment.

Maine Manufacturing LLC

Phase II Award No.: 1152249

Award Amount: $515,980.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Program Director: Juan E. Figueroa

Sector: Electronic Systems & Instruments

SBIR Phase II: Novel Microarray Platforms For Detection Of Rare Molecules In Complex Mixtures

This Small Business Innovation Research (SBIR) Phase II project will provide an optimized composite polymer protein binding surface for proteomics applications. The new surface will be specifically designed for reverse phase protein microarrays to enable detection of rare molecules in complex biological mixtures. Discovery and quantification of rare molecules in complex mixtures is essential to improve the understanding of disease mechanism and progression, and responses to treatment regimes. Current surfaces used in these applications have properties that exhibit limited sensitivity of detection due to optical interferences, low protein binding and accumulation of nonspecific interactions. This project will optimize and introduce the application of a new track etched, nitrocellulose composite membrane for protein array applications. Manufacturing processes for the new composite will be developed to generate multiple forms of the composite to allow it to be incorporated into a variety of binding assay formats. This effort will also shed light on important properties for generating ultrasensitive binding surfaces. The result of this project will be an optimized composite membrane with characteristics and manufacturability suited for the most sensitive binding applications, such as reverse phase protein arrays. The platform initially will be optimized for fluorescent detection of rare molecules in complex cell lysates.

The broader impact/commercial potential of this project will be to provide a family of discovery and diagnostic tools that will expand the understanding, detection and treatment of human disease. The current focus in translational medicine for therapies in clinical trials is to identify expression patterns of proteins (biomarkers) in individual patients. These measurements allow the monitoring and understanding of individualized disease progression and responses to treatment. They will provide the data necessary to create targeted, personalized treatment regimens. Protein arrays have found utility over the past decade as research tools that provide multiplexed detection and quantification of protein expression. However, the full potential of these tools as diagnostic platforms that provide patient-specific information and guide drug treatment has not been realized due to insufficient binding capacity, limited dynamic range and poor sensitivity. This project defines a new composite surface that has a significant increase in both binding capacity and sensitivity when incorporated into multiplexed immunoassay systems. The composite can be included in a variety of platforms to enhance discovery and quantification of important markers on an individual scale as well as high throughput systems for broad diagnostic application.

Nextval Inc.

Phase II Award No.: 1151957

Award Amount: $598,758.00

Start Date: April 1, 2012
End Date: September 30, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Mass Spectrometry Imaging for High-Throughput Discovery of Enzyme Activity

This Small Business Innovation Research (SBIR) Phase II project will further develop and commercialize a groundbreaking technology for high-throughput cost-effective screening and analysis. This technology addresses the growing disparity between the ability to generate high-complexity chemical libraries with molecular genetics and combinatorial chemistry approaches, versus the ability to rapidly screen these libraries for high-value molecules. This new high-throughput screening product is a novel integration of an acoustic ejection device with chip-based mass spectrometry to produce mass readout microarrays that are analyzed in high-throughput with mass spectrometry imaging and computational algorithms. Phase II efforts will focus on a high-throughput screening product for cellulase enzyme discovery, a critical enzyme in the production of alternative fuels that is limited by optically based screens which often generate false leads. Importantly, this integrated high-throughput platform does not require sample labeling, is applicable to a broad range of chemical activities, and provides much more information from a single readout than current approaches. Phase II development will produce a commercial screening technology with these advantages and analysis throughput of 250,000 samples/week, while maintaining the flexibility for future applications in the industrial, pharmaceutical and diagnostic markets.

The broader impact/commercial potential of this project are cost-effective high-throughput discovery of new enzymes and molecules with enhanced or novel activities in the industrial, environmental, pharmaceutical or diagnostic markets. Also, the proposed technology enables entirely new types of high-throughput screens that are currently inaccessible with existing technologies. Most immediately this high-throughput screening product will be commercialized for application in the $1 billion industrial enzyme market with specific focus on one of the largest fractions of this market, the enzymes important for efficient and economically viable production of second-generation alternative fuels. Beyond the application to alternative fuels, Phase II development will produce a flexible discovery platform that can be expanded to numerous commercial markets. For example, the Phase II developments can also help develop new lower-cost therapeutics by reducing false leads and enable higher specificity diagnostics and testing by providing much more chemical information.

PaneraTech Inc.

Phase II Award No.: 1256254

Award Amount: $499,918.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Program Director: Muralidharan S. Nair

Sector: Electronic Systems & Instruments

SBIR Phase II: Structural Imaging of High Temperature Furnace Walls

This Small Business Innovation Research (SBIR) Phase II project aims to develop a prototype 3-D imaging sensor for high temperature furnaces used in the glass industry. These furnaces are also used in many other industries, including cement, coke, iron & steel, and pulp & paper industries. This 3-D imaging sensor creates an interior image of the furnace wall so that maintenance personnel can identify wall erosion, and any molten material leaking through the wall joints. The objective in Phase II is to develop a prototype sensor system that can form 3-D images of the interface between the furnace wall and molten glass. To achieve this, a high performance sensor hardware and corresponding imaging software will be developed. The entire prototyped system will be tested on high temperature furnace walls using in-house kilns followed by tests at an operational glass furnace.

The broader impact/commercial potential of this project is that it will enable maintenance programs based upon real furnace conditions. This will allow longer life span of high temperature furnaces and the ability to make informed local maintenance without a major interruption in production. This translates to significant financial savings for the glass manufacturing industry and improved safety, as several catastrophic accidents have occurred due to molten glass leaking from the furnaces. The sensor technology also offers a platform on which many other applications can be built, including microwave medical imaging, archaeology explorations, and defect detection inside refractories during manufacturing.

Promethean Power Systems

Phase II Award No.: 1256315

Award Amount: $492,147.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Electronic Systems & Instruments

SBIR Phase II: Improved Cold Thermal Energy Storage for Refrigeration Applications

This Small Business Innovation Research Phase II project proposes the commercialization of a new type of industrial refrigeration system for cooling raw milk in Indian villages, without the use of backup diesel generators. The innovation lies in a novel thermal battery pack concept developed by Promethean Power Systems with a Phase I grant from the National Science Foundation. The battery solves a chronic unreliable electricity problem by converting and storing electrical energy in the form of thermal energy through a process of freezing and melting a material. The battery needs just five hours of grid electricity to charge and, once charged, provides constant cooling power on demand when the grid is off.

The broader impact/commercial potential of this project will be the introduction of clean energy technologies in refrigeration applications, eliminating costly spoilage of foods and providing clean energy alternatives to developing economies that currently rely on fossil-based fuels for their continued growth. In developing countries, billions of dollars of perishable foods are wasted annually because of inadequate cold-chain supply networks. A major obstacle in setting up a cold-chain network is the lack of reliable grid electricity to run refrigeration systems in villages and farming areas. In such conditions, diesel generators are often used as backup, a nonideal solution with high cost and environmental impact. Promethean's thermal battery eliminates diesel generators and makes village refrigeration systems economically viable. This could revolutionize dairy industries around the world, especially in India, the largest producer and consumer of milk in the world, where nearly 400 million people depend on milk for their daily protein. Although Promethean's first commercialization efforts are in India where thermal batteries are needed the most, these efforts will benefit US economy by providing a large and growing market to US products and affirming America's leading role in spreading innovative ideas throughout the world.

RemoteReality Corporation

Phase II Award No.: 1152652

Award Amount: $487,554.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Compact Ultra High Resolution 360 Degree Imaging System

This Small Business Innovation Research (SBIR) Phase II project will advance the state of the art in compact 360-degree camera systems, achieving sizes of about 1/8 of current systems, without compromising the quality or resolution of the optics. Convex mirror based optics has resulted in the realization of very high-resolution ultra-wide angle camera systems. A fundamental limitation in these systems has been the size of the optics in relation to the size of the imaging sensor. Mirror diameters in the range of 10 times the size of the sensor have been achieved. The objective of this research is to overcome the above limitation and achieve mirror diameters at the level of 3-5 times the size of the sensor, keeping ultra high resolution across the entire field of view. In this Phase II project, a miniature high-resolution 360-degree prototype system including optics and camera sensor will be built to demonstrate this capability.

The broader impact of this project will be will to increase the market reach of ultra-wide angle cameras for multiple applications, including video-conferencing, robotics and home surveillance. This new approach to designing optics will result in substantially reducing the form factor of high-resolution wide-angle optics. The high-resolution camera sensors available in the consumer market today can be better used in very small ultra-wide angle video cameras with the ability for multiple remote users to decide where they want to look independent of each other. This has the potential of transforming the market for pan-tilt-zoom cameras to "solid-state pan/tilt/zoom" cameras. The very low size, weight and power cameras that would result from this research can result in small wireless, battery powered systems that would increase the proliferation of cameras for a variety of different applications.

SC Solutions Inc.

Phase II Award No.: 1229938

Award Amount: $500,000.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Rapid In-Line Detection of Macro Defects in Semiconductor Manufacturing

This Small Business Innovation Research (SBIR) Phase II project will develop a prototype of a software tool for automatic detection of macro defects on semiconductor wafers based on optical scanning or imaging of the wafer surface, for use in fabs that manufacture integrated circuit chips. A typical semiconductor chip fabrication process involves hundreds of complex and expensive processing steps. With an increase in the number and complexity of process steps involved, it is of critical importance to detect defects early in the manufacturing process. Yield would be maximized if such detection is performed for each and every wafer without affecting throughput. Under this program an innovative in-line tool will be developed to rapidly detect macro defects on whole wafers by integrating inexpensive commercially-available hardware with sophisticated defect detection and classification algorithms. The tool will inspect every wafer and will have zero false positives. In Phase I, the feasibility of the proposed approach was conclusively demonstrated. In Phase II, a prototype of the defect detection and classification software and scanning hardware will be integrated into commercial wafer processing equipment, and its effectiveness will be demonstrated. The tool will have a major impact by reducing inspection cost and increasing yield.

The broader impact/commercial potential of this project is substantial. There is great potential in the semiconductor industry for an inexpensive tool for real-time detection and classification of macro defects right at the equipment where the defect is generated. The successful commercialization of the proposed defect detection tool will assist in significantly increasing manufacturing yields and thus lowering costs. The product will find use in several secondary markets such as solar energy devices, light emitting diodes, photonics, etc. Additionally, with strong relationships with several universities, summer internships will be provided to students from local universities, and the research findings will be presented at international conferences. Thus the proposed work will certainly impact academic research and training and there is a strong commitment to creating opportunities for women and minorities. Finally, microelectronics affects almost every aspect of our lives including wireless and mobile internet technology. Hence, a product that makes a significant contribution to lowering the cost of manufacturing integrated circuits will positively affect the society at large.

SpringActive, Inc.

Phase II Award No.: 0956828

Award Amount: $853,091.00

Start Date: February 1, 2010
End Date: June 30, 2013

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Sector: Electronic Systems & Instruments

SBIR Phase II: Compliant Jack Spring Actuators for Lower Limb Mobility

This Small Business Innovation Research (SBIR) Phase II project will develop a novel, spring-based, adjustable stiffness actuator, that will power future wearable robots and exoskeletons. The actuator will be integrated into a powered prosthetic ankle which will meet the demanding requirements for lower limb mobility. Its unique ability to tune stiffness allows it to be customized to an individual, a significant impact in the wearable robotics field. It will meet the demanding design requirements that include the tradeoffs between high power need, low energy usage, compliance, robust sensing of forces, and high cycle demands. The end result is a powered ankle-foot prosthesis that will provide near able-bodied function to a lower leg amputee.

The broader impact/commercial potential of this project is that it will restore normal walking function to below-the-knee amputees. Such a device will increase symmetry and duration of walking. In fact, a below-the-knee amputee wearing a passive prosthetic device typically uses 20-30% more energy to walk than an able bodied walker. Asymmetry in an amputees gait leads to joint pain, arthritis, and back pain. Because of the difficulty to walk, their conditions often lead to a more sedentary lifestyle decreasing their already limited mobility. It is documented that decreased mobility increases health risks. Elderly or overweight individuals may benefit from the technology as well. Adaptation of the technology to the powered orthosis market will expand its benefits to weak and disabled populations. In general, these groups have a more sedentary lifestyle and sometimes rely on the use of powered scooters. Because of the growing population of people with diabetes, elderly, and individuals with reduced walking ability, powered lower-limb robots will have a significant societal impact improving health by supporting an active lifestyle.

Sunstream Scientific Incorporated

Phase II Award No.: 1230451

Award Amount: $476,170.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Juan E. Figueroa

Sector: Electronic Systems & Instruments

SBIR Phase II: A Pneumatically Actuated Robot System

This Small Business Innovation Research (SBIR) Phase II project addresses the challenge of coupling direct drive servo actuators to industrial robotic plants with uncertainties. Enhanced productivity sought in many applications requires higher cycle rates placing great demands on machine kinematics, actuators and control systems. Further increase in operating speed must resolve dynamic challenges intrinsic in directly coupling servo actuators and robot linkages. When compared with existing electromechanical servo actuators - which route power through complex mechanical transmissions - direct-drive actuation of robot linkages enables simple mechanics and rapid motion, but does not provide dynamic isolation between the actuator and robotic plant. Consequently, direct-drive servo actuators are sensitive to variations in plant parameters, unknown disturbances, and un-modeled dynamics. This project will investigate and develop a prototype of an innovative, direct-drive pneumatic robot actuator that employs an advanced control strategy to rapidly accommodate dynamic system variations. Effectiveness of a new control strategy that relies on limited specific knowledge of the plant to optimize robustness to bounded uncertainties will be researched and developed. Success of this project will provide for significant advances in speed, load capacity, and affordability in contemporary industrial robotic systems.

The broader impact/commercial potential of this project involves engineering research conducted to enhance understanding of the dynamic interaction between direct-drive servo actuators and robotic mechanisms, and further to enhance the effectiveness and understanding of a control strategy which provides for an advantageous coupling between them, heretofore not practically feasible. This has the potential of introducing transformative change in the robotics industry, and to industrial automation in general. Furthermore, the controls knowledge gained from this research can be extended to many electric servo systems and to industrial control systems in general. Two market segments will be targeted: robotics and general motion control (GMC), both estimated at $7 billion. If software, peripherals and systems engineering are included, the robotics market is estimated at $19 billion. Both the robotics and GMC industries significantly support the national economy with applications ranging from manufacturing and food processing, to medical advances such as remotely controlled surgery, and to national defense. Well-paying new hi-tech jobs are created in engineering and technical services. This research will develop new applications in robotics and industrial automation, educational STEM opportunities, enhanced scientific and technological understanding, making the U.S. more competitive globally.

The Laser Sensing Company

Phase II Award No.: 1230427

Award Amount: $499,968.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Towards Precision Ultra-Portable 13C/12C CO2 Atmospheric Isotopic Ratio Monitors Using Quantum Cascade Laser Spectroscopy

This Small Business Innovation Research (SBIR) Phase II project will develop a robust, ultra-portable CO2 isotope ratio sensor. Typically, portable sensors cannot provide good sensitivity and accuracy. Sensors which do provide adequate sensitivity and accuracy are bulky, power hungry, high maintenance, and require a controlled operational environment. This is especially true for existing CO2 13/12C isotope ratio sensors, which require hundreds of watts of power. Portable 13/12C sensors are critical to enable new applications including remote sensor network CO2 sequestration monitoring, environmental carbon cycle measurements, and medical breath analysis. Novel technology using quantum cascade lasers and the latest compact optical cells can provide a compact, power efficient, sensitive, and accurate sensor platform for gas sensing. The research objectives for this project aim to break the tradeoff between power consumption, sensitivity, complexity, and size. This project targets the development of a robust, field-deployable, outdoor sensor, and verifies its performance against existing methods of measuring CO2 isotope ratio. The realization of the final product will deliver a portable 13/12C isotope ratio laser spectrometer that operates in harsh environments using less than 15 Watts of power.

The broader impact/commercial potential of this project deals with enhancing environmental monitoring by: 1) Enabling more precise measurements of carbon sources and sinks to improve climate science; 2) Providing a map of real-time carbon emission which is useful for research, policy, and education; 3) Providing real-time, long-term remote carbon measurements for carbon trading markets; 4) Enabling extremely sensitive leak detection of CO2 in carbon capture and sequestration applications without the significant cost of mobile laboratory infrastructure. A more powerful set of gas sensors such as the ones developed through this project will dramatically lower the great expense currently required to precisely monitor greenhouse gases and air pollution, a critical global concern. Data generated by such carbon isotope ratio sensors will answer many critical questions related to the human impact of burning fossil fuels on the environment. These types of sensors will also simultaneously impact industrial and medical fields, providing new solutions for industrial process control and safety, and portable real-time medical breath analyzers.

Translume

Phase II Award No.: 1256277

Award Amount: $413,829.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Electronic Systems & Instruments

SBIR Phase II: Nutrient Analyzer with Integrated Optics and Glass-Diaphragm Pump for Field Studies

This Small Business Innovation Research Program (SBIR) Phase I project will entail the development of a microfluidic colorimetric analyzer to yield quantitative field measurements out of essential inorganic nutrients (initially nitrite and nitrate, thereafter ammonium and orthophosphate). This analyzer will primarily be used in industrial farms where algae are grown to produce biofuel. Inorganic nutrients affect not only the amount of algae biomass generated, but also its lipid content. Maximizing algae biofuel production requires a series of steps, each associated with an optimal nutrient concentration. The amount of nutrient must be measured on a frequent basis as the timescales associated with algae growth are short. Currently, nutrient concentration data is obtained at rates that are too slow to permit maximization of algae production. This problem is being addressed through the development of a small inexpensive colorimetric analyzer that will perform real-time measurement. The design of this instrument is optimized for prolonged unattended field operations, and minimal maintenance and consumption of supplies. It uses EPA-approved analytical chemistries. These have been selected because they are the least susceptible to interference from other compounds present in the algae bioreactors and/or ponds.

The broader impact/commercial potential of this project effects US energy policy. The world is gradually running out of fossil oil. Renewable biofuels are increasingly seen as a key element of the US energy future. Algae, a source of oily biomass, are a leading candidate to meet biofuel needs. They can yield more fuel per acre than any other crops, they have the capability to grow in freshwater, as well as saltwater, and they are able to flourish in poor agricultural soil, which will reduce pressure on food prices. Furthermore, algae can grow using wastewater as nutrient feedstock. This reduces the ecological impact of wastewater discharges. Presently, the production of biofuel from algae is cost prohibitive due to high culturing and processing costs. Improving the management of inorganic nutrient levels in ponds and reactors where algae are grown will play a significant role in lowering biofuel production costs, ultimately making biofuels competitive with fossil fuels.

Transmed Systems Inc

Phase II Award No.: 1230265

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Efficient Comparative Effective Research Tools In Real Time Environment

This Small Business Innovation Research (SBIR) Phase II project will focus on the enablement of comparative effectiveness research (CER), evidence based medicine (EBM), and personalized medicine (PM) by researchers utilizing both clinical and complex biomolecular data. The first phase of this grant was focused on a feasibility study working with customers to determine the extent to which the tools we were creating would and could be utilized in practice. This phase is focused on implementation of these tools in real-world health care environments and creating systemic improvements of healthcare by improving tools available for self-evaluation by hospital administrators and clinicians alike. There will be four key objectives accomplished as a result of this proposal. The first is the development of care-improvement algorithms for pediatric ICU patients with sepsis and congenital heart disease. The second will be a reporting engine that mines electronic medical records to create CER reports for patients. The third is an easy-to-use enterprise level reporting engine to check compliance with national standard health care quality metrics and to create new metrics for care improvement. The final objective is to create a personalized medicine reporting system based on next generation sequencing data.

The broader impact/commercial potential of this project is significant because it capitalizes on two trends in health care - digitizing patient clinical data and the increasing use of molecular sequencing and microarray data. The commercialization of the technical innovations referenced in this project will enable researchers and clinicians to generate true Comparative Effectiveness Research (CER), Evidence-based precision medicine (EMB) and Personalized Medicine reports (PMR). The ultimate objective of this technology is improving patient outcomes. Leveraging historical patient data in CER to eliminate ineffective therapies from the health care system, coupled with utilizing genetic information to create a more personalized model of health care, will focus precious health care dollars on effective therapies optimized for the individual. Ultimately, this tool will be appealing to every segment of the health care industry including clinicians, researchers, pharmaceutical companies, and insurance companies due to the increases in quality and cost savings that will be created.

Willow Garage, Inc.

Phase II Award No.: 1256643

Award Amount: $499,885.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Sector: Electronic Systems & Instruments

SBIR Phase II: Personal Service Robotics with Tiered Human-in-the-Loop Assistance

This Small Business Innovation Research (SBIR) Phase-II project will create the technological components, operator interfaces, and integration necessary to achieve practical Personal Service Robots. Personal service challenges robots with unstructured, cluttered, and ever-changing environments, and requires execution of complex tasks. Our novel approach allows autonomous algorithms to request human assistance as needed. Across multiple tiers, assistance can range from simply identifying a partially occluded object, to selecting an appropriate grasp configuration, or even to unsticking a wedged object by direct teleoperation; however, sustained operator involvement should only occur infrequently. This approach enables imperfect autonomy to complete full tasks while minimizing manual labor needs as compared to classical teleoperation. Efforts during Phase I established the feasibility of this combined approach while demonstrating the execution of typical household tasks. Developments under Phase II will focus on reducing the human workload. Major innovations will occur from three elements: (a) creating and optimizing distinct operator interfaces for different assistance needs, (b) refining autonomy to reduce the need for assistance, and (c) narrowing applications and support algorithms to relevant and desired service tasks. These developments will allow individual operators to support multiple robots in parallel, with the multiplicative effect amplifying manual labor savings.

The broader impact/commercial potential of this project addresses the fact that the U.S., like many industrialized nations, is seeing its demographics shift to an older population. This implies a shrinking workforce as well as rising labor needs to support the older adult community, which will require greater assistance with tasks of daily living as they age. Robotics is often considered a solution to stretch a limited labor supply. The company specifically target personal service robotics to support older adults via either home care providers or assisted living facilities. By reducing operator workload and allowing a single operator to assist multiple robots performing personal service tasks, this R&D effort can increase the productivity of service labor and provide a higher quality of personal service than traditionally possible. This robotic approach can also more easily distribute the labor across physical distances. This will allow older adults to age in familiar housing, retain greater independence, and reduce their expenses at home or in assisted living facilities.

XW, LLC

Phase II Award No.: 1152622

Award Amount: $500,000.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Sector: Electronic Systems & Instruments

SBIR Phase II: Crosstalk Mitigation for Copper-Based Cellular and Access Backhaul

This Small Business Innovation Research Phase 2 project targets the realization of a cost-effective solution for achieving increased data throughputs in the crosstalk-constrained copper-medium-based cellular and access backhaul networks, to address the growing demand for capacity experienced in them. Existing equipment, confined to the use of twisted-pairs due to the unavailability of fiber in most locations, often avoids the use of spectrally efficient VDSL, whose high-capacity comes at a cost of vulnerability to interference. The technology developed in Phase 1 of this project, and its implementation in hardware and software as part of the Phase 2 project, will effectively address this vulnerability of VDSL and recover most of its potential capacity through crosstalk cancellation. The company's key innovation is in non-iterative, low-latency, reduced-complexity, dynamic interference cancellation algorithms, which greatly enhance performance while requiring less than 10% of silicon-area increase in existing VDSL2 multi-channel solutions. The project will involve both research and development aspects, as well as system implementation challenges associated with the minimization of complexity and power consumption. Based on the Phase 1 project's successful validation of the technology's critically needed throughput enhancements and its commercial potential, it is anticipated that this technology will be widely incorporated in copper-based equipment.

