Abstract
Chemically-reacting flows are encountered in a wide range of applications, including power and propulsion systems, renewable energy production and consumption, and advanced nanostructured material synthesis. The accurate and efficient numerical modeling of these flows is critical to the model-based design and control of these systems. However, the application of computational tools to these complex systems has been limited by the lack of physics-based models for the different processes involved in these flows. In this presentation, I will start by presenting our recent development of sooting tendency measurements and modeling to enable advanced bio-derived fuels in next-generation engines. The objective of this work is to bridge the gap between fundamental studies and engineering applications to maximize the benefits and minimize challenges of renewable fuels. Then I will discuss about current challenges in the reduced-order modeling of turbulent reacting flows using the Large-Eddy Simulation (LES) framework. The emphasis is place on our exploration of the potential of employing reduced basis functions to capture scale-scale interactions and more accurately predict important resolved-scale turbulent flame dynamics. Finally, I will present our numerical modeling of two-dimensional material synthesis by Chemical Vapor Deposition (CVD), using a multi-scale approach connecting quantum mechanics-based calculation, atomistic-scale reactive force-field method, and Computational Fluid Dynamics (CFD).

Bio
Yuan Xuan is an Assistant Professor in the Department of Mechanical and Nuclear Engineering at the Pennsylvania State University. He received his B.S. and his first M.S. degrees in Mechanical Engineering from École Polytechnique, France. He received his second M.S. and Ph.D. degrees in Aeronautics from the California Institute of Technology. Prof. Xuan's research program spans diverse areas where medium and high temperature chemically-reacting systems are critical, including power and propulsion systems, fuel chemistry, and synthesis methods for advanced nanostructured materials. Prof. Xuan's research has received funding support from multiple federal agencies, including the Air Force Office of Scientific Research, Department of Energy, and National Science Foundation.