



THE UNIVERSITY OF ARIZONA

College of Engineering

## Aerospace and Mechanical Engineering Seminar

### **Dr. Francesco Panerai**

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### **Imaging High-Temperature Carbon Oxidation in 4D**

**Abstract:** High-temperature materials constitute critical elements of hypersonic systems for space exploration and national defense. To be safe and effective throughout the extreme conditions of re-entry, designs must anticipate and be robust to changes in the aerodynamic shape and surface roughness due to ablation. Hand-in-hand with the development of computational capabilities has been a need for data to both validate models and identify key physical mechanisms.

This talk will focus on lightweight carbon-phenolic composites, a prominent material class developed at NASA for planetary entry systems. To study ablation of carbon-phenolic materials, laboratory experiments are implemented with the goal of simulating aerothermal loads encountered in real flight conditions. We will discuss how X-ray tomography imaging at high resolution has become an invaluable tool to understand the micro-structure and quantify the response of porous architectures used in charring ablators.

The core of the talk will discuss new experiments at the Swiss Light Source (SLS) synchrotron facility, where carbon fiber oxidation at high-temperature was resolved for the first time in 4D, using real-time X-ray micro-tomography. From the high spatial and temporal resolution scans we were able to resolve oxidation processes at different conditions found in high-speed flight, from the reaction-limited to the diffusion-limited regime. The data constitute the base for predictive modeling tools for carbon ablation.

**Bio:** Francesco Panerai is an Assistant Professor in Aerospace Engineering at the University of Illinois at Urbana-Champaign. Prior to Illinois, he was a research scientist at NASA Ames Research Center in California. His research covers advanced materials for extreme environments, transport in porous media, and hypersonic aerothermodynamics. Francesco received his PhD and Research Master in Aeronautics and Aerospace from von Karman Institute for Fluid Dynamics (Belgium) and a M.Sc. and a B.Sc. in Mechanical Engineering from the University of Perugia (Italy). He is recipient of the 2019 Air Force Young Investigator Award.

**Thursday, March 26, 2020**

**AME Lecture Hall, Room S212**

**Refreshments and socializing at 3:45 pm outside S212**