The broader impact/commercial potential of this project is in extending the useful life of the existing in-ground copper infrastructure, thus allowing equipment providers to continue to focus their resources on delivering ever-increasing bandwidths, while also offsetting the high expense of new fiber deployment. Benefits are also realized through the company's partnerships with universities, where the company works closely with key faculty and with students, provides seminars, and has an ongoing internship program that results in the full-time hiring of graduates. According to publicly available reports, mobile data traffic in North America is expected to increase by a factor of over 20 by the year 2015. This massive increase in data consumption, brought on primarily by the rapid adoption of smart-phones and bandwidth-intensive applications, is already placing an enormous burden on the backhaul infrastructure, which carries telecommunications for cellular, internet and land-line voice traffic. Resolution of the bandwidth congestion requires significant improvement in telecom infrastructure including backhaul and access, both of which are largely copper-based in North America. The company's interference-mitigation technology will address this problem in a cost-effective manner by allowing the growing demand for bandwidth to be satisfied with the existing infrastructure.

Affectiva, Inc.

Phase II Award No.: 1152261

Award Amount: $599,998.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: Cloud-Enabled Analysis Of Facial Affect

This Small Business Innovation Research (SBIR) Phase II project will commercialize the world's first cloud-based emotion measurement platform. Today, the majority of market research is expensive and slow, relying either on subjective self-reports or costly, obtrusive lab-based technologies. The proposed emotion measurement platform aims to democratize market research by translating nonverbal facial expressions into intuitive emotional insights. It also drives down research costs and improves market reach through the use of widely available webcams as the means to record faces. This platform enables businesses of any size to capture consumer's emotional reactions as they engage with their brands, particularly in the areas of advertising, product design and packaging. For example, brand managers, marketers and agencies can optimize ad effectiveness by evaluating viewers' tacit, moment-by-moment emotional response, in real-time over the web, and through the platform's emotion norms database. The technical objectives of this project focus on implementing automated facial analysis as a scalable cloud-based software-as-a-service platform, building the emotion norms database, and deploying the platform with leading market research partners.

The broader impact/commercial potential of this project is to disrupt long-standing methods in market research by objectively measuring people's emotional experiences a) unobtrusively b) in real-time, c) at scale, and d) cost-effectively. While this differentiated emotion measurement technology can be leveraged in several target markets, the company's initial focus is on measuring advertising effectiveness and media research to deliver actionable insights to leading media and market research companies. In addition, the proposed cloud-based emotion measurement platform has the potential to significantly accelerate research in behavioral sciences by enabling the crowd sourcing of huge corpuses of naturalistic and spontaneous responses to a wide range of interactions and experiences from online learning to social gaming. It also allows entirely new research questions to be asked, and tackled with ecologically valid data, such as whether individuals on the autism spectrum respond differently to content. Thus, in line with the origins of this technology, our product accelerates psychological and clinical research on social-emotional intelligence. The long-term vision for this software as a service platform is to 'emotion-enable' the Internet, giving consumers and organizations the ability to add emotion context to all online interactions.

Bioproduction Group, Inc.

Phase II Award No.: 1052566

Award Amount: $1,016,000.00

Start Date: January 1, 2011
End Date: July 31, 2015

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Sector: IT Applications

SBIR Phase II: Enterprise Decision making using Activity Interaction technology

This Small Business Innovation Research (SBIR) Phase II project seeks to further research and implement a Network Algorithm for efficiently running large-scale network simulations and using those simulations to perform enterprise planning and risk analysis. The company's algorithms (and associated early-release software) have been shown to run supply chain models one order of magnitude faster, with one order of magnitude more complexity, than current simulation models commonly deployed. Bioproduction Group has created a simulation methodology that meaningfully links together highly-detailed operational level models with its large network-scale model. Each operations simulation is linked by network relationships such as supply and demand, product path flows, and inventory holding centers.

Bioproduction Group has received contracts with several biotech firms to implement advanced prototypes of this research in biopharmaceutical manufacturing as they come online. The goal is to use this simulator to reduce biopharmaceutical inventory levels across the industry by 10% or more, while reducing risk across the manufacturing network. If successfully deployed in a large enterprise, it is believed that this inventory reduction would have a yearly return of more than $20mm per organization. The technology has the potential to be used across the biopharmaceutical industry to increase quality of care to the patient as well as reduce manufacturing costs. These goals have significant direct flow-on savings benefits to the hundreds of thousands of patients across the entire public and private healthcare sector.

BitSight Technologies, Inc.

Phase II Award No.: 1127185

Award Amount: $500,000.00

Start Date: February 15, 2012
End Date: January 31, 2014

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Sector: IT Applications

SBIR Phase II: Information Security Risk Rating

This Small Business Innovation Research (SBIR) Phase II project builds upon earlier work to develop an information security ratings service. When businesses connect their networks with partners or share data with them, they are often poorly informed about the potential risks they assume. Businesses have 3rd party relationships for a variety of operational reasons and these partnerships almost always involve sharing sensitive and confidential data. Data shared can be customer information, intellectual property, social security numbers etc. Businesses are worried about losing data through breaches in partner networks as they face the consequences - financial, legal, and regulatory. Existing risk management techniques are based on annual audits and only provide a snapshot of a partner's security posture. However, new vulnerabilities are discovered everyday and the industry needs a solution that enables a business to continuously monitor changing risk posture of all its partners and proactively manage assumed risks. The Phase II research objective is to build a scalable fully-automated ratings system. The research will focus on identifying and incorporating new data sources, improving the statistical properties of the ratings model, and making the ratings predictive of future behavior.

Historically, credit scoring has been a "cost and time-saving technology" that has provided tremendous value to lenders and borrowers alike by reducing costs, predicting future performance, and improving credit accessibility and affordability. Unlike credit scoring, no industry standard scoring service exists to rate business with respect to their information security risk. With Saperix's ratings service, businesses and government will have the potential to reap the same time and cost savings that lenders do from credit scoring services. If the research is successful, Saperix's solution would provide market incentives for improving security outcomes, which would be a significant change in how security investments are viewed by businesses.

Cadio Inc

Phase II Award No.: 1127482

Award Amount: $498,395.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: IT Applications

SBIR Phase II: System for Location-Based Mobile Consumer Analytics

This Small Business Innovation Research Phase II project aims to improve data mining technologies for location analytics. This project will focus on the analysis of semi-continuous GPS and/or WiFi-based location data generated by consumer mobile devices. The anticipated improvements would allow consumer insights professionals and advertising effectiveness researchers to better detect emergent patterns and to draw stronger inferences about consumer behaviors, preferences, and lifestyle attributes. The enhanced data mining system would utilize state-of-the-art pattern recognition and machine learning techniques to dynamically process and interpret location and other types of data. If successful, this research will impact the state-of-the-art in location analytics.

This research has the potential to meet the need of consumer insights professionals to better understand how consumers behave, without the use of lengthy surveys. In a broader sense, this research aims to accelerate progress in the emerging field of location analytics. This research can lead to the creation of a location analytics dashboard, similar to existing dashboards for web analytics. Most web analytics dashboards measure metrics such as site visits, page views and time spent for given online properties; analogously, the location analytics dashboard would measure visits by real consumers to physical locations. Such a location analytics dashboard could be offered on a subscription basis to companies that depend on consumer behaviors in the physical world - including retailers, hotel/resort chains, restaurants, and travel companies. Such a dashboard would address a broad range of market research opportunities, from shopper loyalty research to store sitting to marketing effectiveness measurement. Additional future impacts of the proposed effort include the ability to integrate location analytics data into Geographic Information Systems for improved public safety, municipal planning and transit systems design.

ClearEdge3D

Phase II Award No.: 1230262

Award Amount: $488,822.00

Start Date: August 1, 2012
End Date: July 31, 2014

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Sector: IT Applications

SBIR Phase II: Novel Algorithms for Automated 3D Building Models and 3D Street Maps

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize the first automated modeling software to create fully 3D computer models of buildings, streetscapes, and entire cities. 3D models are used extensively in the architecture/engineering (A/E), personal navigation/mapping, and government markets. However, it currently can take hundreds of hours of tedious manual tracing of laser scan or photogrammetry point clouds to create a full 3D model of a single large building. The output of this research will be a fundamental change from current CAD technology that should reduce 3D modeling time by 99%. Automating 3D model creation is a massive mathematical challenge, one that has vexed the CAD/mapping community for decades. Algorithmically accounting for the innumerable geometries of building facades and automatically creating a light-weight, accurate, fully 3D streetscape model has never before been successfully accomplished, according to all published literature. This project should be able to be the first software available that creates fully 3D, centimeter-accurate building models automatically.

The broader impact/commercial potential of this project is significant. The widespread availability of fully 3D city models and streetscapes will have a profound impact on the personal navigation, commercial real estate, design/construction, first responder, security, and defense industries. Although this project is high-risk due to the enormity of the algorithmic challenge, it is high reward with a commercial potential close to one billion dollars. In the A/E market alone, firms spend nearly $800 million per year on manually creating 3D building models. Successful commercialization of this research will reduce those costs by up to 99%. The project should deliver a completely innovative technology and a totally new economic equation to the marketplace - one that will spur the widespread adoption of high-resolution 3D building models and 3D streetscapes among consumers and industry alike.

Cohort FS, LLC

Phase II Award No.: 1152560

Award Amount: $500,000.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: CohortFS: A Replicated, Parallel Storage System for Cloud Computing

This Small Business Innovation Research (SBIR) Phase II Project advances CohortFS, a replicated, parallel storage platform for cloud computing. CohortFS offers unique capabilities for data partitioning, secure data access and retention, and flexible management of storage at very-large scale, with seamless federation across geographically dispersed, separately-managed data centers. CohortFS improves the flexibility and simplicity of cloud storage management and facilitates uniform management of distributed volumes, whether local, remote, or in the cloud. The CohortFS model for transparent encryption protects data from storage providers and others in shared data center facilities, a key consideration for cloud data privacy and security which are consistently found to be the primary barriers to adoption of Infrastructure-as-a-Service (IaaS) and cloud storage.

The broader impact/commercial potential of this project includes advancement of standards-based storage infrastructure, advancement of both open source and proprietary storage technologies, and development of high-value software infrastructure that can be readily commercialized. CohortFS innovations in wide area replication and flexible data placement improve storage performance and manageability in public and private clouds. Using the cloud as an enabling medium, CohortFS translates advances in petascale data organization and secure, wide-area replication to broader markets and commercial sectors. By improving the economy and utility of storage at cloud scale, CohortFS widens the applicability of cloud computing, speeds its adoption, and deepens its impact-goals strongly supportive of the broader NSF mission.

Corporate Portfolio Management LLC

Phase II Award No.: 1127191

Award Amount: $500,000.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: IT Applications

SBIR Phase II: Assessing Private Company Health Using Advanced Language Computing Techniques

This Small Business Innovation Research (SBIR) Phase II project will develop an software system directed at financial institutions (lenders and investors) that will provide them with actionable, realtime intelligence into the health of private companies. The technology being developed will scan and parse millions of structured, semi-structured and unstructured information sources searching for signals of a private company's health. Then, based on context, it will algorithmically process, categorize and assess the sentiment and strength of these disparate signals to offer a comprehensive, coherent and real-time view of a private company's health, its likely financing needs and best fit financing solutions from a financial institution's product portfolio. Using the company's line of products, financial institutions will be able to look at private companies in a fundamentally different, smarter, more scalable and data-driven way that empowers them to efficiently and intelligently make critical financing and capital allocation decisions. Specifically, they will have the potential to able to identify the right private companies in real-time and will be armed with intelligence they can use to offer them appropriate financing solutions.

The system's ability to process a diversity of structured, semi-structured and unstructured information sources and programmatically derive measures of company health would have profound positive effects on the precision, rigor and scalability of institutional lending and investment into private companies. Today, the private company financing market is built on highly imprecise and imperfect heuristics that result in high business loan default rates, or at its worst, bank failures as occurred in 2009. The downstream impact of this is that small businesses do not get the financing they need as evidenced in 2009 when, according to the Federal Reserve, only 40% of private small businesses that sought bank financing actually received the funding they needed. Per the Small Business Administration, businesses with fewer than 500 employees account for more than half the nation's employment and nearly half of GDP. As a result, it is critical that healthy private companies which are an economic catalyst have access to financing. Unfortunately, without credible, actionable, scalable and real-time information which distinguishes between healthy and unhealthy private businesses, financial institutions remain at an informational disadvantage. This increases their risk, which in turn hinders growing, healthy private companies from receiving the financing they need. If successfully deployed, the technology being supported by this proposal has the potential to make a significant impact in the marketplace.

Diani Systems, Inc.

Phase II Award No.: 1229899

Award Amount: $422,880.00

Start Date: August 1, 2012
End Date: July 31, 2014

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Sector: IT Applications

SBIR Phase II: High Resolution Channel Sounding for Indoor TDOA Positioning Using a Narrowband RF Transceiver

This Small Business Innovation Research Phase II project is focused on high-accuracy wireless positioning technology for indoor environments. Indoor time-of-flight-based positioning technologies have had little commercial success to date primarily because of multipath - signal reflections that smear the arrival time of the over-the-air signals, making it difficult to determine the arrival time from the line-of-sight (LOS) or shortest distance path. The best way to combat multipath is to use ultra-wideband (UWB) location beacon signals with bandwidths in excess of 500 MHz; the wide signal bandwidth increases the resolution in the time-domain, allowing the receiver to distinguish the LOS from other paths. The challenges with UWB are that it is plagued by high manufacturing costs, too much DC power consumption and regulatory issues limiting its range and operating frequencies. The focus of our research is to develop a way to overcome these limitations by defining a method for transmitting a sequence of relatively narrowband standards-based (e.g., WiFi) signals in such a way as to make them behave like UWB signals, yielding UWB-like positioning accuracy at no additional cost and without any of the other aforementioned shortcomings.

The broader impact/commercial potential of this project is fueled in part by the ubiquity of the smartphone, whereby a large and growing number of applications could benefit from high-accuracy indoor positioning technology, including: indoor route guidance, mobile retail (find products, receive targeted ads, use proximity-sorted shopping lists), staff and asset tracking for healthcare and manufacturing industries, indoor E911, location-based security, exhibit tracking commentary and route guidance for the blind. However, existing state-of-the-art positioning systems such as WiFi received signal strength (RSS) techniques are not accurate enough (typically 30 feet at 90% confidence) for many of these applications. There are UWB-based solutions available today that are much more accurate than their RSS counterparts, but there is strong resistance to integrating UWB into smartphones due to cost, DC power and regulatory limitations. The goal of this project is to provide a way to make straightforward modifications to a WiFi chipset's MAC and PHY in order to achieve an indoor location accuracy of 3 feet or better with 90% confidence, yielding an order-of-magnitude accuracy improvement at no additional cost, since WiFi is already a standard feature in most smartphones.

dMetrics Inc.

Phase II Award No.: 0956817

Award Amount: $1,000,000.00

Start Date: January 15, 2010
End Date: June 30, 2014

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Sector: IT Applications

SBIR Phase II: Automated Mining of Worker and HR Preferences for On-Demand Job Matching

This Small Business Innovation Research (SBIR) Phase II project aims to improve the quality of on-demand job matching by applying data mining and machine learning techniques to natural language descriptions of job requests, worker reviews, and transaction history. The project will enable lasting job matches by predicting the needs, preferences and constraints of workers and human resource managers. Currently available methods of job matching rely primarily on keyword search, corporate personality assessment tests, or fixed ontologies. Such systems lack comprehensive learning and therefore have difficulty matching workers with jobs. This project approaches job matching with a bias-free learning model that learns from hiring successes, trains on real-world data, and adapts to new job verticals.

The broader/commercial impact of the project is a matching technology that optimizes workers' and employers' strengths, discovering matching opportunities overlooked by traditional search technologies. Online reputation-building through performance reviews can improve workers' ability to market themselves. The global matching technology permits nearly every skill to become marketable by matching workers with all features from every available job request. Natural language processing techniques, developed in the course of this project, have the potential to broaden the appeal of cell phone text-messaging as a comprehensive job-searching tool. Furthermore, the contextual approach to learning about workers and employers enables trends to be identified among users, and has far-reaching commercial implications in fields as diverse as medical research and e-commerce.

ecoATM, Inc.

Phase II Award No.: 1152672

Award Amount: $516,000.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: Automated and Self-Service Electronics Recycling Kiosk

This Small Business Innovation Research (SBIR)Phase II project is designed to commercialize a consumer self-serve, automated kiosk for the evaluation, buy back, and collection of used electronics directly from consumers. Prototype kiosks deployed during Phase I provided convincing proof of the feasibility of the baseline technical approach to the visual and electrical inspection technology, robotics, and the market. Financial metrics achieved were many multiples better than industry leading kiosks such as Coinstar or Redbox. Further R&D is required to achieve enough reliability in the automated inspection systems and the kiosk hardware to lead to the permanent removal the kiosk attendants in field that currently serve as the fail-safe mechanism in the current prototype systems. Broad commercial success relies on the development of a robust, designed-for-manufacturability (DFM), designed-for-serviceability (DFS), commercially reliable kiosk with a minimum retail field life of 5 years that incorporates needed improvements learned from Phase I including refinements to the visual inspection system and algorithms, electrical inspection system, test station robotics subsystems, ergonomics, GUI, and channel management systems. ecoATM also hopes to further develop the system's capability to offer personal data erasure and expand accepted device types to potentially include digital cameras, portable game players, printer cartridges, laptops, eReaders, and tablets.

The broader impact of ecoATM's patented system is that we finally achieved the threshold of consumer convenience and financial incentive required to inspire mass consumer participation in electronics recycling. Our pilot market tests indicate that we harvested 20 times more used phones than the next closest competitor in the test areas. As ecoATM scales nationally we will divert mass amounts of toxic eWaste from our landfills, and put huge sums of cash back in the hands of our customers and the retail locations hosting the kiosks, providing stimulus and incentive for these stakeholders to help forever alter the current wasteful lifecycle of consumer electronics. On average, each ecoATM collects enough eWaste to offset its own annual energy consumption after just 5 days placement resulting in 360 days of CO2 offset. An average ecoATM collects over 7,000 phones per year, which according to the EPA calculator is equivalent to taking the CO2 of 35 houses off the grid for a year. National and global media have taken notice of ecoATM already and even the United Nation's Low Carbon Leadership Program recognized ecoATM as one of the best ideas in the world for the reduction of CO2 on a global basis.

EPIC Engineering & Consulting Group, LLC

Phase II Award No.: 1152694

Award Amount: $574,436.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: Implementing an Infrastructure Intelligence System for Water and Wastewater Utilities Using the Software as a Service (SaaS) Delivery Model

This Small Business Innovation Research (SBIR) Phase II project will build upon the successes of the Phase I research that showed the market need for an intuitive, location-based Infrastructure Intelligence System (Neptune), and demonstrated the technical feasibility to deliver a SaaS solution for water and wastewater utilities and public works agencies. Neptune represents a significant technological innovation in infrastructure information management; it will be a domain trend setter by delivering critical infrastructure information through one intuitive, powerful, comprehensive and affordable product. Current utilities software systems are complex standalone systems, typically used by technical experts. Information retrieval from these systems requires significant resources and technical expertise that are not available for most utilities. This project will design, develop, test and deploy production-ready Neptune product that will provide instantaneous access to infrastructure information through Google Maps-like interface to a broad range of users from field staff to executive management. Neptune will remove the technology barriers of entry, enhance the capture and retrieval of enterprise knowledgebase, and help extend the useful life of our infrastructure.

The broader impact/commercial potential of this project lies in the urgent need for utilities and public works agencies that protect public health and safety to efficiently manage their aging infrastructure with budget shortages. Our nation's infrastructure deficiencies threaten public safety and welfare as well as our economic growth and competitiveness. The EPA estimates over 240,000 water main breaks and 170,000 sewer main breaks annually in the United States. Estimates for fixing our infrastructure run into hundreds of billions of dollars. To prioritize infrastructure maintenance, utilities must analyze diverse datasets including hydraulic models, GIS, SCADA, maintenance, emergency response and project documents. Available software are complex and expensive and presents a huge barrier to entry for most small and medium utilities. This is putting their residents and environment at increased risk. Through its simple interface and SaaS delivery model, Neptune will be accessible and affordable to all infrastructure agencies. It will communicate the importance of infrastructure investment to elected officials and public. Neptune has the potential to provide significant societal benefit by reducing infrastructure failures and guiding utilities towards proactive infrastructure maintenance practices.

GGL Projects, Inc.

Phase II Award No.: 1127567

Award Amount: $600,000.00

Start Date: September 1, 2011
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: Software to Automate the Detection of Websites that are Fraudulent or Otherwise Harmful to Consumers

This Small Business Innovation Research (SBIR) Phase II project will develop software to automatically detect a broad spectrum of websites that are fraudulent or otherwise harmful to consumers. Much work has been done on specific software capable of detecting websites hosting malware or engaged in phishing. However, software does not yet exist which can detect a broader array of harmful websites, including those selling counterfeits, selling illegal drugs, and hosting weight-loss scams, to name just a few. The challenge in doing this involves selecting the right features of fraudulent sites which in isolation or combination are good indictors of a site's harmfulness. Using these features, a machine learning classifier can be trained using data on known harmful websites. Unknown websites can then be run through the classifier to evaluate their potential for harm. Additional challenges involve gathering sufficient data to properly train the classifier, making the classifier general enough to detect a range of harmful sites while still maintaining accuracy, and updating the classifier in real-time such that it can improve with ongoing human feedback and additional data.

The principal impact of this project is the protection of consumers from online fraud. Today, consumers lack reliable resources to evaluate unfamiliar websites. Most use familiar sites like Amazon or take a gamble on Google search results. These gambles frequently result in fraud. It is believed that there are now over 250 million websites and $100 billion lost yearly to online fraud. While the statistics cover many types of fraud, examples of risky sites include online counterfeiters, pharmacies, and retailers. The software developed in this project will greatly improve transparency around websites and protect millions from fraud. The technical achievements in this project involve the use of a vector space model in converting non-discrete features of fraudulent sites into useful data that can be inputted into a machine learning classifier. Additionally, this technology will include innovative feature choices, access to high-quality data, and the creation of a general classifier capable of improving itself in real-time and detecting a broad array of heretofore undetectable fraudulent sites.

Hermes Commerce, Inc.

