Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

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Tuesday, January 30, 2018

4:00pm Tech L211

Additive manufacturing of metals: from monolithic structures to functionally graded components

Layer-by-layer additive manufacturing (AM) of metals can be used to fabricate complex geometry components that cannot be manufactured using traditional casting, forging, or machining methods. However, the processing that metals are exposed to in AM, namely rapid solidification followed by repeated thermal cycles with the addition of layers, results in unique microstructures that differ drastically from their wrought or annealed counterparts. Before AM can be adopted for use in structural, or load-bearing, applications, a fundamental understanding of the connections among processing, microstructure, and properties must be developed. I will present our work on elucidating those links in monolithic components made by additive manufacturing. In addition, I will discuss our work in designing and characterizing functionally graded materials made by AM. In these materials, the chemistry is intentionally varied with position, with the aim of spatially tailoring properties (e.g., mechanical, thermal, magnetic) within a single, complex shaped, 3D component.

Allison Beese received her B.S. degree in Mechanical Engineering from Penn State University. She earned her M.S. and her Ph.D. degrees in Mechanical Engineering at MIT. She spent two years as a postdoctoral fellow in Professor Horacio Espinosa's Micro and Nanomechanics Laboratory at Northwestern University. She joined Penn State as an Assistant Professor in Materials Science and Engineering in 2013.

Her research interests are in experimental and computational multiscale mechanics of materials, with a focus on developing experimental methods to elucidate the connections among the microstructure, macroscopic deformation, damage accumulation, and failure properties of materials. One current research thrust in her group focuses on identifying processing-structure-property relationships in additively manufactured components. Another thrust focuses on uncovering the stress-state dependent microstructural mechanisms of ductile failure of metals toward the development of predictive computational fracture models.

She has received a NSF CAREER award, the 2017 International Outstanding Young Researcher in Freeform and Additive Manufacturing award, a 3M non-tenured faculty award, an Oak Ridge Associated Universities (ORAU) Ralph E. Powe Junior Faculty Award, and a TMS Young Leader Professional Development Award.