MATERIALS ENGINEERING SEMINAR

"Correlative Microscopy and Mechanical Behavior of Extraterrestrial Materials"

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Purdue MSE Ph.D. Final Exam

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ABSTRACT

Meteorites fallen from the sky and surface particles of the moon gathered by lunar space missions, have distinct microstructure and properties that can provide unique insights on the origins and processes for the evolution of our solar system. These extraterrestrial materials contain highly complex microstructures due to the formation and structure evolution events spanning long periods of time. The comprehensive characterization on these samples, to extract multi-scale structural information, is especially crucial to support formation theories, understand material utilization possibility, and preparation for potential hazard mitigation. In addition to the microstructure, an understanding of the mechanical properties of these materials is also vital. Hence, an in-depth investigation on how microstructural phase distribution and their respective mechanical properties connect to macroscopic deformation behavior is required.

In this study, a correlative microscopy-based methodology was used to study several celestial samples; meteorite Aba Panu (L3), meteorite Tamdakht (H5), and a lunar dust grain from mature sample 10084 returned by the Apollo 11 mission. X-ray microcomputed tomography (XCT) was utilized to acquire inherent 3D structural details from samples non-destructively. Scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS) was used to further resolve finer structural features and compositional information to complete the correlative described above.

Both ex situ and in situ compression experiments, in the XCT, were performed on machined cylindrical samples of Aba Panu meteorite. Structure development including crack initiation, propagation, and failure states were analyzed and correlated to the macroscopic stress-strain behavior. Direct 3D correlation on ex situ and in situ images of crack growth were used to obtain a comprehensive mechanistic understanding of crack development and deformation. Finally, nanoindentation was used to complement the 3D microstructural study, by acquiring mechanical properties of individual constituent phases.

Date: Monday, July 17, 2023
Time: 2:00 P.M.
Place: ARMS 1021 or via the link: https://purdue.webex.com/meet/nikc

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