Phase II Award No.: 1230126

Award Amount: $500,000.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: IT Applications

SBIR Phase II: Secure SMS and Web Service Transactions for Mobile Commerce

This Small Business Innovation Research (SBIR) Phase I project will deliver a mobile payment communications infrastructure, mobile device apps for utilizing that payment infrastructure, point-of-sale solutions for merchants that utilize the payment infrastructure, and will establish the framework for a local advertising network. The mobile payment system takes advantage of the speed of contemporary mobile devices to enable secure web-based transactions. This payment system revolutionizes payment by bypassing existing legacy credit and debit card infrastructure. New security algorithms and models will be developed to enable the secure transfer of banking information. The proposed payment system empowers consumers to control privacy, security, and localization settings in their mobile payment apps. The local advertising network changes the value proposition for both merchants and consumers with respect to ads and coupons, creating an environment in which merchants 'push' ads to 'pulling' customers. The local advertisement network will fundamentally alter the way users think about localization, privacy, and data anonymity.

The broader impact/commercial potential of this project includes the creation of a payment system that revolutionizes commerce. The system will dramatically reduce or eliminate payment interchange fees for merchants, will move consumers much closer to the concept of a fully digital wallet, and will create a new level of engagement between merchants and consumers that is mutually beneficial. Small, independent merchants will immediately realize many of the benefits of the payment network. These merchants typically pay between $15,000 and $200,000 annually in credit and debit card interchange fees. The proposed payment system will reduce or eliminate these fees enabling business expansion and job creation. The payment system effectively creates local commerce zones where "buying local" is implicitly strongly encouraged through in-network, in-app local advertising, coupons, and loyalty programs. The payment system includes seamless peer-to-peer digital funds transfers. The ultimate goal is a payment system to make all commerce - all transfers of funds - frictionless, fast, simple, and easy. The mobile commerce market is expected to grow from over $200B this year to over $600B by 2015. The technology developed herein will be a vital driver of that growth.

Imagine Research, Inc

Phase II Award No.: 1026435

Award Amount: $1,016,000.00

Start Date: August 15, 2010
End Date: January 31, 2015

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Sector: IT Applications

SBIR Phase II: Sound-object Recognition for Real-time or Offline Systems

This Small Business Innovation Research (SBIR) Phase II project includes research and development of audio recognition and analysis software for offline and real-time sound recognition. Musicians and audio engineers have access to terabytes of music loops and sound effects. However, musicians are limited to searching for sounds using text-only keyword searches. This is a mundane, inaccurate, and exhausting process that ignores the files' actual audio content. The proposed solution provides a unique "find-something-that-sounds-like-this" search engine. Media production software and hardware is too complex, tedious, and labor-intensive for both novice and advanced users. The proposed sound platform adds capability that was previously missing - recognizing an input sound and automatically choosing the best parameters for the user. This project uses a signal processing and machine learning platform to perform novel experiments for classifying audio streams in real-time, improving recognition accuracy, and retrieving sounds from large collections. Commercial-quality software development kits for offline and real-time sound recognition will be developed. This project integrates state-of-the-art machine learning, digital signal processing, and information retrieval techniques.

If successful, the platform will be able to listen to an audio signal and understand what it is listening to - as human listeners can identify and classify sounds. This innovative technology will be licensed to audio and music technology software and hardware manufacturers. The platform is suited for long-term discoveries and innovation, with demonstrated commercial interest from biomedical signal processing, security/surveillance, and interactive gaming companies. In the first chosen market, (sound engineering) the platform will have direct cultural benefits for musicians, music hobbyists, and audio engineers. It will allow music creation and audio production to become a completely creative task - minimizing the tedious technical issues that hinder the creative process, and lowering the barriers to entry for novice musicians and creative professionals.

IXM Corporation

Phase II Award No.: 1152523

Award Amount: $548,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: IT Applications

SBIR Phase II: A Cloud-Enabled Digital Art Service for User-Generated Music

This Small Business Innovation Research (SBIR) Phase II project will develop of a cloud-based, Internet service that facilitates a free and global exchange of user-generated music (UGM). A recent technological convergence of hardware, software, and the Internet has greatly reduced capital requirements for music production and distribution. The use of inexpensive production tools for music creation has reached a critical point and an opportunity now exists to facilitate a global, open, and free musical exchange directly between producer and consumer. Cloud computing offers the ability to facilitate this exchange in a highly scalable, capable, and cost efficient manner. Cloud computing also enables a cloud-based music consumption methodology which eliminates the consumer burdens of file management and backup while increasing accessibility.

The broader impact/commercial potential of this project is the greater technological understanding of the robustness and cost efficiencies of media-driven, cloud computing application deployments, and a potentially extreme disruption of current music markets and music consumption methods. Music is deeply rooted in human nature and throughout our life experience. Over the past century, the economic activity surrounding recorded music was concentrated in a small number of companies. This Phase II project supports an innovation that spreads this economic activity more equitably and provides the consumer music with cloud convenience, the producer direct access to consumers, affiliates with expanded markets, and society with democratized music.

Lymba Corporation

Phase II Award No.: 1230248

Award Amount: $467,010.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: IT Applications

SBIR Phase II: Hybrid Question Answering Combining a Search Index with an RDF Store

This Small Business Innovation Research (SBIR) Phase II project will provide integrated, seamless access to structured and unstructured information. At present there is no easy way to perform a single federated search across structured databases and unstructured text documents, and complex applications over diverse data sources require considerable time and effort to develop. The multilingual Hybrid Question Answering (HQA) engine will change the way people access heterogeneous data by answering complex questions over semantic models from the database and free text from the search indexes of product literature, call center data, social media, etc. HQA will answer a broad range of questions including factoid, procedural, explanation and scenario-matching. Users will also be able to discover facts, relationships among events, and sentiments; to identify trends and enable predictions. Finally, to ensure high precision, HQA will process information in its native form for 11 languages, including English. A minimum score of 70% MRR is expected for the English HQA system and 60% MRR for the other 10 languages.

The broader impact/commercial potential of this project spans several key areas. The HQA engine will surpass existing Questioning Answering technology by answering a wide range of complex questions with information found in both structured and unstructured data sources. Social media-based applications such as trend finding, sentiment detection, and predictive analysis operating in international markets will greatly benefit from the availability of the multi-lingual HQA system. Customer Relation Management (CRM), Business Intelligence and Social Media are among the primary commercial applications benefiting from the development of the HQA engine. The impact of this technology will result in businesses being able to develop more personalized relationships with customers as a result of a better understanding of customer needs and motivations. Traditional business relationships will become more responsive, resulting in greater understanding and trust, which will mitigate destructive, wide swings in financial markets caused by poor predictive models.

OhMyGov Inc.

Phase II Award No.: 1127190

Award Amount: $600,000.00

Start Date: October 1, 2011
End Date: March 31, 2014

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Sector: IT Applications

SBIR Phase II: Innovative Tools to Visualize Digital Media in Digital Era

This Small Business Innovation Research (SBIR) Phase II project will provide a visual analytics platform that helps visualize how information spreads on the Web through networks of news outlets and social media users. The supported research will extend the interactive visual analytic platform by incorporating better influence modeling, sophisticated propagation cascade models that consider the semantics of the entities and their changing dynamics through time, and new visual paradigms for clustered and grouped data. The interface will allow the end user to manipulate visual representations of how a single press release, news clip, Tweet, or marketing push triggers activity among journalists, micro-bloggers, etc. Public sector policy makers, communications professionals and researchers can use this platform to uncover paradigms in data dissemination, find new ways to influence information dissemination, better inform their leadership, and root out sources of erroneous information online. The Phase II research focuses on dynamic influence monitoring, development of robust propagation cascading models for different social media sites, and the use of visual analytics to understand multi-granularity information propagators. The three areas of research for Phase II are all complementary methods that attempt to characterize, measure, and understand the ubiquitous process of information spread and the influence of individuals in this process as well as allow the user to interact with the underlying data to enhance public outreach.

This grant will continue development of an interactive platform within which users can see and uncover patterns describing how messages are distributed across networks. The tool will locate key influencers, allowing communicators to see exactly how a message was distributed and ways to expedite message delivery during emergencies. Equally important is the ability of the tool to quickly uncover the source(s) and major purveyors of harmful misinformation on the Web. Data and filters further allow users to assess the size and demographic makeup of the audiences being reached enhancing governments interface with the public providing objective measures of the organization's effectiveness in penetrating traditional, new, and social media outlets. This insight will be used to better inform the organization and enhance public awareness of local, state and federal initiatives. Paired with the broader media analysis platform constructed earlier, the supported research will provide a comprehensive means of monitoring and measuring federal, state, and local municipality organizational performance.

OmniSpeech

Phase II Award No.: 1230296

Award Amount: $494,250.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Juan E. Figueroa

Sector: IT Applications

SBIR Phase II: Single-Channel Stationary/Non-Stationary Speech Extraction for Mobile Phones

This Small Business Innovation Research (SBIR) Phase II project addresses the problem of everyday noisy environments that limit when and where people can be heard clearly over various communication devices (phones, first-responder radios, voice-over-IP, etc.). Given the inability of single-microphone noise-reduction techniques to handle non-stationary noise (e.g. restaurant noise) the industry's current solution is the use of dual-microphone techniques. However, dual-microphone techniques cost more, require more hardware, need spatial separation between the noise and speech, and can only process the signal on the transmit side. The proposed technology is a single-microphone software-only solution that effectively handles non-stationary noise coming from any direction and can process the signal on both the transmit and receive sides. The novelty of the approach is its use of speech-specific characteristics and knowledge of human perception to extract speech from the noisy signal. The objective of the proposed research is to improve the current method of detecting voice activity, enabling better speech extraction thereby resulting in enhanced speech quality. The resulting technology will be architecture agnostic, cost effective and have superior performance in everyday situations.

The broader impact/commercial potential of this project is considerable and compelling. The initial focus will be the mobile phone industry, which is now the single largest user of noise suppression products with a market size that includes nearly all of humanity. The technology will then be optimized to improve the listening experience for hundreds of millions of potential hearing-aid/cochlear implant users worldwide. According to the World Health Organization, there are 278 million people worldwide that have hearing loss. This number is expected to at least double over the next 30 years due to the growth in the number of senior citizens over 65 years of age and the growth in the number of younger people who are needing hearing aids 20 years sooner than their parents due to loud-music listening habits. Additional markets include first-responder radios, voice-over-IP and military/intelligence/homeland-security. The research required to reduce computational complexity will illuminate the essential aspects of auditory scene analysis needed for improved speech perception.

PublicRelay, Inc.

Phase II Award No.: 1127464

Award Amount: $500,000.00

Start Date: October 1, 2011
End Date: September 30, 2013

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Sector: IT Applications

SBIR Phase II: Building a Flexible, Technology Adaptive Architecture to Support Processing of Content by Knowledge Workers

This Small Business Innovation Research (SBIR) Phase II Project addresses the gap between the capabilities of today's semantic analysis systems and the accuracy requirements of knowledge workers (analysts and researchers) in language-sensitive fields such as public relations, foreign affairs, and crisis management. Knowledge workers in many organizations monitor and analyze print and web coverage for content of interest. When the volume of search results is large, some filter, classify and score the results using products or systems based on semantic analysis technology utilizing extensive libraries of words, patterns, and context-specific algorithms. However, users complain that these systems fall short of desired accuracy, missing rhetorical devices such as irony, sarcasm, metaphors, double entendre, and improperly interpreting connections between sentiment and topics. Users with high thresholds for accuracy thus turn to manual processes to either supplement or substitute for technology. Building upon Phase I work, the company will create and integrate a larger set of content processing modules and enhance a pluggable architecture to support quick insertion and testing of new modules in the content processing "pipeline."

Once commercialized, the system will enable more rapid adoption of technology by knowledge workers. In fields with high accuracy requirements, the need for human judgment has constrained technology use to discrete areas like search, while in subsequent processing steps, analysts must manually capture, classify, score, analyze, and report on the output. Feedback to date suggests the product can substantially enhance the productivity and effectiveness of professionals in these fields and that it addresses a number of frustrating gaps in the marketplace.

Quantifind Inc.

Phase II Award No.: 1026493

Award Amount: $900,112.00

Start Date: August 15, 2010
End Date: January 31, 2015

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Sector: IT Applications

SBIR Phase II: Units-based numeric data extraction with knowledge of scientific context

This Small Business Innovation Research (SBIR) Phase II project aims to establish that a units-based approach to retrieving quantitative data from scientific and technical documents is a powerful alternative to keyword and document based search models. Keyword approaches to data extraction and contextualization are limited due to poor semantic contextualization and because quantities are often written in a wide variety of numeric and unit formats. The proposed approach to reliable numeric data extraction begins with quantity-intelligent indexing that recognizes many numeric formats and converts quantities to standardized base-unit tokens, to significantly enhance search recall over keyword approaches. The resulting number-unit pairs will anchor the index to enable efficient scientific exploratory search with high semantic precision, but without overly relying on sophisticated imposed semantic ontologies. Research will focus on a proprietary search-time data scoring algorithm that utilizes context-sensitive numeric spectra, to score otherwise ambiguous results based on probabilistic methods. This approach is expected to improve both precision and recall of contextual numeric data extraction. In turn, the resulting search engine will enable instant visualization and analysis of collective technology landscapes and trends, which will guide researchers in any area of technology represented by the indexed documents.

The broader impact of this project will be to enable reliable and efficient extraction of numeric data from diverse sources such as scientific literature and patent databases. These unstructured document sets contain a wealth of latent quantitative data which, if properly extracted and aggregated, can enable powerful modes of data exploration. The unit-based index and data-scoring algorithm are customized for an exploratory search model that will allow non-expert users to rapidly aggregate thousands of relevant data points, with simple keyword inputs and without laboriously opening and parsing individual documents. Researchers and students may thus explore data sets that were previously inaccessible, or known only to experts in a field. This will also contribute to knowledge discovery within large unstructured databases, since patterns and correlations between seemingly disparate variables can be immediately visualized. The platform will provide the capability to efficiently generate technology landscapes, anticipate emerging trends, and recognize competitive technical outliers. If successful, this will be valuable for high-tech industrial innovation including for engineers involved in R&D as well as business development executives and intellectual asset managers who focus on asset allocation, new technology ventures, prior art and patent infringement within a technical parameter space.

Safaba Translation Solutions, LLC

Phase II Award No.: 1150589

Award Amount: $500,000.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: Software-as-a-Service Customized Machine Translation for Commercial Language Service Providers and Their Clients

This Small Business Innovation Research Phase-II project develops advanced technology capabilities for constructing and deploying client-adapted automated language translation systems within commercial settings that are used by globalizing enterprises and the language service provider companies (LSPs) that provide translation services to such enterprise clients. The developed technology leverages databases of previously-translated material in order to produce client-adapted high-quality fully-automatic translations for commercial language service providers (LSPs) and their enterprise clients. This approach provides a scalable and less-costly solution for creating and deploying client-specific customized Machine Translation (MT) engines. Once deployed, these customized MT systems expand the capabilities of clients to translate volumes of content that are not feasible to translate using current methods.

The broader impact/commercial potential of this project lies in the impact that it will have on the broad commercial translation industry. The technology developed in the project is likely to significantly reduce barriers to wide-spread adoption of MT technology by the broad LSP industry and their enterprise client-base. The 2010 commercial translation market is a $26 billion industry, growing at a healthy pace. Current commercial MT offerings are expensive and too difficult to deploy for most enterprises and service providers. Free web-based translation services serve casual users, but do not meet the quality and security needs of enterprises. The technology developed in this project and the cloud-based delivery model support scalable, easy-to-integrate MT services, which are highly attractive to a broad range of potential clients. This approach will support cost-effective content generation into multiple target languages at a massive scale, a capability that is essential for globalizing US enterprises in order to compete in the information-rich market place of the 21st century.

Sifteo, Inc

Phase II Award No.: 1026699

Award Amount: $935,886.00

Start Date: September 15, 2010
End Date: March 31, 2015

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Sector: IT Applications

SBIR Phase II: Siftables - Distributed, Gestural Human Computer Interaction

This Small Business Innovation Research (SBIR) Phase II project aims to accelerate commercialization of a new human-computer interface (HCI) platform: Siftables. These are small, wireless, gesture-sensitive displays that act together as one interface. People can efficiently execute cognitive tasks through manipulation of groups of physical objects. These abilities find little purchase in both keyboard/mouse User Interfaces (UIs) and newer UIs with single displays.

The proposed platform provides a UI that can address a broad range of human-computer tasks, from media creation to data analysis to social communication. Historically, the entertainment domain has provided a profitable staging area in which to introduce novel UI systems - this market is large, has price flexibility, and its consumers have a demonstrated desire for novel interactions. This domain will provide a path to profitability, familiarize consumers with multi-object interfaces and allow the Siftables technology time to mature before other market opportunities are pursued. If successful, this system will allow the company to advance the state of the art of distributed operating systems and sensor networks.

StartUpHire LLC

Phase II Award No.: 1127357

Award Amount: $500,000.00

Start Date: August 15, 2011
End Date: July 31, 2013

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Sector: IT Applications

SBIR Phase II: Matching Algorithms and Talent Acquisition System to Improve Start-Up Staffing

This Small Business Innovation Research (SBIR) Phase II project aims to create core algorithms for a Talent Acquisition System to pragmatically match candidates to startup job opportunities. Startup hiring needs are unique, and the market lacks an effective platform to accelerate and improve this core competency for company building. Generic search of a resume database does not sufficiently capture the unique fit requirements of startup employment nor return acceptable results. This research aims to incorporate (a) limited employer input of search criteria using a simple interface with (b) a broad range of normalized inputs, each individually scored for startup fit, to create a self-tuning algorithm for the search, discovery, and pairing of candidates to the unique needs of startups. The innovation in this approach is to create a system inherently weighted to both the hard and soft attributes of startup work/life. If successful, this effort will remove much of the guesswork by pointing employers to those most likely to excel in these opportunities. Data extraction, scoring techniques, and full text search will be applied to resumes, questionnaires, job search histories, social networking maps and search terms to feed the algorithm.

The broader impact of this project will be to improve the success rate for young companies by accelerating and improving the staffing of strong teams at every level in the organization. StartUpHire believes there is significant commercial potential for a startup centric career resource in the $6 billion annual U.S. online recruitment industry. Competitive approaches treat startup recruiting as identical to large company recruiting, yet experience indicates there is tremendous demand for an approach built around the unique needs of this community. Companies benefit by (a) focusing on talent which self-selects into this ecosystem and (b) algorithmically filtering these candidates using startup-specific success criteria. This research will create the first platform of its kind specific to startups, something employers have repeatedly requested. The proposed system will deliver both quality and speed biased to the needs of emerging growth companies.

Team Patent LLC

Phase II Award No.: 1057933

Award Amount: $500,000.00

Start Date: March 15, 2011
End Date: May 31, 2013

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Sector: IT Applications

SBIR Phase II: Patent End-To-End (PE2E) Examination

This Small Business Innovation Research (SBIR) is directed to developing Patent End-To-End (PE2E) application examination capabilities that utilize cloud-enabled software services to enable the United States Patent and Trademark Office (USPTO) to collaboratively examine patent applications with enhanced validation, search, and office action support, resulting in higher quality and lower pendency. PE2E objectives include support for formalities review, search planning, annotation/collaboration, and office action formulation. The outcome of this investigation would potentially shift the way in which intellectual property is examined; providing examiners with tools to more deeply understand patent applications, collaboratively research prior art, and more easily document their assessments of the application prior art.

The U.S. economy relies heavily and increasingly upon intellectual property, and patents are one currency of this economy. As patents become more significant in the operations and outcome of U.S. businesses, it becomes increasingly important to assure that the patent examination system delivers high quality and timely examinations in order to support the next-generation of innovations. If successfully-deployed the proposed innovation has the potential to make a significant positive impact upon the US patent and trademark landscape.

Telineage, Inc.

Phase II Award No.: 1256637

Award Amount: $500,000.00

Start Date: April 1, 2013
End Date: March 31, 2015

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Sector: IT Applications

SBIR Phase II: A Robust Caller-ID Alternative for Securing Telephony Based Transactions

The innovation in this project comes from the novel call audio analysis techniques that can be used to create a fingerprint of the source of a telephone call. Such fingerprints can reveal valuable information about the call source, including the type of the calling device (landline, Voice-over IP or mobile), its geographical location and the networks over which the call audio may have been transported prior to it reaching the called party. To detect potentially fraudulent calls in real-time with such fingerprints, this proposal plans to extend the identification of the geography of a call source and the creation of an active call analyzer that performs audio analysis in real-time. The focus of this Phase II project is on exploring design options for an active call analyzer; including accuracy, scalability and timeliness tradeoffs and its integration in call center infrastructures. The call analyzer will also be used to build a phone fraud intelligence service that proactively detects phone numbers used for committing fraud. Such a service, including mechanisms for sharing of intelligence with partners and customers, can help secure the telephony channel from a variety of attacks.

The broader impact and commercialization potential of this project can be seen readily from the observation that phone fraud is already a serious problem for multiple sectors, including banking, healthcare and even law enforcement. Also, because fraudulent calls are already responsible for considerable financial loss, customer agents in call centers are asking multiple knowledge-based questions to authenticate a caller. This leads to higher costs for call handling and also degrades customer experience. A successful active call analyzer solution that can automatically generate a risk score for caller authentication will have broad impact because the entire service sector relies on call centers for customer contact and it could reduce costs and improve customer experience. The project will also enable Pindrop to play a leadership role in organizing the broader community to launch a phone anti-fraud alliance similar to the anti-phishing working group. The thought leadership provided by such a group will be necessary to define the telephony security challenges and approaches for addressing them. Again, this will ensure broad impact of the project across several industries.

Thousand Eyes

Phase II Award No.: 1058602

Award Amount: $1,000,000.00

Start Date: March 1, 2011
End Date: February 28, 2014

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Sector: IT Applications

SBIR Phase II: An Integrated Solution for Global Visibility and Security of Internet Services

This Small Business Innovation Research (SBIR) Phase-II project will develop a software-as-a-service product that provides actionable network intelligence to online businesses, enabling them to quickly identify and troubleshoot problems that affect their end users. Studies have shown that a poor end-user experience results in a tangible loss of revenue. Yet, online businesses are dependent not only on their own infrastructure, but on the state of the rest of the Internet as well. From the end user perspective, problems with the network infrastructure, third-party content provider issues, or traffic redirection attacks can result in sites being unavailable or slow. Hence, outside-to-inside monitoring of online services is critical for any Internet business if they wish to remain competitive. Unfortunately, existing products often treat the Internet as a black box. They are unable to capture where things have gone wrong or what could be improved inside the network. In this Phase-II proposal, the company takes a bottom-up approach to capturing end-user experience by focusing on understanding and measuring the components of the Internet infrastructure (such as DNS) that are responsible for data delivery. If this effort is successful, businesses will be able to ensure that their service is globally available, proactively identify performance bottlenecks at the network level, and be alerted immediately when under a traffic redirection attack.

