PRESENTATION ABSTRACT

The goal of my research is to realize the industrial-scale production of metal parts using additive manufacturing (metal AM/3D printing). In pursuit of this goal, I aim to deliver the scientific insight to answer two fundamental questions. First, what causal phenomena lead to flaw formation in metal AM parts, and why. Second, what processing strategies can prevent flaw formation.

Despite considerable cost and time advantages safety-critical industries, such as aerospace and biomedical, are hesitant to use metal AM processes due to their tendency to create flaws, e.g., porosity and non-uniform microstructure. The root cause of flaw formation in metal AM is attributed to the temperature distribution in the part as it is being printed. The temperature distribution, also called thermal history, is a complex function of over 50 processing parameters and the shape (design) of the part. Hence, to mitigate flaw formation it is essential to understand, predict, and control each link in the following metal AM process chain.


To create this end-to-end understanding of flaw formation in metal AM, my research integrates four aspects: (1) ultrafast computational modeling to predict the effect of processing parameters and part design on the thermal history, (2) materials characterization to understand the link between thermal history and flaw formation (porosity and microstructure), (3) monitoring (tracking) the process signatures symptomatic of flaw formation using in-situ sensor arrays, (4) machine learning models that combine thermal history predictions with in-situ sensor data to detect and prevent flaw formation. In my talk I will exemplify the integration of these four aspects based on results from ongoing collaborations with industrial partners.