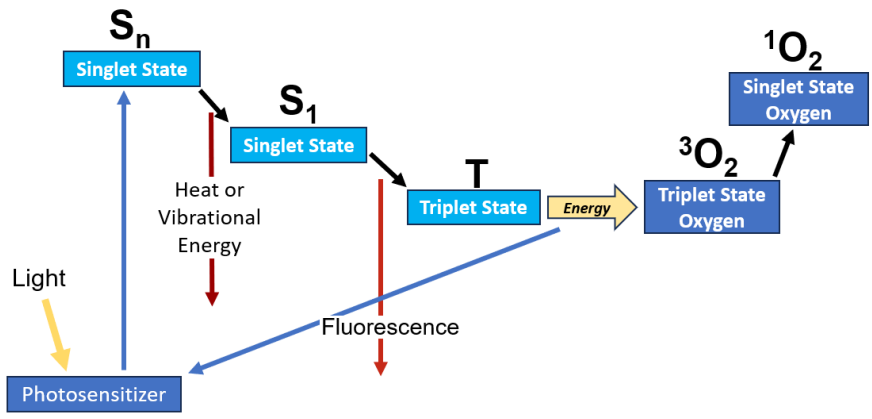
Are DNA-Templated Silver Nano-Clusters (AgNC) Type II Photosensitizers?

Project Description

A. Description of Project

Type II photosensitizers (PS II) have critical applications due to their ability to produce singlet oxygen ($^1\Delta gO_2$) upon light activation. This reactive species plays a important role in photodynamic therapy (PDT), antimicrobial treatments, and pollutant oxidation. DNA-templated silver nanoclusters (AgNCs) are loops of custom sequenced DNA chains that each hold a small number of silver atoms. The ability to change the sequence allows for much customization of the final structure. AgNCs with their biocompatibility, fluorescence, and structural tuning, may serve as PS II. This project evaluates 10 similar but slightly different AgNCs' potential PS II ability by detecting singlet oxygen generation through Electron Paramagnetic Resonance (EPR) and Singlet Oxygen Sensor Green (SOSG) reagent.



B. Activities, Process, or Methodology

Synthesis: DNA-templated AgNCs are synthesized by combining DNA, nuclease-free water, NaCl, $AgNO_3$, ammonium acetate, and sodium borohydride. In total 10 DNA loop sizes (C5–C15) will be investigated.

Detection:

1. **EPR Spectroscopy**: Measures paramagnetic changes after light exposure, confirming singlet oxygen generation.
2. **SOSG Reagent**: Reacts with singlet oxygen to generate fluorescence, providing complementary data.

These dual methods ensure comprehensive analysis of AgNC photosensitizing potential.

C. Project Timeline

- **February-March 2025:** Optimization of singlet oxygen detection using SOSG and EPR.

- **March-April 2025:** Final optimal experiments of singlet oxygen generation tests and analysis of experimental data.
- **April 2025:** Compilation and analysis of final data, preparation of the final report.

D. Student/Faculty Mentor Roles

- **Student Role:** Responsible for refining detection techniques, conducting repeat experiments, analyzing results, and preparing the final documentation.
- **Faculty Mentor Role:** Provide guidance in refining detection methods and data interpretation to ensure robust analysis.

E. Previous Internal Funding

No previous FUSE or UCRCA funding has been received. This project builds on earlier research efforts but focuses on refining detection methods and determining a fundamental property of AgNC.

Budget and Budget Justification

Budget:

- **Stipend:** $2,000 for refining detection methods, conducting experiments, analyzing data, and preparing reports.
- **Materials and Supplies:** $500 for SOSG reagent and the EPR spin probe CPH (1-Hydroxy-3-carboxy-2,2,5,5-tetramethylpyrrolidine). Both will be essential for singlet oxygen detection.

Justification:
The stipend compensates for the time-intensive work of refining methodologies, analyzing results, and preparing final deliverables. Material costs support essential reagents for high-precision detection tests.

University of Nebraska Omaha

COLLEGE OF ARTS AND SCIENCES
Department of Physics

Re: Recommendation letter for Robert Buller.

November 11, 2024

Dear FUSE program Referees,

It is my great pleasure to write this recommendation letter in support of Mr. Robert Buller's proposal "Are DNA-Templated Silver Nano-Clusters (AgNC) Type II Photosensitizers?" for the FUSE grant application.

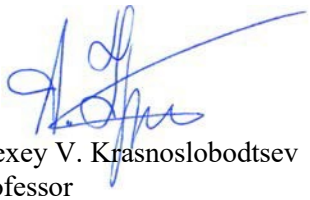
Robert is majoring in Physics and has completed all required courses for a concentration in Biomedical Physics. He is a highly capable student with strong analytical skills and a keen interest in research, particularly in formulating feasible hypotheses. Since joining my lab in the fall of 2022, Robert has worked on research into detecting singlet oxygen species. Under my supervision, he has contributed to establishing various methods, including chronoamperometry and singlet oxygen fluorescence detection. This work is now being included in our next publication to be published early next year. Robert has also presented his research at two regional conferences organized by the Prairie Section of the American Physical Society.

Robert selected his project topic after an extensive literature review, aligning with our lab's focus on silver nanoclusters – a promising class of novel quantum materials. Based on computational predictions from our lab, he aims to demonstrate that these nanoclusters can efficiently produce singlet oxygen, which has practical applications in fields such as photodynamic therapy, antibacterial treatments, and other oxidation-dependent processes.

This project aligns closely with my research on nucleic acid-templated silver nanoclusters, and I am enthusiastic about its potential impact. The novel approach of using nanoclusters for singlet oxygen production holds significant promise, and I fully support Robert's proposal. I intend to provide the mentorship and resources needed for its success.

I hope that you also will find this proposal scientifically interesting and beneficial for Mr. Robert Buller's academic growth.

Sincerely yours,



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