Businesses that operate on the Internet expect data from monitoring services to be actionable. While some products provide actionable information regarding problem components in web pages, The company offers actionable insight into the network infrastructure that drives content delivery to end users. The impact of this technology is two-fold. First, the technology enables customers to improve content delivery to their end users, which leads to increased revenues. Second, the technology can protect businesses from falling prey to traffic redirection attacks, protecting both themselves and their users from financial losses due to fraud. If successfully deployed, the proposed innovation will address an emerging and significant pain point for online merchants and service providers alike.

txteagle Inc

Phase II Award No.: 1026853

Award Amount: $1,000,000.00

Start Date: August 1, 2010
End Date: January 31, 2014

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Sector: IT Applications

SBIR Phase II: Large-Scale Analysis System for Mobile Crowdsourcing

This Small Business Innovation Research (SBIR) Phase II project seeks to create a new, innovative system to manage a highly-scalable, geographically-distributed labor force through wireless technology - what is refered to as " mobile crowdsourcing." The plunging cost of handsets and the introduction of prepaid call plans have allowed individuals throughout the world to have the ability to communicate and transact electronically. This project will create the infrastructure needed to provide wireless subscribers the ability to do work and earn money - leveraging today's mobile phone's ability to send, receive and display images, audio files and text. The system will: deconstruct a client's work into "micro-tasks;" preferentially route micro-tasks to individuals most likely able to complete them; statistically analyze completed work across individual responses to automatically reach a decision on when work is complete, and who has provided the most useful input; compensate workers in proportion to the value they have added; and, finally, reconstruct the completed task for the client, with a statistical assurance the work has been accomplished correctly.

The first application of this system will be for the business process outsourcing (BPO) industry. The company will integrate with several mobile carriers in Africa and South America to allow subscribers direct access to transactional BPO tasks including transcription, translation and text categorization. Communicating with workers directly through phones and emphasizing quality control on work, rather than worker will enable users to perform tasks when they want, where they want, and as they want. Automated compensation through existing mobile payment and airtime transfer systems will allow for much lower overhead costs. In addition to cost savings, however, clients who use this system to complete work will also have the benefits of: increased security (no one worker will be able to see an entire document or hear an entire audio recording), access to a scalable workforce (when "spikes" of work come through, labor can be seamlessly scaled up), and potential for very fast turnaround on work (micro-tasks can be done in parallel by many individuals, greatly reducing total time to complete a workload). Additional applications of the mobile crowdsourcing platform include data gathering related to local content and surveys, productivity tools for auditors, and mass reporting abilities following disaster-related events.

Xandem Technology LLC

Phase II Award No.: 1256633

Award Amount: $483,912.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: IT Applications

SBIR Phase II: Through-Building Device-free Localization for Emergency and Tactical Operations

The innovation of this SBIR Phase II project is the development and commercialization of a low-cost through-building surveillance product for police and SWAT teams that locates and tracks people across an entire building using a network of wireless sensors deployed around the outside of the building. Unlike other through-single-wall imaging technologies, a device does not need to be held against a wall. This project will develop new technologies that make the system useful for police team end-users to quickly deploy and use without extensive training. Specifically, the produce should investigate methods to achieve robust connectivity across larger buildings; develop capabilities for 2.5-dimensional (x,y + floor) imaging and tracking; develop adaptive estimation algorithms that automatically adjust to the environment; develop devices suited for rapid deployment, and develop a real-time commercial prototype including user interface. At the end of the project, the combination of these developments should allow delivery of a prototype to a SWAT team for them to deploy and use on their own in a training exercise.

The broader/commercial impact is the commercialization of a technology for police and SWAT (special weapons and tactics) teams to quickly obtain situational intelligence that will save lives. Lives are lost every year because law enforcement officers do not know what is happening inside a building prior to entering. In addition, other life-saving applications will benefit from technologies developed, for example: military urban operations; building security and homeland security systems; finding people alive in collapsed buildings or during fire rescue; and worker safety systems. The firms technology is also useful in systems that allow elderly to live longer in their own home by monitoring their activities to ensure their safety and health. The proposed solution to these challenges is uniquely useful because it does not require a person to wear or carry any device, and cannot image a person's face or features, thus preserving privacy. The technology is capable of "seeing" through walls, even in the dark or through smoke. These features make it compelling for indoor and outdoor security systems, in-home monitoring systems, "smart building" energy-conservation systems, and other context-aware computing systems. This project develops technologies for a new sensing modality with many compelling applications.

ZOOZ Mobile

Phase II Award No.: 1127163

Award Amount: $499,960.00

Start Date: December 1, 2011
End Date: November 30, 2013

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Sector: IT Applications

SBIR Phase II: An Interactive Music Analysis, Re-synthesis and Distribution Engine

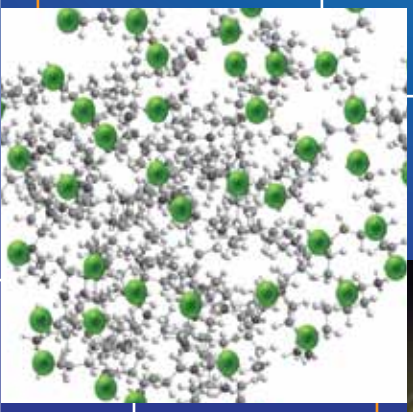
This Small Business Innovation Research Phase II project aims to extend work in developing computational music systems that will automatically analyze and re-synthesize digital music for the purpose of transforming a linear and passive music listening practice into an interactive, expressive and creative music experiences. Building on the work in phase I, which focused on segmentation and user interaction, the company propose to extend the work in the following areas: Utilizing machine-learning techniques to extract instrumental content of musical segments; Developing automatic compositional techniques that would sequence annotated musical segments to create musically meaningful compositions; Developing visualization techniques for representing musical compositions; Develop a set of applications utilizing our technology, and implement a Cloud based service that would support seamless interaction with these applications. The intellectual merit of the project lies in the fundamental contribution to human knowledge in the areas for music perception and analysis, machine learning, automatic composition, user interaction, and visualization. The project will advance current knowledge in areas such as music information retrieval, music perception, machine learning, automatic composition, signal processing, visualization and cloud computing. The proposed research would shed light on broader concepts such as human and artificial creativity and expression and the feasibility of utilizing artificial music intelligence as an enabler of novel forms of music creativity for children, novices and experts.

The project will lead to broad impact in the public sphere by creating engaging and rewarding musical experience for users at all skill levels. Zooz's music intelligence engine will allow even those who believe they are not musically inclined to become engaged in expressive and creative musical experiences. As part of the project, we will continue to conduct workshops with educational and musical institutions where children and novices will interact and create music using the Zooz engine. High visibility public concerts will be conducted to bring the technology to the public eye. From a business perspective, the broad impact of the project is in providing a novel solution to the significant problems faced by the music industry today. The industry, which has suffered from a significant annual drop in music sales, is looking for new ways to monetize their content by engaging fans with music games, personalization tools and cloud-based musical interaction. Zooz Mobile will address these needs by providing an intelligent system that will allow fans to interact, personalize and share their favorite music in the Cloud in novel and expressive manners.

NSF SBIR/STTR

PHASE II GRANTEE CONFERENCE

NANOTECHNOLOGY, ADVANCED MATERIALS & MANUFACTURING



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IMAGES AND CREDITS

Images from left:

Phase II # 1127380
Credit: ***Novan, Inc.****; Description: Example Nitricil™ macromolecule illustrating the stable reservoirs of nitric oxide (green).*

Phase II # 1230442
Credit: ***Halotechnics, Inc****.; Description: Halotechnics Green Glass. The grant-supported research resulted in the development of stable, low melting point, thermal storage materials such as Saltstream 700.*

Phase II # 1026896
Credit: ***Soraa, Inc.****; Description: Photograph of Soraa MR16 lamp, an example of an application which can incorporate wafers fabricated by the NSF-supported technology.*

Phase II # 1230458
Credit: ***Persimmon Technologies Corporation****; Description: Application in material-handling robotics.*

Araca, Inc.

Phase II Award No.: 1152253

Award Amount: $500,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: Novel Slurry Injector Device for Chemical Mechanical Planarization Application

This Small Business Innovation Research (SBIR) Phase II project aims to develop a novel slurry injection device for applications in chemical mechanical planarization (CMP), a key technology for integrated circuit (IC) manufacturing. Different from the current slurry application method that applies slurry on the pad center area during wafer polishing, this novel slurry injector device is placed on top of the pad surface, injects the fresh slurry to where it is needed, and reduces slurry mixing and dilution effects by blocking used slurry, pad debris, and rinsing water from re-entering the pad-wafer interface. Tests will be performed on various polishers to optimize the slurry injector device design for different CMP processes. This slurry injector device is expected to achieve higher material removal rates and reduce polishing defects compared to current pad center area slurry application method.

The broader/commercial impacts of this project will be the potential to reduce slurry consumption and increase yield during CMP processes for the IC manufacturing industry. In 2012, the global point-of-use slurry usage is estimated to be in excess of 600 million liters corresponding to a total slurry expenditure of approximately $1 billion. Assuming a conservative slurry savings of 15 percent by this slurry injector device, it represents a potential $150 million savings in slurry and an additional $25 million savings in waste treatment.

Arcast Inc.

Phase II Award No.: 1256255

Award Amount: $499,911.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Program Director: Rajesh Mehta

Sector: Advanced Manufacturing

SBIR Phase II: Reactive and Refractory Metal Processing

This Small Business Innovation Research (SBIR) Phase II project will deliver a system that can continuously process advanced refractory metal alloys from elemental, scrap or preprocessed feed stock into powder or small castings. The advanced hybrid plasma arc induction furnace uses the latest in clean melting techniques maintaining the full theoretical properties of these promising materials. This is a direct processing route for near net shape products. Advanced titanium alloys, for example, require special processes to maintain their material properties. This process will allow the development of specialist alloys without the cost and complexity of large and expensive foundry processes and rolling mills. The process developed takes pure elemental material and produces castings or powder in one direct cycle.

The broader impact/commercial potential of this project will be the creation of new methods for development of specialist and advanced reactive and refractory alloys. Currently there is no economically viable route for these alloys to move from small, lab-scale experiments to use in large-scale commercial applications. This new process will speed the process of transitioning these materials into emerging applications. The overall objective of this project is to create a pilot-scale plant to produce castings and powder of these specialist materials. Some selected material systems where this new process will have a potential impact include advance titanium-based shape memory alloys and intermetallics such as niobium-silicide based compounds. These new materials will create value for customers and users in the medical and aerospace industries, among others. The new process will be commercialized via the sale of a toll production service for castings and powder, and also via direct sales of the resulting equipment. Finally, the ability to easily produce pilot-scale quantities of novel alloys more cost-effectively will enhance the scientific understanding and application of these materials.

Ceralink Inc.

Phase II Award No.: 1127538

Award Amount: $647,820.00

Start Date: November 15, 2011
End Date: April 30, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: Ultra High Temperature Microwave Processing of Ceramics

This Small Business Innovation Research (SBIR) Phase II project addresses the need for breakthrough technologies in the production of ultrahigh temperature (UHT) ceramics, including nanograin structures, with improved performance-to-cost ratio. UHT ceramics are often challenging to densify. The development of UHT microwave assist technology (MAT) furnaces will dramatically improve the commercial applicability of UHT ceramic products through lower temperature densification and faster heating cycles. MAT, the combination of microwaves with radiant heat, is proven to enhance diffusion, leading to finer grained microstructures. This project will extend the use of MAT to temperatures above 1700 deg. C, into the range of sintering temperatures for UHT ceramics. A prototype UHT MAT furnace will be designed and built, capitalizing upon in-house MAT system design expertise and research results from Phase I. Proprietary MAT-modeling software will assist with optimizing furnace design and process efficiency. Selected UHT ceramics will be studied to demonstrate sintering with the prototype. Three current industrial UHT ceramic manufacturers, who expressed strong interest in using MAT for sintering products, will collaborate on the project.

The broader impact/commercial potential of this project includes performance enhancements at reduced processing costs, and growth in the use of ultrahigh temperature (UHT) ceramics. Expanded uptake of UHT ceramics will benefit a wide array of manufactured products in electronics, automotive, and aerospace applications. The process of sintering UHT ceramics is extremely energy-intensive. UHT microwave-assist technology (MAT) processing will reduce energy consumption and green house gas emissions by 50-80% for UHT ceramic production. This process may replace pressure-assisted methods, by combining MAT with techniques such as variable rate sintering. MAT may also decrease the use of sintering aids to improve erosion and wear resistance, and high-temperature strength. This faster process enables just-in-time manufacture and enhances competition with respect to foreign competitors. Finally, the UHT MAT furnace technology will lead to new and value-added products, through property improvements from finer grain sizes and cost reduction. This will position American manufacturers for new revenue opportunities and job growth.

Ceralink Inc.

Phase II Award No.: 1256628

Award Amount: $485,748.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Sector: Advanced Manufacturing

SBIR Phase II: Microwave Heating of Reaction-Bonded Silicon Carbide Ceramics

This Small Business Innovation Research (SBIR) Phase II project enables an innovative low cost approach to reaction bonded silicon carbide (RBSC). RBSC is a preferred material for mechanical seals, which are critical, costly components in many major manufacturing lines. The high cost of RBSC limits its use in favor of cheaper, shorter lived materials. A microwave heating process, combined with lower cost raw materials addresses RBSC cost issues. Phase I research identified a process range for producing RBSC with flexural strength above the industry average. The Phase II research will yield reliably high strength RBSC. The key objective for Phase II is optimization of all-carbon preform formation, and microwave infiltration methods, to fabricate prototype mechanical seals for industrial evaluation. The new RBSC will be characterized according to mechanical seal industry approval specifications. Innovative forming processes including 3D printing will be studied for the ability to quickly form complex, custom, near net preforms for infiltration. The anticipated result is a commercially ready, lightweight, high strength RBSC that will be preferred for existing and new applications.

The broader impact/commercial potential of this project will include significant cost reductions for wear resistant applications. A low-cost, superior performance mechanical seal will improve efficiency, with fewer costly production shut-downs due to pump failures. RBSC provides a longer overall lifetime than tungsten carbide, graphite, or alumina parts, further reducing life cycle costs. Mechanical seals cost on average $750 per inch of diameter, ranging up to 15" across. This research will enable a 50% reduction in RBSC cost, developing a viable, high performance product, along with market demand. Recent consolidation of major silicon carbide suppliers provides an opening in the market to support a new, independent RBSC source. The RBSC process uses a greener microwave process, with time, energy and greenhouse gas reductions of 50 to 80%. The commercial demonstration of microwave RBSC product will provide a needed boost to encourage other manufacturers to uptake cleaner, efficient microwave processing. The project also supports Science Technology Engineering Mathematics (STEM) education through high school projects and at least four undergraduate engineering co-op students.

Free Form Fibers L.L.C.

Phase II Award No.: 1152698

Award Amount: $500,000.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: The Digital Spinneret

This Small Business Innovation Research (SBIR) Phase II project will build upon recent advances in nanotechnology and laser processing of materials to pursue the large-scale production of stoichiometrically pure silicon carbide (SiC) fibers which are very difficult to obtain by other means. The transition from laboratory scale to industrial production requires a sea change in manufacturing approach. The proposed research will investigate the parameters involved in creating a "Digital Spinneret" (DS), a novel technology platform which enables the production of large qualities of high-quality fibers. The Phase I project demonstrated feasibility of the Digital Spinneret to produce many fibers in parallel; the Phase II research will extend and optimize this manufacturing method.

The broader impact/commercial potential of this project will be the enabling of scaled production of high-purity ceramic fibers for application in military and aerospace (turbomachinery, rockets, advanced structures), automobile, medical, energy, and other industries that require advanced materials with exceptional strength, stiffness, heat resistance, and/or chemical resistance. These are fast-growing fiber markets with great potential, and with a collective size exceeding $1 billion. The projected energy footprint of this production method is 1/1000th that of competing methods, providing a huge cost advantage.

Fusion Coolant Systems, Inc.

Phase II Award No.: 1058288

Award Amount: $734,320.00

Start Date: January 15, 2011
End Date: June 30, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: Minimum Quantity Lubrication Delivered by Supercritical Carbon Dioxide for Forming Applications

This Small Business Innovation Research (SBIR) Phase II project aims to develop next-generation supercritical CO2 metalworking fluid (MWF) technology for highly demanding metal forming applications. The approach is to deliver specialized environmentally-friendly lubricants with supercritical CO2, achieving tool wear rates, forces, and surface finish at least as good as aqueous-based MWFs that are currently in use. It is anticipated that a much smaller amount of MWFs will be required with this technology. The formulation of new supercritical MWFs and the optimization of flowrates of oil and CO2 for metalworking processes will be studied. The patented supercritical CO2 system (so-called CHiP Lube) will be evaluated in real industrial settings to confirm its capability to replace current MWFs. The effectiveness and efficacy of CHiP Lube system will also be scaled and applied to other common industrial metal working processes such as rolling, extruding, and cutting.

The broader/commercial impacts of this project will be the potential to provide an environmentally-benign lubricant system as an alternative to conventional MWFs with equal or better performance and lower cost. At any given time, approximately 2 billion gallons of MWFs are in use in the U.S.A. This represents a massive waste stream that must be treated and remediated. Plus, the negative effects of MWFs on worker health and safety are well documented. The components of CHiP Lube are naturally occurring and used in extremely low quantities. Therefore, the waste treatment and worker health concerns are minimized. CHiP Lube has been demonstrated in simple metal removal applications as providing lower tool wear and/or higher machining speeds than conventional MWFs, thereby leading to a lower overall cost of manufacturing. In addition, no carbon dioxide will be produced to run the process, as the CO2 used in the process will be recovered from other industrial processes such as ammonia and ethanol production.

Materials Innovation Technologies, LLC.

Phase II Award No.: 1127219

Award Amount: $539,145.00

Start Date: October 15, 2011
End Date: September 30, 2013

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Sector: Advanced Manufacturing

SBIR Phase II: Long Fiber Thermoplastic Composites from Recycled Carbon Fiber

This Small Business Innovation Research Phase II project will develop long fiber thermoplastic (LFT) compositions based on recycled carbon fiber. In Phase I, we demonstrated the ability to make high quality LFT formulations based on (1) waste carbon fiber and (2) composites scrap and end-of-life thermoplastic and thermoset carbon fiber composites. Mechanical properties of these composites were similar to, and in some cases superior to, those for virgin carbon fiber. In this project, we will continue to develop manufacturing capabilities to make both thermoset and thermoplastic composites. In this Phase II project, we will look at the following technical issues: (1) examining the use of new recycled fiber forms and comparing the results to prior data; (2) investigating the molding parameters associated with the "forging" of flat blanks of LFT; (3) optimizing the LFT compositions; (4) demonstrating consistent moldability and mechanical properties; and (5) demonstrating the conversion of molded LFT parts back into LFT compound to "close the loop" on recycling. This effort will feature partnerships with a not-for-profit composites laboratory and another small business, both of whom have extensive experience in developing LFTs using virgin carbon fiber.

The broader impact/commercial potential of this project includes a reduction in the amount of carbon fiber going into landfills and lower greenhouse gas emissions. Worldwide carbon fiber production is ~80 million pounds per year, with demand growing at ~15% annually. Conservatively, 20% of this fiber ends up as waste during composite manufacture (~16 million pounds/year) and is landfilled. The aerospace industry is a main consumer of this material (military aircraft, Boeing 787 and Airbus A380), but industrial, automotive, and recreational markets are also growing. However, few composite manufacturing processes are designed to work with chopped fibers, which is the primary form of recycled carbon fiber. Developing LFTs based on recycled carbon fiber will allow us to achieve "Three Shades of Green" by eliminating landfilling, reducing energy costs relative to virgin fiber, and improving sustainability. A significant business opportunity exists if manufacturing methods can be developed that use recycled fiber in the forms that are typical of reclaimed material. The potential market for composites made from recycled/reclaimed carbon fiber is more than $200 million. Finally, the amount of energy needed to recycle carbon fiber is only about 4% of that needed to make virgin fiber, reducing associated greenhouse gas emissions.

MicroGREEN Polymers, Inc.

Phase II Award No.: 1127360

Award Amount: $499,941.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Program Director: Rajesh Mehta

Sector: Advanced Manufacturing

SBIR Phase II: Continuous Production of Lightweight and Energy Efficient Solid-State Microcellular Panels from Recycled PET

This Small Business Innovation Research (SBIR) Phase II project aims to continuously produce multilayered microcellular from recycled polyethylene terephthalate (RPET) for rigid printing substrate applications. There is an increasing demand for sustainable substrates in the printing sector, which is America's third largest manufacturing industry. PET is the most recycled plastic in the United States. However, only 28% of the 5.15 billion pounds of water bottles used annually are currently recycled. Products made from RPET could utilize this untapped resource and in turn, could be recycled again, making them environmentally sustainable. The proposed approach is to fusion bond thin microcellular RPET sheets into thicker panels, thereby eliminating the need for a bonding adhesive, which in turn eliminates volatile organic compound (VOC) emissions that cause indoor air pollution. In Phase I of this project we established lab-scale feasibility for continuous fusion bonding of microcellular RPET sheets to produce such panels. In Phase II, we will build a production-scale laminator that is capable of producing microcellular RPET panels with a size of 4' x 8' at a speed of at least 8 feet/minute. The commercial feasibility of manufacturing this product will be established by developing a detailed cost model.

The broader impact/commercial potential of this project will be to satisfy the printing industry's rapidly growing need for sustainable products. The microcellular RPET panels to be developed are targeted for use in rigid printing substrate applications. Compared to current materials, the advantages of these panels include significantly higher post-consumer recycled (PCR) content, zero VOCs, premium printability without the need for surface treatment, enhanced barrier properties against mold/mildew/corrosion, excellent conformability, and compatibility with end-of-life recycling. The Phase II research will focus on using RPET as a raw material due to the immediate positive environmental and economic impacts. The resulting increase in the use of RPET in high-value applications will thereby provide an economic stimulus to the recycling industry. The results of this research will also expand the application frontiers for solid-state microcellular plastics technology and enable collaborative research to develop further markets for these lightweight materials in other industries such as construction, transportation, and maritime. Finally, the new technology resulting from this research will preserve resources for a sustainable environment, enhance the competitiveness of the US plastics industry, and create new job opportunities that will benefit society as a whole.

Persimmon Technologies Corporation

Phase II Award No.: 1230458

Award Amount: $499,786.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: SBIR Phase II Spray-Formed Soft Magnetic Material for Efficient Hybrid-Field Electric Machines

This Small Business Innovation Research (SBIR) Phase II project aims to develop a novel soft magnetic material and fabrication process for magnetic circuits of electric machines, such as winding cores of electric motors. The technology utilizes a unique single-step near net-shape fabrication process based on metal spray deposition to produce an isotropic metal microstructure characterized by small domains with high permeability, high saturation and low coercivity with a controlled formation of insulation boundaries that limit electric conductivity between neighboring domains. The resulting material provides an excellent three-dimensional magnetic path while minimizing energy losses associated with eddy currents. It can replace anisotropic laminated winding cores, which currently constrain the design of conventional electric motors to geometries with two-dimensional magnetic paths. As a further objective of the project, a new hybrid-field motor topology, with three-dimensional magnetic paths enabled by the proposed material and fabrication process, is being developed.

The broader impact/commercial potential of this project is to enable production of electric motors with improved performance and efficiency while reducing cost and material scrap associated with manufacturing of motor winding cores. Electric motors are used extensively in a growing number of applications, including robotics, semiconductor and LED process equipment, industrial automation, electric vehicles, heating, ventilation and air conditioning systems, appliances, power tools, medical devices, and military and space exploration applications. These markets drive an increasing demand for electric motors with improved performance, higher efficiency, and lower cost. Considering the extensive use of electric motors globally, the disruptive change resulting from the proposed hybrid-field motor technology with spray-formed winding cores is expected to provide significant commercial, societal and environmental benefits, including improved manufacturing efficiency, waste reduction, and energy conservation.

Starfire Industries LLC

Phase II Award No.: 1127557

Award Amount: $560,000.00

Start Date: October 1, 2011
End Date: September 30, 2013

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Sector: Advanced Manufacturing

SBIR Phase II: Microwave Surface-Wave Plasma Source for Large-Area, High-Throughput, High-Quality Thin-Film Manufacturing for Solar Panels and Semiconductors

This Small Business Innovation Research (SBIR) Phase II project aims to develop a Plasma-Enhanced Chemical Vapor Deposition (PECVD) system for the deposition of silicon layers for a solar cell to absorb sunlight and convert to electricity. Current PECVD processes face challenges that limit the quality and speed at which the silicon thin film can be deposited. This translates into higher capital cost and less efficient photovoltaic modules, thus higher cost. In this project, a novel microwave surface-wave plasma source for the PECVD processing step will be developed. This source has the potential to increase deposition rates by 10 times over the current state of the art, while maintaining excellent film quality needed for high energy conversion efficiency and long lifetime. The expected outcome of this project is to offer a technology with high processing speed that is suitable to manufacture advanced tandem and triple-junction solar cells with high energy conversion efficiency.

The broader/commercial impacts of this project will be the potential to enable the manufacturing of high-efficiency thin-film silicon solar cells at costs meeting or exceeding the 2020 grid-parity goal of $1/Watt installed cost. Thin-film silicon uses earth-abundant, sustainable materials with inexhaustible supply of raw materials and no toxicity concerns. The solution provided by Starfire addresses a critical manufacturing challenge that has the potential to break the thin-film silicon bottleneck and enable its wide adoption. This technology can also be used in areas such as semiconductors and advanced lighting.

Thermal Conservation Technologies

Phase II Award No.: 1230294

Award Amount: $499,998.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: Vacuum Insulation Panels with Tensile Structural Elements

This Small Business Innovation Research (SBIR) Phase II project will develop an ultra-thin high-R-value robust vacuum insulation panel (VIP). Thermal models indicate that with a half-inch thick VIP, an R-value of 40 can be achieved with an expected cost of ~$3 per square foot. The technology uses tensile structural elements as thermal impedances and is based on a 2011 patent which has been exclusively licensed from the University of Illinois at Chicago. The VIP is expected to be suitable for installation in industrial and residential structures, since it has a stainless steel foil exterior as opposed to current VIP technology, which uses a laminate of polyester and aluminum foil as its vacuum barrier. The aluminum foil creates a thermal short (edge losses) in current VIPs which can greatly reduce their effective R-value. The use of stainless steel has the additional advantage of significantly reducing edge losses as well as increasing puncture resistance.

The broader impact/commercial potential of this project will be a drastic reduction in the energy required to heat and cool buildings, or to refrigerate trucks used to transport perishable goods. In transportation, a refrigerated hi-cube trailer with two inches of polyurethane foam has an R-value of ~10, which can be increased to 50 by incorporating a half-inch-thick VIP. Most refrigerated trailers in the US consume ~1 gallon of diesel fuel each hour to keep their loads cold. Since there are ~330,000 refrigerated trailers operating for ~1,500 hours/year, this translates into a fuel savings of 80%, or nearly 1% of the total diesel fuel consumption in this country each year. Compact and inexpensive thermal insulation can allow better use of space inside new dwellings, and be used to retrofit existing dwellings with more effective insulation. Finally, a 2002 review prepared for the US Department of Housing and Urban Development cited low puncture resistance as a key factor slowing the adoption of vacuum insulation panels in the residential market. The proposed innovation will mitigate this factor and speed adoption in this market.

Transfer Devices, Inc.

Phase II Award No.: 1126916

Award Amount: $975,000.00

Start Date: October 1, 2011
End Date: September 30, 2015

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Sector: Advanced Manufacturing

SBIR Phase II: Molecular Transfer Lithography of Functional Materials

This Small Business Innovation Research (SBIR) Phase II project aims to develop processes for high-resolution patterning of advanced functional materials by a patented technique called molecular transfer lithography. The approach is to use water-dissolvable templates of polyvinyl alcohol (PVA), which are replicated from master surface topography, coated with functional materials that are transferred to a substrate as an active component of the resulting nanopatterned device. A range of functional materials are considered including dielectrics, metal oxides, conductive inks, phosphors, ceramics, optical polymers, nanoparticle-loaded composite materials, sol-gels, specialized resists, monolayer and semi-permeable polymer films, and luminescent materials. In combination with a platform equipment technology, these processes for functional material patterning comprise a comprehensive nanolithography solution that should enable nanomanufacturing of a broad range of novel devices.

The broader/commercial impacts of this project will be the potential to enable the nanopatterning of various functional materials that previously were difficult, not possible, or too costly to produce as high-resolution features for integration in advanced devices. Lithography technology, approximately a $10 billion market opportunity, creates dense circuitry and related nanostructures for high performance devices including semiconductors, displays, data storage, solid state lighting, solar cells, and biological sensors. In this project, the lithography procedure, which uses water-dissolvable templates and dry functional materials, enables an environmentally-friendly approach to high-resolution patterning, a foundational step in advanced manufacturing.

Uncopiers, Inc.

Phase II Award No.: 1127460

Award Amount: $500,000.00

Start Date: December 15, 201
End Date: November 30, 2013

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Sector: Advanced Manufacturing

SBIR Phase II: Clean Tool: A Unified Approach to Wafer Cleaning

This Small Business Innovation Research (SBIR) Phase II project aims to develop a single wafer processing clean tool for semiconductor wafer cleaning at all stages of wafer processing. The method relies on using acoustically controlled micro-cavitation to remove on-wafer particles. This is a chemical-free cleaning method, using ultra-pure water as the only processing fluid. During cleaning the particles will be counted as they get removed. The cleaning is deemed complete when there remain no more particles to be removed. The wafer will then be rinsed and dried in the same tool. This project is expected to provide a one-at-a-time wafer cleaning method with all the four functionalities of cleaning, inspection, rinsing and drying accomplished in a single setting.

The broader/commercial impacts of this project will be the potential to provide a complete environmentally-friendly solution to the wafer cleaning predicament. Cleanliness is a critical requirement in semiconductor manufacturing that directly impact the chip yields. Among all processing steps in semiconductor manufacturing, approximately one in every five processing steps is wafer cleaning. Perfect wafer cleaning is a significant, yet unsolved, problem in semiconductor industry, and the need is becoming more urgent as the technology moves towards sub-50nm design nodes. In this project, a wafer-cleaning tool will be developed to address this market need. This tool will also be useful in precision cleaning needed in the cleaning of lithography masks, Microelectromechanical Systems (MEMS), solar cells, flat panel displays, and hard disk drives (HDDs).

XRSciences LLC

Phase II Award No.: 1152704

Award Amount: $600,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Advanced Manufacturing

SBIR Phase II: Rapid Clinker Analyzer (RCA)

This Small Business Innovation Research (SBIR) Phase II project aims to develop an on-line analyzer to enable the increased use of alternative fuels in cement manufacturing, and thus reduce energy costs. Cement manufacturing is highly energy-intensive, accounting for a significant portion of fuel use in the world. The rising cost of energy has motivated cement manufacturers to use alternative fuels available at low or no cost (e.g., tires, municipal waste etc.). However, the use of alternative fuels creates manufacturing problems due to the lack of adequate and timely analysis feedback. In this project, a Rapid Clinker Analyzer (RCA) will be designed, built and evaluated to demonstrate that the system captures and analyzes data in a much faster and cost-effective manner to allow cement manufacturers to analyze product clinker in near-real time.

The broader/commercial impact of this project will be the potential to significantly increase the use of alternative fuels in cement manufacturing. Widespread adoption of this technology will result in significant savings to cement manufacturers, while greatly reducing the use of fossil fuels. In addition, the shift to alternative fuels will reduce landfills, and thus mitigate negative environmental impacts of waste products. This new technology will also provide a unique advancement in analyzer technology because of the more rapid performance and smaller sample required.

ZoomEssence, Inc.

Phase II Award No.: 1254328

Award Amount: $500,000.00

Start Date: March 15, 2013
End Date: February 28, 2015

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Sector: Advanced Manufacturing

SBIR Phase II: No Heat Spray Drying Technology

This Small Business Innovation Research Phase II Project of "No Heat Spray Drying" fundamentally changes the process of spray drying liquids to powders by eliminating the use of heat. Typically, a liquid emulsion consists of a high value liquid ingredient that is emulsified with a carrier system that when dried captures the liquid ingredient in a powdered form. High temperature spray drying remains the preferred method of drying many thermally sensitive materials such as foods, chemicals, probiotics, pharmaceuticals, and in many other applications where the production of a free-flowing powder is required. The current spray drying process employs air heated up to 400¡ Fahrenheit to dry the liquid into a powder. Exposing sensitive, volatile liquid ingredients to high temperatures causes molecular degradation that negatively impacts performance. By eliminating the use of heat the end result is a significantly improved powder in terms of product quality, solubility, stability and overall performance. Our research will be focused on improving our proprietary technology through dryer optimization and atomization development. This research should yield an innovative, commercially viable 'no heat' spray drying technology with the ability to manufacture significant amounts of powdered products.

The broader impact/commercial potential of this project spans markets including food & beverage, chemicals, pharmaceuticals, infant formula, coffee, vitamins and numerous other segments where the production of a free flowing powder ingredient is desired. The challenge: how to eliminate the use of heat in converting liquids to powders. By eliminating the use of heat in the manufacturing process, we create significantly improved powder products. Our process is more economical, delivers products with longer shelf life, better encapsulation and improves solubility. Our technology has several societal benefits including decreasing energy consumption and preventing the evaporation of volatile ingredients into the atmosphere. Our technology may be able impact the bioavailability of drugs, decrease tablet sizes, deliver stable Omega 3 ingredients and improve dried milk powder. We are only beginning to explore the potential applications of our revolutionary process technology

Absorbent Materials Company LLC

Phase II Award No.: 1127225

Award Amount: $1,007,586.00

Start Date: October 1, 2011
End Date: September 30, 2015

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Sector: Advanced Materials

SBIR Phase II: Produced Water Treatment Using Animated Organosilicas that Rapidly and Reversibly Swell

This Small Business Innovation Research (SBIR) Phase II project will develop commercial systems to economically purify produced water streams. Produced water is the water that is co-extracted from oil and gas production and is often ten times as voluminous as the extracted hydrocarbon. Phase II efforts will be focused on scale-up to fabricate a 200 gallon-per-minute produced water treatment system to effectively mine hydrocarbons from the fluid. The process uses a newly developed nano-engineered organosilica that rapidly and reversibly swells when exposed to organics, yet is hydrophobic and does not absorb water. The organosilica material is unique that it acts as a nanomechanical sponge extracting dispersed and dissolved hydrocarbons. The captured hydrocarbons can be recovered from the silica and the sorbent material re-used. Successful development of these water purification systems will allow for an entire new mechanism for produced water management.

The broader impact/commercial potential of this project development is tied to the ability to treat numerous produced water streams which are currently difficult or expensive to treat, and to obtain a higher yield in the recovery of valuable products. Approximately 800 billion gallons of produced water must be managed annually in petroleum operations around the world. This treatment process will allow existing oil and gas production fields to meet existing or higher environmental discharge standards at a lower overall cost. The system will also reduce the impact or potential impact of the discharge of produced water in emerging markets with sensitive environmental concerns. From an economic impact the system will result in a higher yield for many oil and gas fields, by capturing for refinement valuable hydrocarbons which would otherwise have been disposed of as waste. Phase I results showed that 0.4-3.5% of a typical "waste" stream is composed of potentially valuable hydrocarbons which are not recoverable with existing technology. The recovery of these hydrocarbons, which are often the lightest and most energy-valuable compounds, such as toluene and octane, will increase the value of every producing well using this system.

Advanced Diamond Technologies

Phase II Award No.: 1058505

Award Amount: $985,933.00

Start Date: April 1, 2011
End Date: March 31, 2015

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Sector: Advanced Materials

SBIR Phase II: Low-cost Long-life Diamond Electrodes for Wastewater Treatment using Advanced Electrochemical Oxidation

This Small Business Innovation Research (SBIR) Phase II project will employ the boron-doped ultrananocyrstalline diamond (BD-UNCD) electrodes developed during the Phase I project to fabricate and characterize electrochemical cells and systems for the on-site generation (OSG) of advanced oxidants (chlorine-based mixed oxidants - hydrogen peroxide combined with hypochlorite - and sodium persulfate) and apply them to targeted water treatment applications. The primary research objectives are to determine the optimal conditions to generate oxidants and to establish the projected lifetime of the electrodes. BD-UNCD cells will demonstrate higher rates of oxidant production at lower costs and with greater energy efficiency than competing electrodes due to higher current densities and over-potentials for O2 and H2 evolution at the anode and cathode. The known difficulties with existing approaches of disinfection, such as the inadequate destruction of pathogens (Cryptosporidium), ineffective operation below 10¡C, generation of large quantities of O2 and H2, and electrode fouling are expected to be mitigated substantially through use of BD-UNCD electrodes. Sodium persulfate (SPS) has been used as a highly effective oxidant capable of oxidative destruction of recalcitrant organics such as in oil-contaminated sea water. BD-UNCD technology will dramatically reduce the cost and increase flexibility of OSG water treatment using SPS.

The broader impact/commercial potential of this project is the development of a safer, cheaper, more environmentally friendly technology to generate "green" oxidants using diamond electrodes that can be used for a number of water treatment applications including purification, disinfection, and remediation. The market for chlorine-based disinfection systems alone is $20 billion with a correspondingly large impact on human health and national security issues associated with transporting vast quantities of hazardous materials. Overcoming technical barriers that have prevented diamond from being used for oxidant generation will require advances in the synthesis and large-scale manufacturing of diamond thin films that will impact other applications of this material. The electrochemistry of diamond is not well understood in the conditions needed for OSG. Better understanding of these reactions and the technological trade-offs between cell design and electrode geometry will impact related applications including the development of compact systems for third-world potable water generation, small scale desalination, the energy efficient electrochemical synthesis of new materials and other point-of-use applications of advanced oxidants. Large scale on-site generation of persulfates will enable highly effective treatment of refractory organics found in oil contaminated sea water and waste water associated with bitumen refining.

ATSP Innovations, LLC

Phase II Award No.: 1230439

Award Amount: $484,988.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Advanced Materials

SBIR Phase II: Ultra-Low Wear Coatings Based on a Novel Family of Aromatic Thermosetting Copolyesters

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize a new family of polymers (aromatic thermosetting copolyesters, or ATSP) for application to tribological surfaces for compressors used in air conditioning and refrigeration. Surface treatments/coatings are key to improving wear performance and durability in a wide range of applications. The main advantages of polymeric-based coatings are their relatively low cost and simple substrate surface conditioning. ATSP can be processed into highly effective wear-resistant coatings by blending with polytetrafluoroethylene (PTFE) and other additives. Key features of the new material are: (1) thermal stability at temperatures required to process with PTFE (350-450 deg. C); (2) excellent tribological properties, with several samples of selected compositions evidencing "zero" wear and low friction coefficient values that remained stable during testing - both important attributes for a long-term wear coating. Additional advantages are the ability to undergo interchain transesterification reactions, permitting reincorporation of wear debris into the coating, and good adhesion to metals such as stainless steel and cast iron. Technical objectives in the Phase II include tailoring the polymer backbone to improve powder/coating properties, optimizing thermal spray parameters for this industrially relevant process, and performing both in-house and customer-based evaluations.

The broader impact/commercial potential of this project is the potential to realize a new materials family which will permit lower cost and more versatile wear coatings for industry. There is strong customer demand for innovations that significantly improve the performance of the tribopair in compressors for refrigeration and air conditioning. Recent investigation for this specific market segment has shown that the ATSP system exhibits the crucial features of merit: low friction coefficient and an order of magnitude reduction in wear rate compared to state-of-the-art polymeric coatings. With the current societal focus on energy efficiency, more attention is being given to the fact that proper coatings and surface treatments are key to increasing efficiency for a wide range of mechanical surfaces (bearings, seals, turbines blades, etc.). Thus, there are opportunities in the much broader market, with the potential for major societal impact, since engines, pumps, and compressors are common equipment that represent a significant share of U.S. energy demand. ATSP has also shown excellent performance in adhesives, rigid foams, matrices for composites, and dielectrics for microelectronics, all of which suggest additional potential markets.

Composite Technology Development, Inc.

SBIR Phase II: Novel Fire-Resistant Toughened Benzoxazines

Phase II Award No.: 1026873

Award Amount: $681,622.00

Start Date: September 15, 2010
End Date: August 31, 2013

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Sector: Advanced Materials

This Small Business Innovation Research (SBIR) Phase II project seeks to develop and demonstrate flame-resistant, polymer-composite materials based on novel benzoxazine resin chemistries. In the Phase I project, low-viscosity benzoxazine resins were synthesized and composite formulations prepared that exhibit suitable processing characteristics for use in composite manufacture, as well as good mechanical strength and flame resistance. These successes were achieved through the development of polymer synthesis techniques, and validated by the subsequent fabrication and testing of continuous fiber-reinforced composites. For example, the Phase I results showed that these new polymer formulations offer significantly reduced processing temperatures, which simplifies composite manufacturing processes and reduces tooling costs. In addition, the fiber-reinforced composites produced using these materials exhibited 15-20% higher tensile strengths and 50% higher toughness values as compared to composites fabricated using the as-synthesized (i.e., not toughened) material. This finding is important and shows that composites with strengths comparable to those of epoxy-based systems, but with superior flame resistance, can be achieved with these new materials.

The broader impact/commercial potential of this project will initially be in the electronics and aerospace markets. Flame-resistant polymers and composites are becoming increasingly important systems in both of these industries. In each case, the use of fire-resistant materials offers enhanced public safety, while also improving the overall performance of the systems in which they are used. The value of high-strength flame-resistant materials is perhaps most evident in the civil aviation industry. In this instance, the transition to composite materials offers a significant weight savings, with reductions in weight accounting for a large percentage of recent improvements in aircraft fuel efficiency, while also enhancing the flame resistance of aircraft structures. In addition, the use of advanced materials is expected to increase steadily in electronics applications over the next 10 years, and the further development and commercialization of benzoxazine resins will provide the users of this technology with enhancements in both fire safety and system-level performance.

ECOSIL Technologies LLC

SBIR Phase II: High-Performance Metal Pretreatments

Phase II Award No.: 1152518

Award Amount: $578,402.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Advanced Materials

This Small Business Innovation Research (SBIR) Phase II project aims to develop a chromate- and phosphate-free metal surface pre-treatment product that reduces cost, and provides significant environmental and health benefits. Iron and zinc phosphate chemicals are currently widely used in surface treatment processes, which require from 7 to 10 process steps, consume energy to heat treatment baths, and produce a large quantity of waste that must be treated. This adds cost, and results in phosphate discharge to the environment. Based on the Phase I project, a chromate- and phosphate-free pre-treatment chemical will be further developed in this project. This chemical reduces the number of pre-treatment process to less than 5 steps, can be used at ambient temperature, and produces 90% less waste. It is expected to demonstrate enhanced performance in corrosion protection and paint adhesion over similar products.

The broader commercial impacts of this project will be to dramatically reduce cost, complexity and negative environmental impact of metal surface pretreatment in manufacturing processes without compromising performance. Potential applications will be in automobile, aerospace, steel (coil coatings), consumer electronics, appliance, and many other industries. An important societal impact will be the better protection to workers in plants, as this process is not toxic and does not require elaborate waste disposal procedures. This project will also enhance the scientific understanding of mechanisms by which pretreatments contribute to the protection of metals.

Ecovative Design

Phase II Award No.: 1058285

Award Amount: $929,372.00

Start Date: March 1, 2011
End Date: February 28, 2015

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Sector: Advanced Materials

SBIR Phase II: Method of Disinfecting Precursor Materials using Plant Essential Oils for a new Material Technology

This Small Business Innovation Research (SBIR) Phase II project seeks to further develop, and demonstrate at scale, a biological disinfection process that has exhibited superior microbial inactivation to steam pasteurization at a lower cost. This process leverages dilute concentrations (0.5-0.875% by volume) of plant-derived phenols and aldehydes to inactivate lower level fungi and bacteria found on agricultural byproducts (seed husks and hulls). The application focus for this demonstration is a novel material technology that converts lignocellulosic waste into a high performance, low cost replacement for synthetics (plastics and foams) using a filamentous fungus. This biological disinfection process can reduce process energy consumption by 83% and system capital expense by upwards of 50%. This project will fully quantify the efficacy of this disinfection process at scale (production volumes) as well as analyze the integration of this technique into a mycological material production facility that is presently addressing the protective packaging industry. Batch and continuous systems will be explored, and a comprehensive economic model will be developed based on the results. The mycological materials that are produced under this demonstration will be compared with materials fabricated with the existing pasteurization system, and samples will be evaluated by customers to ensure product adoption.

High-embodied energy disinfection processes, autoclave sterilization or pasteurization, are ubiquitous within industries such as agriculture, food processing, and biotechnology. These methodologies are implemented to reduce or remove background bioburden (bacteria, yeast, mold) that can be detrimental to downstream processes due to contamination. Mycological materials production represents such a process since raw material contamination results in product loss and added labor. The plant essential oil (PEO) disinfection technique was proven under the Phase I research to offer a comparable process time to steam pasteurization and superior disinfection efficacy; thus this technology could serve as a drop-in replacement in some industrial applications. This process minimizes capital equipment and operations costs due a reduction in system complexity and energy consumption. In regards to the production of mycological products, this disinfection process bolsters the process robustness by extending contaminate inactivation periods which promotes rapid mycelium colonization or a reduction in incubation time. Therefore new market opportunities for mycological materials can be addressed while further supporting the business case for regional manufacturing using domestic agricultural waste as raw materials. Finally, the benefits obtained from this novel disinfection process permit an accelerated deployment and development of turnkey production systems to displace synthetic materials.

Ecovative Design LLC

Phase II Award No.: 1152476

Award Amount: $481,604.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Sector: Advanced Materials

SBIR Phase II: Using Mycelium as a Matrix For Binding Natural Fibers And Core Filler Materials in Sustainable Composites

This Small Business Innovation Research (SBIR) Phase II project seeks to further quantify the mechanical performance of mycological bio-composites that address the automotive and structural core industries, while concurrently scaling and demonstrating material production. The engineered composites market continues to grow steadily because of the high strength-to-weight and stiffness-to-weight ratios of these systems, as compared to conventional engineering materials. Engineered woods are ubiquitous in the construction and furniture industries, but due to domestic indoor air quality regulations (Toxic Substances Control Act), these materials are being phased out or are forced to use expensive formaldehyde-free adhesives. Similarly, the automotive industry is under regulatory pressure in Europe to find alternatives to fire-retardant foams that cannot be recycled due to inorganic filling agents. The technical results from the Phase I effort have demonstrated bio-composite materials which can compete both economically, and on mechanical performance, with the aforementioned competitors, while meeting these legislative demands. A preliminary cost analysis based on the process economics of our existing production facilities projects retail costs 45% and 35% below the current state-of-the-art in the automotive and furniture industries, respectively. We will work with key industry partners to meet performance metrics and demonstrate quality pilot production.

The broader impact/commercial potential of this project would be a customizable bio-composite for a broad range of markets, including automotive, transportation, architectural, furniture, sports, and recreation. These materials are truly sustainable, since both the laminates and cores used in the sandwich structure consist of renewable materials. They also require significantly less energy to make than other biocompatible composites, because the material is grown instead of synthesized, and the material is completely compostable at the end of life. The outcome of the proposed development and demonstration will ensure that the bio-composite properties meet the requirements for the target markets. Furthermore, over the course of this grant, and in cooperation with Rensselaer and Union College, we will demonstrate and scale the best manufacturing processes to a pilot stage capable of manufacturing high volumes of quality product. Since these materials leverage regional lignocellulosic byproducts from domestic agriculture and industry, a regional manufacturing model is presently being pursued to reduce transportation and feedstock costs. This will not only bring additional value to U.S. agricultural markets, but will spur rural economic development through domestic manufacturing. Finally, these advanced biological materials represent a new paradigm in manufacturing, offering safe, biodegradable alternatives to traditional petroleum-based alternatives.

EnVitrum LLC

Phase II Award No.: 1256642

Award Amount: $499,999.00

Start Date: April 1, 2013
End Date: March 31, 2015

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Program Director: Ben Schrag

Sector: Advanced Materials

SBIR Phase II: Evaporative Cooling Building Envelope Materials Created from Recycled Glass

This Small Business Innovation Research (SBIR) Phase II project is focused on the reuse of waste glass to generate high-value replacements for traditional masonry products. Masonry manufacturers cannot meet the construction industry's needs with their status quo product and are therefore losing market share. The industry seeks products with higher quality, consistency and performance that address environmental concerns, while remaining cost competitive. The material which has been developed meets or exceeds all required performance standards, and its high recycle content and low embodied energy significantly reduce production costs. The research objectives for this Phase II project include scale-up of this process via extrusion and expansion of the usable waste glass supply. The transition to extrusion will require increasing the plasticity of our material and research will result in extrudates that are compatible with masonry production equipment. The effort will also explore the impacts of contamination on the microstructure and mechanical performance of glass materials sintered at low temperature; this work will be the first of its kind. The ultimate project goal is successful development of the first high-recycle content glass composite paste that is ready for industrial manufacturing via cold extrusion.

The broader impact/commercial potential of this project is significant. Successful completion of the Phase II activities will have a positive impact on both the glass recycling and construction industries. One key result will be the development of a novel, high-efficiency glass manufacturing process. This work will contribute to the scientific understanding of plasticity theory and mechanical behavior with respect to glass composites and porous materials. The evaluation of organic and inorganic contaminants, as they relate to advanced glass processing technologies, will be the first research of its kind. This research will provide a commercial outlet for waste glass, particularly the vast quantity that cannot currently be recycled, and therefore is simply hauled off to landfills. This material will allow manufacturers to adopt high-value, cost-competitive product lines and will also bring value to the construction industry by providing a truly green alternative to traditional facing materials. The environmental and societal impacts of this novel building material include improving environmental quality by decreasing energy consumption and associated greenhouse gas emissions, and also by minimizing the burden on solid waste storage infrastructure.

Halotechnics, Inc.

Phase II Award No.: 1230442

Award Amount: $500,000.00

Start Date: September 15, 2012
End Date: August 31, 2014

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Sector: Advanced Materials

SBIR Phase II: Advanced Molten Salt for Solar Thermal Power Generation with Supercritical Steam Turbines

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a novel molten salt for solar thermal power generation with supercritical steam turbines. Solar thermal technology developers must increase the operating temperature of their plants to lower their levelized cost of electricity and reduce the cost of thermal storage. Building upon a successful Phase I program, the project team has developed a prototype salt mixture that could enable this trend. It is low cost, exhibits a melting point below 240 deg. C, and has a high maximum temperature of 700 deg. C, a broad operating range currently unavailable elsewhere. The project will conduct a high throughput R&D program to rapidly screen up to thousands of unique mixtures of inorganic salts to optimize the physical properties of the prototype fluid. The project will apply combinatorial chemistry techniques, originally developed for pharmaceutical applications, to this new field. After screening many candidates, the project will evaluate the materials compatibility of a few promising mixtures with common steel and nickel-based alloys. Corrosion mitigation techniques will be developed and evaluated. The project will conduct flow testing in a lab-scale test loop capable of 700 deg. C operation.

The broader impact/commercial potential of this project will be the enabling of low-cost electricity from the sun. It is imperative that society reduce its usage of fossil fuels (oil, natural gas, coal) to address pressing concerns - climate change and environmental degradation, energy security, and price volatility. Solar thermal power, a compelling source of renewable electricity at large scale, is the most promising solution to reduce fossil fuel use. However, electricity from solar thermal power currently costs too much to be directly competitive with fossil fuels. Furthermore, solar thermal plants need a cheap way to store heat in order to produce power after sundown or when utilities demand it. This project focuses on the material at the heart of these plants - the heat transfer fluid - and thermal storage system. The market for thermal storage is projected to reach $3.7 billion by 2015. Thermal storage is growing increasingly valuable as utilities realize the need for solar power that can deliver smooth, reliable output regardless of weather conditions. The development of the proposed innovation would both reduce the cost of solar thermal power and enable economical thermal storage, bringing the nation significantly closer to eliminating the use of coal.

Heavystone Laboratory, LLC

Phase II Award No.: 1127286

Award Amount: $500,000.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: Advanced Materials

SBIR Phase II: Functionally Graded Cemented Tungsten Carbide -- Process and Properties

This Small Business Innovation Research (SBIR) Phase II project aims to develop an innovative process which can transform conventional cemented tungsten carbide (WC-Co), the most widely used industrial tool material, into functionally graded cemented tungsten carbide (FG WC-Co). Compared to the homogeneous structure of conventional WC-Co, FG WC-Co has a harder surface and tougher core due to a gradual increase of cobalt content from the surface to the core, which offers considerably higher wear resistance without sacrificing fracture toughness. This combination of mechanical properties leads to the superior engineering performance of FG WC-Co which translates to significantly improved tool life, reliability, and productivity.

The broader/commercial impacts of this project will be the potential to replace conventional WC-Co used in numerous manufacturing industries including auto and aerospace manufacturing, oil and gas drilling, geothermal energy exploration, mining, construction, and applications where extreme wear resistance is required. The replacement of conventional WC-Co tool materials with FG WC-Co is expected to lead to significant productivity improvements in these manufacturing industries. The annual addressable market is estimated to be over $5 billion.

Inmatech, Inc.

Phase II Award No.: 1230387

Award Amount: $445,782.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Sector: Advanced Materials

SBIR Phase II: High Power and Energy Density VN-based Asymmetric Supercapacitors

This Small Business Innovation Research (SBIR) Phase II project will demonstrate asymmetric supercapacitors that meet or exceed the cost and performance targets set by the United States Advanced Battery Consortium for FreedomCar applications. These devices will be based on low-cost VN and NiOOH with aqueous electrolytes. Currently available commercial products are based on carbon with organic electrolytes and deliver 3-6 Wh/kg with power densities of 700 W/kg at a cost of ~$0.10 per Farad. The cost must be decreased by at least a factor of two for broader market acceptance, and the energy density improved to reduce the supercapacitor size. The proposed SBIR program will lead to next generation supercapacitors with energy densities that approach 15 Wh/kg and costs that are as much as 10 times lower than those for currently available commercial devices. The superior performance and cost are derived from the use of inexpensive, base metal nitrides and oxides tailored to give high specific capacitance, low impedance aqueous electrolytes that enable fast, efficient high power cycling, and an asymmetric design that maximizes the operating potential window. This combination of performance and cost will enable significant expansion in the use of supercapacitors for a number of important applications.

The broader impact/commercial potential of this project lies in efficient peak power management of electric loads, such as automotive start/stop systems, acceleration and regenerative braking of hybrid electric vehicles (HEVs), and uninterruptible power supplies. Supercapacitors offer a combination of energy and power that complements other electrochemical storage and conversion devices, including batteries and fuel cells. With improvements in energy density and reductions in cost, the markets for supercapacitors are expected to grow rapidly. Transportation and smart grid applications represent large markets with >30% annual growth. The automotive supercapacitor market totaled $55 million in 2009 and could grow to $243 million by 2015, fueled by the demand for HEVs. The smart grid market for supercapacitors is forecasted to reach $2.5 billion in 2015 driven by peak-load management and regenerative braking for light rails. The devices developed during this SBIR program could support minimizing our nation's production of greenhouse gases and dependence on foreign energy sources. Federal agencies including the Department of Defense will also benefit, in particular, for applications such as extended range vehicles, exoskeleton systems, and electromagnetic armors.

Innova Dynamics, Inc.

Phase II Award No.: 1152722

Award Amount: $615,171.00

Start Date: May 1, 2012
End Date: April 30, 2014

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Program Director: Steven Konsek

Sector: Advanced Materials

SBIR Phase II: Efficient Manufacturing of Nanostructured Flexible Transparent Conducting Electrodes

This Small Business Innovation Research (SBIR) Phase II project aims to develop high-performance transparent conductors as a replacement to Indium Tin Oxide (ITO) in touchscreens. ITO suffers from a number of disadvantages, including being one of the most expensive components of a touchscreen device, complex manufacture, and inflexibility. In this project, a transparent conductor will be developed using solution-based conventional coating equipment. Two key features of this novel transparent conductor are: (1) ease of processing, which eliminates many conventional processing steps involved in coatings; and (2) extreme durability, which enables the creation of next-generation touch devices that are otherwise impossible to realize with ITO or other ITO-alternative materials. The tradeoff between photonic transmission and electronic conduction will be theoretically and experimentally studied by extracting effective optical parameters of transparent conductor films. The printed touchscreen sensors will be integrated into functional multi-touch projected-capacitive devices, which are expected to show mechanical flexibility, higher signal to noise ratios, and faster response times.

The broader/commercial impacts of this project will be the potential to enable enhanced performance of touchscreens at disruptively lower costs. The total addressable market of patterned transparent conductor materials for touchscreen industry is about $1.3 billion today. Currently, material and processing costs of ITO represent a growing portion of the bill of materials for touchscreen devices. Transparent conductors to be developed through this project offer low-cost, high-performance, and high production throughput benefits, which will address the ITO-related challenges in touchscreen industry. Other applications of this technology includes liquid crystal displays, organic light emitting diodes, e-paper, flexible displays, thin film photovoltaics, electromagnetic shielding, defrosting windshields, low-emissivity architectural glass, and smart windows.

Inpria Corporation

Phase II Award No.: 1152266

Award Amount: $500,000.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Steven Konsek

Sector: Advanced Materials

SBIR Phase II: Aqueous Precursors for High Performance Metal Oxide Thin Films

This Small Business Innovation Research (SBIR) Phase II project aims to develop spin-coatable liquid precursors for extremely high etch resistance pattern transfer layers (hardmasks) to enable novel devices in advanced integrated circuit manufacturing. The approach is to employ the fully inorganic metal oxide dielectric precursors demonstrated during the Phase I project to provide unparalleled etch selectivity for lithography spin-on hardmask layers. Such materials enable new architectures and deep etches required for future device generations which demand increasingly complex integration of materials to compensate for the limited etch selectivity of conventional organic patterning materials. The expected outcome is one or more inorganic spin-on hardmask materials ready for scale up to manufacturing.

The broader/commercial impact of this project will be the potential to provide materials to improve performance of integrated circuit devices manufactured at dimensions below 22 nm. This project addresses key challenges in the International Technology Roadmap for Semiconductors related to patterning requirements for future high performance electronic devices. The aqueous precursors are synthesized from environmentally benign raw materials, thereby reducing the environmental impact relative to conventional organic materials. The materials and low temperature processes developed in this project will also lay the foundation for broader applications in electronics, energy, and optical coatings.

Inpria Corporation

Phase II Award No.: 1026885

Award Amount: $1,100,000.00

Start Date: June 15, 2010
End Date: May 31, 2014

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Sector: Advanced Materials

SBIR Phase II: Directly Patternable Inorganic Hardmask for Nanolithography

This Small Business Innovation Research (SBIR) Phase II project aims to develop a robust, high-speed inorganic resist platform to revolutionize the manufacture of semiconductor devices with feature sizes < 30 nm. At present, there is no demonstrated organic or inorganic resist that satisfies all of the requirements - high speed, low line-width roughness (LWR), sufficient etch resistance - for patterning devices at these feature sizes. A fundamentally new approach, relying on depositing extremely high-quality oxide films from aqueous solution and very efficient photon-induced network-forming reactions, is being pursued. The approach has enabled the production of extremely small feature sizes and linewidth roughness, enabling optimization within a uniquely high-performance triangle of sensitivity, linewidth roughness, and resolution. Resist deposition, resist formulations, exposure conditions, and processing parameters will be examined in detail to simultaneously address International Technology Roadmap for Semiconductors (ITRS) roadmap requirements for 193i and extreme ultraviolet (EUV) lithography. Anticipated results include 26-nm line/space (L/S) resolution at 3 nm LWR with 193-nm exposures and double patterning, and 22-nm L/S resolution at 1.2 nm LWR with EUV exposures. This resist platform will also lead to a high-resolution electron beam resist with unprecedented sensitivity.

The broader/commercial impact of this project is to develop high-performance resist materials to fill critical unmet needs for semiconductor manufacturing with features smaller than 30 nm. The material being developed addresses two of the ITRS "difficult challenges" for lithography: an EUV resist that meets 22-nm half-pitch requirements, and the containment of cost escalation of the extension of 193 nm patterning. The resulting product will serve a quickly growing market with a combined opportunity of $250 million in 2015. Success in the project will have a considerable impact on continued productivity gains in the ITRS roadmap, which supports the electronics industry. New levels of device performance will be enabled, providing broad societal impacts through the introduction of advanced electronics, while enhancing prospects for domestic employment in advanced materials and semiconductor manufacturing. The broader scientific and engineering research communities will benefit from new techniques to build and study novel devices at the extreme end of the nanoscale. Finally, solution processing with aqueous materials will reduce the use of toxic solvents and permit a smaller carbon footprint from reduced reliance on vacuum process equipment.

Integrated Surface Technologies

Phase II Award No.: 1026571

Award Amount: $959,240.00

Start Date: September 15, 2010
End Date: August 31, 2014

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Program Director: Ben Schrag

Sector: Advanced Materials

SBIR Phase II: Durable Super-Hydrophobic Nano-Composites

This Small Business Innovation Research (SBIR) Phase II project seeks to further develop and commercialize a new class of durable, water-resistant nanocomposite coatings identified and explored during the Phase I project. The unique processing conditions used to make these nanocomposite coatings produce a virtually invisible, conformal, nanometer-scale film that is comprised of surface bound nanoparticles and offers superior water barrier properties while still permitting through-film electrical connections. The newly developed coating has the potential for great commercial impact and can be thought of as a "game changer" for certain consumer electronic markets. The innovation and research plan for Phase II centers on two critical issues for commercial integration: 1) the overall processing efficiency of the material and 2) issues of long-term reliability and chemical interaction with existing platforms.

The broader impact/commercial potential of this project will be felt in a number of consumer, military, and medical products. It is estimated that about 1.2 billion mobile handsets are produced annually and that 8% of all the damages that occur to handsets are from liquid ingress. If fully adopted by the industry, this coating could reduce the liquid ingress damage to nearly zero, resulting in significant savings to consumers. Additionally, medical hearing aids would benefit from the oleophobic protection provided by this material, and its use would result in a decrease in the number of units returned annually for corrosion, water damage and ear wax contamination (this number currently stands at 11 million). Finally, the integration of our protective coating into other existing electronics products will add significant value to these products and will make them more durable and attractive to consumers globally.

Lightwave Photonics, Inc.

Phase II Award No.: 1256630

Award Amount: $500,000.00

Start Date: February 15, 2013
End Date: January 31, 2015

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Program Director: Steven Konsek

Sector: Advanced Materials

SBIR Phase II: GEMM Materials for High-Efficiency and Low-Cost III-Nitride LED Technology for Solid-State Lighting

This Small Business Innovation Research (SBIR) Phase II project will support the development and commercialization of Lightwave Photonics, Inc.'s novel light emitting diode (LED) technology for use in solid-state lighting. Adoption of LED solid-state lighting is still constrained by the prohibitive upfront cost of commercially available LED solid-state lighting products. Lightwave Photonics has developed a unique material structure that will enable LED manufacturers to improve LED device performance and efficiency as well as reduce the manufacturing costs. During Phase II Lightwave Photonics will work to further improve the performance of their LED technology, develop a commercially viable manufacturing processes, design advanced LED devices that take advantage of the benefits of Lightwave's technology. Lightwave Photonics will also work with commercial LED manufacturing partners to integrate their advanced LED devices in a commercial LED fabrication facility and qualify Lightwave's LED technology for production manufacturing.

The broader impact/commercial potential of this project is the development of commercially viable technology for improving the performance and efficiency and reducing the cost of solid-state lighting. According to the U.S. Department of Energy (DOE), over the 20-year period spanning 2010-2030, the cumulative energy savings from widespread adoption of solid-state lighting in the United States is estimated to total approximately 2,700 terawatt-hours, representing approximately $250 billion at today's energy prices. These savings could also reduce greenhouse gas emissions by 1,800 million metric tons of carbon. Lightwave's advanced technology will allow LED researchers to design new and novel advanced LED device structures that, until the recent development of the Lightwave's technology, were not possible in a manufacturable way. By improving the performance of solid-state lighting and reducing the upfront cost, Lightwave Photonics will accelerate the widespread installation of solid-state lighting.

MTPV LLC

Phase II Award No.: 1256583

Award Amount: $494,665.00

Start Date: April 15, 2013
End Date: March 31, 2015

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Sector: Advanced Materials

SBIR Phase II: Epitaxially Grown GaSb Thin Films on GaAs Substrates For Near-Field Conversion of Heat to Electricity

This Small Business Innovation Research (SBIR) Phase II Project goal is to produce GaSb photovoltaic devices of multicell (MIM) construction for TPV use. Current devices use single cell. MIM devices have significant advantages over single cell in efficiency and cost. A MIM device is composed of many sub-cells physically isolated on the same substrate. This proportionally increases output voltage and decreases output current resulting in lower internal power loss. To date there have been no publications describing MIM Ge or GaSb MIM devices. The Phase I Program demonstrated that high lifetime GaSb can be epitaxially grown on semi insulating GaAs and an IR&D program demonstrated that 50 subcell MIM devices can be fabricated from epitaxial germanium on semi insulating GaAs. Combining these elements will produce an ideal device. Although the Ge MiM is suitable for TPV a GaSb MIM would give a three to tenfold improvement in performance.

The broader impact/commercial potential of this project is to economically & efficiently recover waste heat as electricity. 57% of all power generated in the US is rejected as waste heat, however, to date there have been no successful attempts to recover this heat as electricity as opposed to steam for heating purposes. MTPV is developing a thermophotovoltaic solution to address this problem and is a pioneer in the use of near-field evanescent coupling to dramatically increase the power density obtainable from a heat source at a given temperature. MTPV has published a clear demonstration of this phenomenon and is engaged in commercializing its use. Silicon emitter chips designed to transfer energy from a heat source in such a manner as to facilitate the formation of a sub-micron gap are currently being produced in a foundry as well as both single cell and MIM Ge devices. The unique housing that is required to contain these chips and allow insertion into an 1100 degree C furnace is designed/ fabricated at MTPV's facility where power generation tests are conducted.

Natural Composites, Inc.

Phase II Award No.: 1026842

Award Amount: $1,003,000.00

Start Date: August 1, 2010
End Date: July 31, 2014

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Program Director: Ben Schrag

Sector: Advanced Materials

SBIR Phase II: Coconut (Coir) Fiber Automotive Composites

This Small Business Innovation Research (SBIR) Phase II project will resolve the technical issues associated with scaling up the manufacturing of non-woven fabric composites made from a blend of coir fiber (from coconut husks) and recycled polypropylene. Final product variability due to the coir fiber itself, the milling of coir fiber from coconut husks, and the manufacturing process to make the felted composite, will be minimized. The variability of the coir fiber feedstock will be determined, along with the resulting variation of the composite's flexural stiffness. The most cost-effective production process to produce consistently clean, 2-3" long fibers in-country from husks will be defined. Finally, the manufacturing processes required to produce these coir fiber composites with the required consistency for automotive applications will be developed. This project will include continuous input from a major automotive manufacturer as well as an automotive parts maker. This research will result in an improved readiness of a polypropylene/coconut fiber based non-woven fabric composite that meets industry certifications for use in automobile trunk liners, and which is greener, less expensive, and better performing than current all-synthetic parts.

The broader/commercial impact of this project will take many forms. The total market for automotive non-woven fabric composites is 300 million kg/year. Each vehicle platform that adopts this technology will require 2 million kg/year just for the trunk liners. Replacing synthetic fiber with coconut fiber makes parts more environmentally friendly while utilizing a waste material. Petroleum consumption can be reduced 2-4 million barrels per year and CO2 emissions reduced by 450,000 tons per year by replacing polyester fibers with coir in automotive interior composites. Additionally, the improved performance and lower weight of these materials will lead to cost savings through increased fuel economy, saving up to 3 million gallons of gasoline per year in the U.S. Finally, this project will lead to great economic opportunities for poor coconut farmers and to a very positive environmental impact. Ninety-five percent of the 50 billion coconuts grown worldwide are owned by 10 million coconut farmers whose average income is less than $2/day. Approximately 85% of the coconut husks are currently disposed of as trash, creating pollution. The successful adoption of these materials would create a market for this material, in many cases doubling the annual income for these farmers.

NCD Technologies, LLC

Phase II Award No.: 1127516

Award Amount: $600,000.00

Start Date: September 1, 2011
End Date: August 31, 2013

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Sector: Advanced Materials

SBIR Phase II: Improving the Adhesion of Nanocarystalline Diamond Films to Tungsten Carbide Micro End Mills

This Small Business Innovation Research (SBIR) Phase II project aims to develop a novel, commercially-viable, hybrid system that improves the adhesion of nanocrsytalline diamond (NCD) coatings to tungsten carbide (WC) cutting tools. A new hybrid system will be assembled, tested, and optimized. Research will be conducted to scale up the process to reach the capability of coating more than 3,000 cutting tools at one time. Further research will be conducted through laboratory and industrial machinability testing on these diamond-coated micro end mills. Testing variables include tool size, tool geometry, machining parameters (cutting speed, axial depth of cut, feedrate), workpiece material and environmental conditions. Industrial feedback will be used to ensure coating optimization to meet the needs of real users.

The broader/commercial impacts of this project will be the potential to significantly improve the performance of micro tools. An important area of this industry is currently limited by poor micro end mill performance. Improved tooling performance will not only reduce the capital machine cost in this field, but also help realize the miniaturization of existing cutting-edge technology limited by current manufacturing capabilities. The most promising societal benefits of NCD tool coating will be realized in healthcare industry as diamond coatings are essential for the development of next generation biosensors and biomedical devices. This will significantly improve the quality and substantially reduce costs associated with biological sample testing, reducing the financial burden of healthcare expenses on individuals and the country.

Orthogonal, Inc

Phase II Award No.: 1058509

Award Amount: $491,701.00

Start Date: April 1, 2011
End Date: September 30, 2014

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Program Director: Rajesh Mehta

Sector: Advanced Materials

SBIR Phase II: Enabling large-scale manufacturing of organic electronic devices using photolithography

This Small Business Innovation Research (SBIR) Phase II project aims to develop a photoresist system that is compatible with a much wider range of materials than traditional photoresists, allowing for the patterning of advanced semiconducting polymers and small molecules on existing photolithographic equipment. Through Phase I project, Orthogonal has improved its fluorinated photoresist system by making two new materials with lower manufacturing cost and enhanced performance. In this Phase II project, the patterning of the widely used conductive polymer poly(3,4-ethylene dioxythiophene):poly(styrene sulfonic acid) (PEDOT:PSS) and similar acidic materials will be studied. Multiple approaches will be taken to continuously improve the performance of the new photoresist materials. The scalability of one or both photoresist materials to large quantities will be investigated by addressing the major issues that may be challenging to the scale-up, including dealing with heat generation and finding a suitable initiator.

The broader/commercial impacts of this project will be the potential to enable the large-scale manufacturing of organic electronic devices by leveraging the existing photolithographic infrastructure currently used in the industry. The availability of the new photoresist materials in large quantities and consistent quality will help meet the performance and volume demands of organic electronic industry, which is expected to grow rapidly once a scalable and high-yield manufacturing technique is available.

Oscilla Power, Inc.

Phase II Award No.: 1127503

Award Amount: $1,317,723.00

Start Date: August 15, 2011
End Date: July 31, 2015

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Sector: Advanced Materials

SBIR Phase II: Materials for Renewable Energy Systems

This Small Business Innovation Research (SBIR) Phase II project will demonstrate a prototype wave energy harvester using advanced materials developed in the Phase I effort. We have developed a patented concept for wave energy harvesting using low-cost magnetostrictive alloys. This technology shows promise as a means for delivering utility-scale electric power to the grid at a price that is competitive with conventional fossil or renewable technologies. The technology will also be applicable to other proprietary energy harvesting systems that we are developing. In the Phase II project, we will design, build, optimize and demonstrate a sub-scale system in one of the largest open-air salt water wave tanks in the world. After prototype validation in Phase II, we will pursue further scale up and commercialization of the device with additional private/government funding.

The broader impact and commercial potential of this project address the global need for the rapid development and deployment of low-carbon, renewable electricity sources, which unquestionably ranks as one of this century's global grand challenges. Such technologies will fuel our economic growth, contribute to global environmental sustainability, and reduce our dependence on polluting and exhaustible fossil fuels such as coal and natural gas. The world's oceans, with global capacity estimated to be around 2 TW, constitute a vast but untapped energy source that is particularly well-suited to address underserved and/or growing coastal populations. The World Energy Council estimates that wave energy can meet up to 6.5% of U.S. energy needs. Efforts to tap utility-scale energy from the ocean continue to be hampered by high capital costs, high maintenance costs, and low energy efficiencies. The technology developed through this project will accelerate the commercialization of a wave energy harvester with substantially lower capital and operating costs than existing alternatives, enabling a levelized cost of electricity that is competitive with conventional electric power technologies.

Pipe Wrap LLC

Phase II Award No.: 1152577

Award Amount: $500,000.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Program Director: Ben Schrag

Sector: Advanced Materials

SBIR Phase II: A High Strength and Durable Composite Nano Wrap for Repair and Rehabilitation of Piping and Other Civil Infrastructure Systems

This Small Business Innovation Research (SBIR) Phase II project will continue the development, validation, and full-scale testing of a new patent-pending nanoparticle-reinforced composite product for the repair and rehabilitation of piping and other civil infrastructure systems. The overarching goal of the research is to develop and demonstrate a composite system that can be used to repair pipes without requiring expensive, and sometimes dangerous, cutout and repair of pipe sections, while also meeting Department of Transportation (DOT) requirements to qualify it as a permanent rather than temporary repair. In order to meet these requirements, a composite wrap system is needed with fatigue properties that are much better than current systems. Test results obtained in Phase I demonstrate that the fatigue resistance of our new nanoparticle-reinforced composite repair system outperforms traditional pipeline repair composite materials currently on the market. The specific goals of Phase II will be: 1) validation of initial results from Phase I; 2) extension of property testing to prepare for full-scale testing under American Society of Mechanical Engineers (ASME) PCC-2 requirements; 3) design of a manufacturing machine to produce the new composite product and 4) completion of full-scale testing to prove compliance with DOT regulations.

The broader impact/commercial potential of this project will be to significantly improve the safety and reduce costs for repair of DOT-regulated and industrial pipelines through the development of a high-strength, fatigue- and corrosion-resistant pipe repair system with a design life over 50 years. There were 6,042 "significant incidents" related to pipeline damage from 1988 to 2008, resulting in 427 fatalities, 1,805 injuries and property damage totaling $3.8 billion. Composite repair products currently used to prevent pipeline failures are economical, easy to apply, and can be used to repair other civil infrastructures such as bridge columns and piers. However, current composite repair systems for pipelines qualify only as a temporary repair due to their susceptibility to fatigue, and therefore require eventual replacement via cutout. Development of a composite wrap system that qualifies as a permanent repair would have a transformational impact on the pipeline industry, placing the commercial potential of this product at $50-100 million, even with a relatively small market share. In addition, with the availability of stronger and less expensive field repairs, pipeline companies are likely to become more proactive with their composite repair programs, resulting in an overall reduction in catastrophic failures and incidents.

Premix, Inc.

Phase II Award No.: 1256123

Award Amount: $495,648.00

Start Date: February 1, 2013
End Date: January 31, 2015

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Sector: Advanced Materials

SBIR Phase II: Composites Based on High Bio-content, Low Toxicity, Green Matrix Resins

This Small Business Innovation Research (SBIR) Phase II project will advance the development of Epoxidized Norbornylized Linseed Oil (ENLO) resin as a matrix for reinforced composites. This ENLO resin is a high bio-content, low hazard system with roughly three times the bio-content of any commercially proven resin. In Phase I feasibility was demonstrated and benefits of the system were explored. Phase II funding will be used to scale and refine the resin manufacture process and to develop and demonstrate performance of Bulk Molding Compound (BMC) and Sheet Molding Compound (SMC) utilizing the ENLO resin matrix. The research objectives are to scale the resin process to 1000-gallon reactor size, to identify a cost effective initiation system, to formulate compounds for improved fiber wetout, to characterize and benchmark performance relative to competitive molding compounds, to develop compounds and component prototypes for specific applications, and to explore enhancements to the technology that would provide a wider range of potential market segments. The anticipated technical results are the realization of cost competitive molding compounds based on the ENLO resin, the demonstration of performance in targeted initial application components, and the realization of an ENLO resin chemistry and process for the coatings market.

The broader impact / commercial potential of this project will derive from the regulatory and green benefits that customers desire to meet strengthened Environment Health and Safety (EHS) demands. The ENLO resin is derived from rapidly renewable raw material streams that can be domestically controlled, liberating the U.S. from the dependence on depleting oil reserves from unstable regions of the world and providing U.S. jobs for our farmers, plant oil processors, and resin manufacturers. Commercial composites resins include unsaturated polyesters, which contain styrene, epoxies made from Bis-phenol A, and urethanes with isocyanate. The ENLO resin contains none of these chemicals of significant EHS concern resulting in safer processes, workplaces, and products. Another major benefit of the technology is that the molded end products will sequester carbon dioxide for the life of the composite, reducing the life cycle contribution to global warming. These benefits will be magnified well beyond the scope of the $18 billion composites market because the same matrix resin can be used in the much larger $99 billion coatings market.

Refactored Materials, Inc.

Phase II Award No.: 1151896

Award Amount: $1,000,000.00

Start Date: March 1, 2012
End Date: February 29, 2016

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Program Director: Ben Schrag

Sector: Advanced Materials

SBIR Phase II: Commercial Scale Production of Synthetic Spider Silk Fibers

This Small Business Innovation Research (SBIR) Phase II project will continue the development and commercialization of spider silk fibers commenced in the Phase I effort. Spider silk is a unique material in nature that is currently inaccessible on a commercial scale. Spider silk and other protein polymers are broadly useful in fields ranging from specialty textiles, to medical devices and advanced composites. The critical limitation in producing artificial spider silk fibers has been the lack of availability of bulk silk material and the knowledge of how to appropriately process the polymer into a product of native quality. This project will continue prior work to deliver scalable quantities of material through microbial production of spider silk protein using a commercially viable cost structure. In addition, this project will examine the key parameters for processing silk polymer into fibers whose properties surpass those of native spider silk. The ability to produce prototype silk fibers from recombinant protein will enable the initial steps towards commercializing spider silk fiber-based products.

The broader impact/commercial potential of this project is important to the adoption of a job-creating bio-based economy in the United States. The ability to produce protein polymers has bedeviled biological researchers for decades. Many important structural proteins and enticing commercially-useful materials have remained effectively impossible to produce. The advent of cutting-edge techniques in synthetic biology, microfabrication, and materials processing now make the production of protein polymers and the processing of them into beneficial technologies a realistic goal. Potential applications of protein-based polymers include a full range of sophisticated materials that are furthermore "green" and sustainable. Spider silk polymers, due to their mechanical properties, can potentially be used to create the next generation of ballistic fibers in the production of armor for military, law enforcement, and private users. In addition, the ability to produce advanced polymers independent of petroleum sources is a key goal of the emerging bio-based economy. Lastly, many protein polymers (including silk) are biocompatible and biodegradable and thus can form the basis for new classes of medical materials used to replace or re-grow connective tissues with implants or devices.

Sensor Electronic Technology, Inc.

Phase II Award No.: 0956746

Award Amount: $1,034,727.00

Start Date: January 15, 2010
End Date: June 30, 2014

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Sector: Advanced Materials

SBIR Phase II: Deep UV LED with High Quality p-AlInGaN Layers by Digital Doping Control

This Small Business Innovation Research Phase II project will develop and commercialize next-generation high-power deep ultraviolet light emitting diodes (DUV LEDs) with high quality p-type doped AlInGaN layers via migration-enhanced metal-organic chemical vapor deposition (MEMOCVD). DUV LEDs operating in the spectral region from 240 nm to 365 nm are of great importance for medical, bio-analytical, sensing, and homeland security technologies. This project aims to improve the LED efficiency and lifetime by improvements in the material quality, doping, and device design. These enhancements will lay the groundwork for large-scale penetration of high volume markets, such as global sanitation and disinfection. This Phase II project will achieve efficient multiple pass extraction in transparent epitaxial structures through use of high-quality MEMOCVD doped p-AlInGaN top contact layers. Achieving an improved quality of highly doped p-AlInGaN layers will allow creation of a low-cost, high power semiconductor DUV radiation source with wall plug efficiency exceeding 5% and operation lifetimes longer than 5,000 hours.

The broader impact/commercial potential of this project will originate from the market penetration of DUV LEDs into existing markets that require compact and environmentally friendly UV radiation sources. This project will also allow penetration into new applications that were previously unattainable due to the inherent limitations of existing UV lamps or lasers. The primary markets for these devices include bio-medical and analytical instrumentation, fluorescence sensing, ink curing, phototherapy and water/air disinfection. This new technology for manufacturing high-efficiency and long-lifetime DUV devices will allow these semiconductor light sources to have a price point which is competitive with the mature UV lamp technology. This will allow the increased use of an environmentally friendly, mercury-free UV technology for a variety of applications, which will result in a reduction of toxic waste and in the costs associated with mercury lamp disposal. The purification, sterilization, and early warning applications enabled by these new DUV LED sources will also result in an improved quality of life, particularly in the developing world.

SmarterShade, Inc

Phase II Award No.: 1152252

Award Amount: $600,000.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Sector: Advanced Materials

SBIR Phase II: Thin Film Patterned Optical Retarders for Low Energy Smart Glass Applications

This Small Business Innovation Research (SBIR)Phase II project will develop a low-cost smart-window technology. This project will utilize contemporary display industry fabrication and processing technologies to create unique large-area optical films. These films will be subsequently used to construct energy-efficient smart windows that modulate transmission or reflection of light on command. Windows, skylights, and other glazings made with this technology will have the ability to darken on command. In this Phase II project, window-size prototypes will be designed, constructed and evaluated. Production, material costs, and prototype operation will be considered. Successful fabrication of these prototypes will enable smart windows to be manufactured in an electrochemically passive manner, simplifying their installation in existing windows, minimizing up-front costs, and ultimately reducing energy bills. The technology is also uniquely capable of being applied as an aftermarket or retrofit solution.

The broader impact of this project will be a potential savings of billions of dollars in energy costs in the United States alone, and a reduction of carbon footprint. Buildings are responsible for seventy percent of the electricity consumed in the United States. As part of a daylighting /natural heating strategy, smart window technologies have received much attention for their ability to reduce building energy consumption. Unfortunately, existing smart window products suffer from severe limitations in lifespan, scalability and cost. The technology to be developed is a radically different approach to smart windows because instead of electrochemical processes, it utilizes stable films. This affords more chemical stability, longer life, better manufacturing scalability, power independence (via manual operation), and lower costs to the consumer.

Soraa, Inc., aka SJS Technologies

Phase II Award No.: 1026896

Award Amount: $1,031,999.00

Start Date: September 1, 2010
End Date: August 31, 2014

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Sector: Advanced Materials

SBIR Phase II: High quality, low cost bulk gallium nitride substrates

This Small Business Innovation Research (SBIR) Phase II project aims to develop a scalable, compact and rapid ammonothermal method to grow high-quality, low-cost bulk gallium nitride (GaN) substrates. A novel apparatus that is scalable to large volumes at modest cost will be utilized to achieve high-pressure, high-temperature conditions and grow single-crystal GaN. This project is expected to demonstrate the synthesis of ultrapure raw material and the growth of high-quality bulk GaN crystals with excellent crystallinity, improved transparency, a diameter of at least 1 inch and a process capable of rapid scale-up to larger sizes.

The broader/commercial impact of this project will be the potential to offer high-quality and significantly lower cost GaN substrates, which may enable their applications in next generation displays including light-emitting diodes (LEDs), green and blue laser diodes etc. Bulk GaN substrates, currently in use for 405 nm laser diodes only and grown by a vapor-phase technique, are projected to be a $405 million market in 2010. The availability of low-cost and high-quality bulk GaN substrates is anticipated to improve efficiency and reduce cost of GaN-based LEDs, which will enable a large reduction in electrical power consumption.

Transparent Materials, Inc.

Phase II Award No.: 1057826

Award Amount: $967,551.00

Start Date: February 1, 2011
End Date: January 31, 2015

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Program Director: Ben Schrag

Sector: Advanced Materials

SBIR Phase II: Innovations in Nanoscale Manufacturing: Nanomaterial Composites for Dental Restorations

This Small Business Innovation Research (SBIR) Phase II project seeks to develop nanomanufacturing methods for producing nanocomposites for use in dentistry. Nanocomposites have shown great promise in dentistry but have limited applications because of the lack of reliable manufacturing methods to prepare them at scale. This Phase II project seeks to develop a new, highly-efficient and low-cost approach to the manufacture of these materials that allows their assembly from the individual components at the nanoscale. The process produces highly homogeneous nanomaterials with increased functionality. These materials simultaneously have multiple property enhancements such as radiopacity (aiding diagnostic capabilities), high strength and durability, and improved optical properties. This technology can be further leveraged to expand market opportunities into adjacent segments where cost constraints have limited the adoption of advanced nanocomposites.

The broader impact/commercial potential of this project is to provide nanomaterial composites that improve the function of dental restorations and of biomedical implants. The technology is anticipated to facilitate medical implant materials that better integrate into the human body, improve durability and use-life, and aid diagnosis, ultimately reducing the rate of revision procedures and improving patient outcomes. In the context of dental restoratives, these materials offer improved aesthetics, enhanced radiopacity for diagnostics, and state-of-the art strength and durability. The development and maturation of the proposed products will have significant impact upon the dental industry, allowing dentists to better diagnose recurrent caries, which will improve clinical outcomes and ultimately reduce the occurrence of clinical revision/replacement procedures. The cost savings associated with the new process will increase access of the general public to the highest quality dental restorations.

Vorbeck Materials Corp

Phase II Award No.: 1152700

Award Amount: $497,243.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Rajesh Mehta

Sector: Advanced Materials

SBIR Phase II: Graphene Conductive Inks for Flexible Printed Electronics

This Small Business Innovation Research (SBIR) Phase II project aims to develop high-performance graphene-based conductive inks for printed electronics to meet its stringent cost, flexibility, and conductivity requirements. Components printed with existing conductive inks are challenged by repeated flexing cycles that can break conductive paths. In this project, a graphene filler technology and a novel formulation will be used to achieve the combination of electrical, mechanical, and environmental durability properties specified for the flexible printed electronics at a price point that enables high-volume applications.

The broader/commercial impact of this project will be the availability of a conductive ink that meets performance requirements of next-generation printed electronics. The printed electronics market is growing across multiple sectors driven by applications including radio-frequency identification (RFID) tags for tracking inventory, smart packaging for anti-theft and anti-tampering purposes, smart cards and printed displays. Conductive inks are a critical component in printed electronics, and limitations of existing conductive inks have curtailed market growth. The new graphene-based conductive inks are expected to demonstrate flexibility and mechanical robustness that improves lifetime and performance of printed electronics, while providing significant cost advantage over silver-based inks currently widely used in printed electronics industry.

Zwitter Technology, LLC

Phase II Award No.: 1127475

Award Amount: $441,415.00

Start Date: September 15, 2011
End Date: August 31, 2013

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Sector: Advanced Materials

SBIR Phase II: Commercialization and Scale Up of Ultra Low Fouling and Functionalizable Surface Coatings Based on Zwitterionic Polycarboxybetaine

This Small Business Innovation Research (SBIR) Phase II project aims to demonstrate the extraordinary performance of zwitterionic technology in protein interaction analysis. Zwitterionic polycarboxybetaine (pCB) is not only highly resistant to nonspecific protein adsorption, but also has abundant functional groups for the convenient and effective immobilization of biomolecules via conventional chemistry. This dual-functional property distinguishes pCB from other existing low-fouling materials, and enables diagnostics or molecular recognition in complex media. In this project, high-quality zwitterionic materials and coatings will be scaled up with low-cost and simple production process. The expected outcome is that one can immobilize molecular recognition elements directly onto a non-fouling background for a wide range of applications.

The broader/commercial impacts of this project will be the potential to offer an effective approach in protection of surfaces from unwanted interactions in complex media for biomedical and engineering applications. Zwitterionic technology has superior advantages of low cost, stability, effectiveness and additional functionalities. For protein interaction analysis and medical diagnostics, this technology will improve the sensitivity and specificity of a biosensor, and enable the detection of analytes in undiluted human blood plasma and serum.

Anasys Instruments Corp.

Phase II Award No.: 1126871

Award Amount: $500,000.00

Start Date: October 1, 2011
End Date: September 30, 2013

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Program Director: Ben Schrag

Sector: Nanotechnology

SBIR Phase II: NanoIR: Infrared Chemical Spectroscopy at the sub-20 nm Scale

This Small Business Innovation Research (SBIR) Phase II project will involve research and development of infrared nanospectroscopy, leading to the first commercial instrument capable of infrared spectroscopy and chemical imaging at the sub-20 nm scale on a broad range of samples. We will develop and demonstrate key technologies to dramatically improve the resolution and sensitivity of atomic force microscope-based infrared spectroscopy (AFM-IR). Conventional infrared spectroscopy is the most widely used technique for chemical characterization, but fundamental limits prevent it from being applied at the nanoscale. The AFM has excellent spatial resolution, but until recently had no ability to perform chemical spectroscopy. AFM-IR has demonstrated infrared spectroscopy at well below conventional diffraction limits, but the current spatial resolution and sensitivity are on the order of 100-200 nm, and the method requires specialized sample preparation. This effort will expand on successful Phase I research to develop a robust instrument for obtaining high-resolution chemical spectra on a wide variety of samples with minimal sample preparation. This project will combine simulations with development of experimental techniques and prototype instrumentation to enable commercialization of infrared spectroscopy and chemical imaging down to the scale of single monolayers and individual molecules.

The broader impact/commercial potential of this project will be to give researchers a robust capability to leverage the power of infrared spectroscopy over broad wavelength ranges and at resolution scales well below current limits. Infrared spectroscopy is arguably the most widely used technique for chemical characterization, but spatial resolution limits have prevented it from being widely applied at the nanoscale. With billions of dollars of global investments in nanoscience and nanotechnology, the lack of IR nanospectroscopy technology leaves an enormous gap in needed characterization capabilities. The novel AFM-IR platform will enable a wide range of high-resolution characterization methodologies in materials science and life sciences including correlation of morphological, chemical, mechanical and optical properties. Based on specific early customer measurement requests, we anticipate significant downstream benefits in areas including the development of block co-polymers, advanced polymer nanocomposites, functional nanostructures, catalysts, materials for energy generation and storage, and many other areas.

Anasys Instruments Corp.

Phase II Award No.: 1152308

Award Amount: $699,955.00

Start Date: March 1, 2012
End Date: February 28, 2014

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Sector: Nanotechnology

SBIR Phase II: Nanoscale Ultrafast Dynamic Mechanical Analysis (nu-DMA)

This Small Business Innovation Research (SBIR) Phase II project will develop technologies to enable commercialization of nanoscale Dynamic Mechanical Analysis (DMA). Conventional DMA works by applying an oscillating stress to a sample and measuring the time-dependent strain. Analysis of DMA data gives information about material stiffness, viscosity, thermal transitions and activation energies, for example. DMA is a critical and widely used tool to measure the viscoelastic properties of bulk materials, but it suffers from three key limitations: slow speed, limited frequency range, and the lack of spatially-resolved information. Large and growing material classes employ nanoscale composite structures to achieve desired material properties. No current tool can rapidly examine the temperature-dependent viscoelastic response of these materials on the scales they are being engineered. To address this unmet need, we will extend successful Phase I research to develop instrumentation based on atomic force microscopy (AFM) using rapidly heatable AFM cantilever probes. Specifically, the nanoscale DMA platform will provide: (1) variable temperature DMA in seconds; (2) measurement frequencies three orders of magnitude higher than conventional DMA; (3) spatial resolution down to < 100 nm; and (4) sensitive and spatially-resolved measurements of glass transitions on wide range of commercially important polymers not previously measurable.

The broader impact/commercial potential of this project will stretch across multiple industries and academic research areas. Metrology and characterization are foundations of successful materials science and materials manufacturing. The lack of materials characterization tools at the nanoscale has been identified by the chemical industry as a key bottleneck for the rapid development of new materials. This proposal aims to fill a major gap in required instrumentation. With the ability to measure temperature-dependent viscoelastic properties at the nanoscale, materials scientists and engineers will be able for the first time to directly investigate local material stiffness, energy absorption, and damping in heterogeneous materials over a wide range of operating temperatures and frequencies. In addition to spatially resolved measurements, the dramatic measurement speed improvements (a thousand-fold improvement over conventional DMA) will enable higher measurement throughput, lower cost per measurement, more frequent sampling and better measurement statistics. Based on interactions with customers in diverse industries, we have already has already identified strong market pull in areas including epoxies, polymer blends, multilayer films, medical devices, semiconductor packaging, and aerospace markets.

Applied Nanostructures, inc.

SBIR Phase II: Integrated Thermal Scanning Probe Development

Phase II Award No.: 1256640

Award Amount: $498,715.00

Start Date: March 1, 2013
End Date: February 28, 2015

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Sector: Nanotechnology

This Small Business Innovation Research (SBIR) Phase II project aims to commercialize a unique scanning probe capable of mapping thermal properties with nanoscale resolution. A large number of physical science, engineering, and biological materials and phenomena require thermal conductivity and temperature measurements with high spatial resolution and sensitivity. Yet such measurements are challenging, with conventional thermal probe technology limited to a lateral resolution of only about 100 nanometers. This phase II project will overcome the major challenges of scanning thermal microscopy. The intellectual merits of the proposed activity are related to new and innovative designs and processes to realize thermal sensing elements integrated into a scanning probe design. This design maximizes heat flow from a sample to the probe while minimizing background heat transfer to areas away from the sensor. These devices will be nanofabricated using both unique and scalable semiconductor processing techniques to minimize the cost of manufacturing and ensure repeatability and reproducibility.

The broader impact/commercial potential of this project is the availability of a high resolution thermal measurement tool which will enable scientists and engineers to investigate new materials and develop next-generation products. In the semiconductor industry, the tool will aid in process monitoring, material characterization, and failure analysis. The data storage industry will find applications ranging from mapping thermal effects on recording head "fly heights" to the characterization of recording technologies incorporating integrated laser pulsing to the investigation of superparamagnetic effects which limit areal densities. These are both multi-billion dollar industries that have broad impacts on society. Moreover, applications of this new technology will be geared towards soft-structure thermal mapping, which is not possible with current technologies because of large probe size. These measurements will also be ideally suited for medical research. For example, thermal microscopy of heated gold nanospheres localized in tumors and magnetic nanoparticle tracking inside cellular structures under radio frequency magnetic fields are areas where the impact of this technology will be very high. Such research has the potential to improve therapeutic interventions targeting a number of diseases.

Chromation Partners, LLC

Phase II Award No.: 1152707

Award Amount: $490,207.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Program Director: Ben Schrag

Sector: Nanotechnology

SBIR Phase II: A Photonic Crystal Based Spectrometer for Manufacturing Process Control

This Small Business Innovation Research (SBIR) Phase II project investigates an inexpensive ultra-compact optical spectrometer based on photonic crystal arrays. Current spectrometer technology, based on diffraction gratings, has pushed the limits of current manufacturing in terms of miniaturization, and has already benefited from economies of scale. In contrast, the photonic crystal spectrometer does not use diffractive grating optics, allowing significantly decreased size and cost. The photonic crystal spectrometer is a compact spectral sensing solution suitable for applications where grating spectrometers are too bulky or expensive and dye filter arrays do not offer the needed performance. In this project, the photonic crystal spectrometer module developed in Phase I will be further developed and customized for visible and UV applications. Low-resolution implementations targeting molecular absorption/emission applications will use extensions of the technology developed in Phase I. In addition, a new technology will be developed for high-resolution implementations targeting atomic absorption/emission. The anticipated results of this project are customizable spectrometer modules suitable for applications in water, biological, and chemical analysis, as well as other applications where a moderate number of spectral signals are indicative of state.

The broader impact/commercial potential of this project includes the expansion of low-cost spectroscopic techniques to applications which have previously been infeasible due to limitations in range or resolution of commercially available technologies. The commercial potential includes new handheld and portable instruments for chemical, photometric, and biological sensing. Photonic crystal spectrometers can be integrated into compact form factors that enable in situ measurement for manufacturing process analysis and in-process feedback control. Applications include solid-state lighting characterization and testing, emissions control, portable sensing, and personal health care. The electrochemical pH and oxidation-reduction potential (ORP) measurement market, a proxy for the pH sensing market addressed by this technology, was valued at $112 million in 2006. The platform spectrometer technology has the additional potential to be applied in other areas within the water testing market, which has an aggregate value of $4 billion.

ColdQuanta, Inc.

Phase II Award No.: 1126099

Award Amount: $483,931.00

Start Date: November 1, 2011
End Date: October 31, 2013

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Program Director: Ben Schrag

Sector: Nanotechnology

SBIR Phase II: Atom Chips for Cold and Ultracold Matter Applications

This Small Business Innovation Research (SBIR) Phase II project seeks to develop the next generation of atom chips for producing and manipulating ultracold atomic gases (temperatures < 1 μK). While atom chips developed in Phase I provided only magnetic control, these new hybrid atom chips will be able to manipulate ultracold matter both magnetically and optically. These chips will be incorporated into atom-chip vacuum cells, allowing optical techniques to be implemented in compact ultracold matter products. In Phase I, we developed silicon/glass wafers for both creating ultrahigh vacuum electrical feedthroughs with near perfect yield as well as in-trap imaging of ultracold matter. In Phase II, we will further develop this technology by incorporating miniature on-chip optical elements as a vehicle for bringing optical potentials (e.g. produced by laser beams) into the vacuum system. Our research plan includes redesigning existing chip layouts to accommodate small-sized optics that will be anodically bonded to silicon regions of the chip. To further enhance functionality, we will pursue both anti-reflection coating of atom chips and redesigns of the connectorization scheme used to bring electrical currents to the chip.

The broader impact/commercial potential of this project is to greatly expand the number and variety of experimental techniques that can be implemented with atom-chip vacuum cells. Of key interest here are optical techniques, such as optical lattices, used to trap and coherently control quantum mechanical systems (e.g. Bose-Einstein condensates). An important application of ultracold lattice-trapped atoms is interferometry, which can be used to realize gyroscopes, accelerometers, and gravimeters that are expected to be orders of magnitude more sensitive than current state-of-the-art technologies. Such devices are crucial for navigational positioning systems and satellite communications, and therefore are of great interest to both commercial and defense-oriented markets. Optical trapping is also vital for the next generation of neutral atomic clocks, whose accuracy is now exceeding a phenomenal 1 part in 10^17 (i.e. a loss of 1 second every 3 billion years). Optically trapped atoms are also ideal for implementing quantum information algorithms, and therefore have many applications in the emerging fields of quantum computation and information processing. For basic science, optical lattices have been used for precision measurements of fundamental constants, some of the most stringent tests of the Standard Model of Physics, and groundbreaking studies of many-body physics.

Cosmas

Phase II Award No.: 0956628

Award Amount: $1,002,913.00

Start Date: March 15, 2010
End Date: June 30, 2014

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Program Director: Rajesh Mehta

Sector: Nanotechnology

STTR Phase II: A Simple and Innovative Approach to the Synthesis of Metal, Alloy, Metal Oxide, and Mixed-Metal Oxide Nanoparticles

This Small Business Technology Transfer (STTR) Phase II project aims to develop a manufacturing process to synthesize metal oxide, sulfide and other nanoparticles. The subject method simply involves mixing of common dry chemical starting materials and heating the resulting precursor material to a modest temperature. The objective is to demonstrate feasibility and scalability of this low-cost manufacturing process. Methods of dispersing aggregated particles in aqueous and polar solvents will be also be investigated.

The broader/commercial impact of this project will be the potential to offer a cost-effective and environmentally-friendly process to produce a broad spectrum of high quality nanoparticles. Current methods of making nanoparticles involve heavy energy consumption, large amounts of waste, and/or purification problems. The synthetic approach in this project has the potential to become the method of choice to supply novel nanoparticles in many low to high technology applications. It is anticipated to obtain nanoparticles with particle sizes less than 15 nm, size variations within ±10-20%, and purities as high as 99.9999%.

CSD Nano, Inc.

Phase II Award No.: 1230456

Award Amount: $499,026.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Program Director: Rajesh Mehta

Sector: Nanotechnology

STTR Phase II: Low-cost Nanostructured Anti-reflection Coatings for Solar Energy Applications

This Small Business Innovation Research (SBIR) Phase II project proposes to optimize and demonstrate the scale-up of nanostructured anti-reflective coatings (ARCs) to meet the specifications of solar energy customers using high-performance processes along with a novel solution-phase synthesis and deposition microreactor. Results from Phase I and industrial partner input demonstrate that the nanostructured ARC has an optical performance that far exceeds existing industry solutions, with a low reflectance across a broad wavelength spectrum. The intellectual merits are not limited to a single discovery, but a series of breakthroughs will will allow this low-cost, industry-compatible ARC solution to satisfy the solar industry's need for increasing efficiency. This is accomplished by leveraging the nanostructure's properties of incremental change in the refractive index as light waves pass through the coating structure (i.e. gradient surfaces) and an environmentally benign, low-cost microreactor technology that can be integrated with existing industry processes.

The broader impact/commercial potential of this project concerns an enabling competitive advantage for glass and solar module manufacturers, which will also drive government initiatives for low-cost solar energy. The anti-reflective coating being developed focuses on increasing solar module efficiency by providing a low-cost method to reduce light reflection from solar modules. The International Technology Roadmap for PV (ITRPV) calls for a reduction in front-side module reflection from 4% to 2% in 2013 and reduction from 2% to 0.5% by 2017. The proposed ARC can reduce front surface reflection from 4% (bare glass) to less than 0.5%, beating the ITRPV roadmap by five years. The increase in light reaching the solar cells will enhance electricity output and decrease balance-of-system (BOS) costs. This performance and cost advantage creates significant commercial opportunities in the solar module value chain. This innovation has the potential to capitalize on the estimated 2011 $4.6 billion thin-film photovoltaic (PV) market, for which production is expected to grow at a 30% annual rate through 2016.

nanoGriptech, Inc.

Phase II Award No.: 1152551

Award Amount: $500,000.00

Start Date: April 15, 2012
End Date: March 31, 2014

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Program Director: Rajesh Mehta

Sector: Nanotechnology

SBIR Phase II: Manufacturing of Bio-Inspired Polymer Micro/Nano-Fiber Arrays as New Gripping Materials

This Small Business Innovation Research (SBIR) Phase II project aims to develop a pilot-scale production system and process to enable the large-scale fabrication of continuous arrays of elastomeric micro/nano-scale fibers with complex geometry. Inspired by hairs that occur naturally on gecko feet, these micro/nano-scale elastomeric fibers demonstrate strong adhesive, shear, and peel strengths over a wide range of test substrates. Unlike other classes of adhesives such as pressure-sensitive tapes, these biologically-inspired adhesives can be repeatedly used over thousands of test cycles with very little contamination and performance degradation over the material lifespan. However, this class of material has only been able to be fabricated through expensive micro/nano fabrication processes including photolithography, chemical etching, or time-consuming batch micro/nano molding processes. In this project, a pilot-scale manufacturing system will be constructed, optimized and evaluated. A roller-based molding and peeling process for high-speed, continuous, and large-area manufacturing of high aspect-ratio and three-dimensional micro/nano-scale fibers with a compliant backing layer will be developed using elastomer materials.

The broader/commercial impacts of this project will be the potential to provide a low-cost, high-volume process to mass produce continuous arrays of elastomeric micro/nano-scale fibers with complex geometry for applications in apparel, sporting equipment, healthcare, defense, industrial clamping, and consumer goods. These fibers will provide strong reversible adhesive or enhanced shear interfaces that are resistant to contamination and maintain their adhesive ability over the product lifespan.

Novan, Inc.

Phase II Award No.: 1127380

Award Amount: $999,568.00

Start Date: November 1, 2011
End Date: October 31, 2015

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Program Director: Rajesh Mehta

Sector: Nanotechnology

SBIR Phase II: Scale-up Manufacturing of Nitric Oxide Nanotechnology for Healthcare Infections

This Small Business Innovation Research (SBIR) Phase II project aims to develop the process and engineering controls necessary to scale up the manufacturing of a nitric-oxide-releasing active pharmaceutical ingredient (API). One of the applications is a wound-healing product for diabetic foot ulcers. This project will focus on 1) optimizing the process parameters required to scale production of a nitric-oxide-releasing API to reproducible 1 kg batches, and 2) implementing the analytical methodologies to meet the requirements of the Chemistry, Manufacturing and Control (CMC) sections of an Investigational New Drug (IND) application. The expected outcome is a manufacturing process capable of producing large batches of the API that are suitable for an IND submission of a wound-healing product for diabetic foot ulcers or other nitric-oxide-releasing drug.

The broader/commercial impacts of this project will be the potential to provide a new standard of care for the treatment of diabetic foot ulcers. Currently, there are no products that address both wound healing and infection in diabetic foot ulcers. Infection is particularly problematic in diabetic foot ulcers due to the lack of normal skin barrier function, long duration of wound exposure to the external environment (months to years), poor blood circulation to the extremities that limits the migration of inflammatory cells to the site of infection, and the recent understanding of biofilm formation which protects bacteria from topically applied antimicrobials and systemically administered antibiotics. Nitric-oxide-releasing wound-healing therapeutics have the potential of addressing both infection and healing in diabetic foot ulcers.

Optofluidics, Inc.

Phase II Award No.: 1151966

Award Amount: $515,591.00

Start Date: March 15, 2012
End Date: February 28, 2014

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Program Director: Ben Schrag

Sector: Nanotechnology

SBIR Phase II: Single Molecule NanoTweezers

This Small Business Innovation Research Phase II project aims to develop a commercial optically-resonant nanotweezer chip and corresponding instrumentation. The nanotweezer technology, originally developed at Cornell University, uses localized optical forces to directly manipulate biological (nucleic acids & proteins) and non-biological (nanoparticles) materials as small as a few nanometers in size. Efforts will be focused on developing a commercial system which facilitates the study of single-molecule interactions, as this sector has immediate market appeal and is experiencing very high growth. At present, research into the understanding of how single molecules interact is greatly impeded by the lack of a fast and simple technique which can: (1) capture and suspend small molecules in free solution for an indefinite period of time, (2) effectively "concentrate" the set of molecules of interest to a point where protein-protein or other multi-molecule interactions can be studied, and (3) allow rapid modulation of the external environmental conditions. The nanotweezer product line to be developed here, consisting of optical chips which carry the core technology, as well as a driving instrument, represents a quick and cost-effective system that allows researchers to solve all three of these problems simultaneously.

The broader impact/commercial potential of this project will be a commercially-available product that can directly manipulate extremely small biomolecules and particles, and could be transformative to scientific and industrial advancement in a number of areas including: (1) the understanding of faulty protein-protein events and other single-molecule interactions, (2) the analysis of individual nucleic acids for rapid sequencing, and (3) the directed assembly of new forms of nanomaterials for energy production. The importance of the first item (which is the target application for the initial version of this platform) is highlighted by the large number of sufferers of neurodegenerative disorders such as Alzheimer's and Parkinson's, which are diseases that have been linked by protein misfolding events. The development of tools that can facilitate experimental studies of how single biomolecules and small aggregates interact can reveal information about the fundamental molecular processes that lead to these deficiencies. The nanotweezer technology has a series of key advantages over existing commercial methods that can enable researchers to better understand these phenomena in environments closer to the physiological state. We believe that these advantages will create a significant commercial advantage over competing products.

Orthogonal, Inc

Phase II Award No.: 1230454

Award Amount: $499,951.00

Start Date: September 1, 2012
End Date: August 31, 2014

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Program Director: Rajesh Mehta

Sector: Nanotechnology

SBIR Phase II: Flexible Organic Circuits with Photolithography for eReader Applications

This Small Business Innovation Research Phase II project aims to quickly enable the large-scale manufacturing of organic and flexible electronic devices by leveraging the existing infrastructure used in the display industry. Currently, proven manufacturing techniques do not exist that can make flexible electronics at scale, and all proposed methods would require the abandonment of billions of dollars of equipment and decades of manufacturing expertise based around photolithography. This proposal aims to solve this problem, using photoresist technology that is designed to work with a wide range of materials including organic electronics. Previous research has established the feasibility of these resists, but there is still much work needed to apply the technology to more complex and integrated systems, especially when working with flexible substrates. The Phase I project has revealed the areas of improvement needed to reach mass production and high yields for demanding display applications. This project will address these issues and will create a high-performance process capable of making flexible eReaders with high yield. Researchers will work with industrial and academic partners to gain a better understanding of all of the issues required to be overcome as the process is scaled up to a real application.

The broader impact/commercial potential of this project will be very large for the display industry, which seeks to manufacture innovative flexible eReader displays for the large worldwide education market. The broader commercial potential lies in the sales of high-margin and high-volume chemicals to an industry that will quickly ramp production. The photoresist market for liquid crystal displays (LCDs) is currently $1.2 billion, and it is anticipated that the proposed technology will dominate the organic electronic resist market, which is anticipated to reach similar values. The societal benefits will be seen when the eReaders are brought to classrooms around the world. Their low weight, low power consumption, and physical robustness will allow these displays to fully replace heavy and expensive textbooks, changing the lives of millions of children domestically, and in developing countries such as China and Russia.

Sila Nanotechnologies Inc

Phase II Award No.: 1228723

Award Amount: $499,609.00

Start Date: August 15, 2012
End Date: July 31, 2014

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Sector: Nanotechnology

SBIR Phase II: Microporous Carbons with Aligned Pores for Supercapacitors

This Small Business Innovation Research (SBIR) Phase II project aims to develop novel type of porous carbon materials with aligned pores for applications in electrical double-layer capacitors (EDLCs). These devices are serving multiple applications, such as smart electrical grids, hybrid-electric vehicles, energy-efficient industrial equipment and personal electronics. Conventional EDLCs store energy by adsorbing organic electrolyte ions on the internal surface of activated carbon electrodes under the application of electrical potential. They commonly take 10 to 100 seconds to charge or discharge. This charge rate is limited by the diffusion of ions inside the tortuous pores of activated carbons. The growing numbers of pulse-power applications, however, often need current boosts for only 1-10 seconds. These applications, therefore, will utilize a fraction of the energy storage capability of conventional EDLCs, which greatly increases the total weight and cost of the energy storage system, slowing down technology adoption. Herein, we propose an innovative low-cost material synthesis route for the formation of porous carbons with finely controlled microstructure, tunable pore size, high surface area, and, most importantly, aligned micropores for rapid ion transport and high power density. These materials offer a combination of fast charging rate and high specific capacitance.

The broader impact/commercial potential of this project is the contribution to dramatic improvements in EDLC technology and reduction of its cost. EDLCs, unlike secondary batteries, exhibit much higher specific power and demonstrate outstanding cycle life and greatly improved safety. The use of EDLCs in transportation and industrial equipment could lead to a major reduction in energy consumption and greenhouse gas emissions. Their application in electrical grids will make multiple renewable energy technologies, such as wind and solar, more economical. The rate of adoption of this important technology could be significantly enhanced if EDLCs could be produced at a lower cost or if they offered further improved performance. These device characteristics are linked to the cost and properties of activated carbon electrodes. Unfortunately, nearly all EDLC manufacturers rely on the existing manufacturers of activated carbon. The expected improvements in material properties from this Phase II project are expected to have a major impact on the EDLC market size and the EDLC technology adoption.

SolRayo, Inc.

Phase II Award No.: 1156229

Award Amount: $515,998.00

Start Date: April 1, 2012
End Date: March 31, 2014

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Program Director: Rajesh Mehta

Sector: Nanotechnology

STTR Phase II: Using Nanoparticle Oxide Coatings to Extend Cycle Life of Cathode Materials in Lithium-Ion Batteries

This Small Business Innovation Research (SBIR) Phase II project seeks to increase the cycle life of cathode materials used in lithium-ion batteries by a factor of ten in high-temperature applications by applying protective nanoporous ceramic coatings. SolRayo will investigate the effects that changing several variables that control the nanoporous structure of ceramic coatings have on the cycle life of cathode materials. Such variables include the amount or thickness of the coating, the pH of the suspension of the coating material, the deposition of layers of different ceramic materials on the cathodes, and different methods for depositing the coatings on the cathodes. The materials to be investigated will include TiO2, ZrO2 and others proposed by our industrial partner.

The broader impacts of this research are that, if successful, this project will improve the cycle life of lithium-ion batteries and allow inherently safer and less expensive materials to be employed. Although lithium-ion batteries have gained wide acceptance in consumer electronic products, their use in other markets has been limited by their lifetimes and safety concerns, particularly in applications at higher temperatures. Improving the lifetime and safety of the materials used in these batteries will enhance their market penetration. Preliminary cost estimates indicate that licensing the coated materials to industry could provide approximately $100 million annually in royalties on sales. This work will also benefit the nation by improving our understanding of nanoparticle coating techniques suitable for a variety of energy storage applications.

Tiptek, LLC

Phase II Award No.: 1256510

Award Amount: $482,747.00

Start Date: April 1, 2013
End Date: March 31, 2015

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Program Director: Ben Schrag

Sector: Nanotechnology

SBIR Phase II: Batch Wafer-Scale Fabrication of Improved Probe Tips for Scanned Probe Microscopy

This Small Business Innovation Research (SBIR) Phase II project will perfect a proprietary batch-scale processing technique for fabricating ultrahard and ultrasharp atomic force microscopy (AFM) tips. The new process involves two steps. First, chemical vapor deposition (CVD) is used to coat the tips with a chemically inert, highly conductive, and extremely hard material. Second, a patented process that we have developed, field directed sputter sharpening (FDSS), sharpens the probe tip to atomic dimensions (1- 4 nm radius of curvature at the tip apex). Hard, sharp tips are of considerable scientific and market interest because tip geometry and mechanical properties significantly impact the results of AFM measurements. The current project will carry out research to perfect a batch wafer-scale process able to manufacture hundreds of tips at once. In order to bring the technique to market, the following research and development tasks will be carried out: (a) optimization of process conditions to reproducibly sharpen arrays of AFM probes fabricated on 4-inch wafers, (b) investigation of the ability to coat and sharpen AFM probes with a variety of hard film materials, and (c) assessment of the performance of batch-fabricated probe tips for market-driven probe microscopy applications.

The broader/commercial impact of the project arises from the development of robust, reproducible, and durable tips that are more resistant to wear (due to the high hardness) and have favorable characteristics for AFM imaging (small radius of curvature, controlled aspect ratio, and electrically conductive). The project will benefit the academic and industrial communities who use scanning probe microscopy imaging. Although AFM and related probe microscopies have many advantages over electron microscopy (e.g., they can be used under ambient conditions and they can be easily interfaced with optical spectroscopy), one significant drawback is that the probe tips have limited lifetimes owing to wear during use. The development and commercial introduction of probe tips that are ultrasharp, very hard, conductive, and relatively inexpensive will significantly enhance the capabilities of AFM and related techniques such as scanning capacitance microscopy (SCM), a technique of great interest to the microelectronics industry because it is useful for the on-board testing of integrated circuits for delay faults. The research will also be of benefit to those who image insulating surfaces such as polymers and other soft materials where static charge build-up limits efficacy, and to those developing multi-tip probe arrays for lithographic and nanomanufacturing applications.

NSF SBIR/STTR

PHASE II GRANTEE CONFERENCE

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