THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT WINTER COLLOQUIUM SERIES PRESENTS:

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Magnetically Assisted Processing: theory, observation, and application for microstructural design using applied magnetic fields

Applied magnetic fields can provide novel routes for microstructural manipulation – including texturing, and phase formation and evolution – and to reduce processing times or temperatures. However, many of these exciting examples are under large field strengths (e.g. >10T) or limited process volumes (e.g. within the bore of an electromagnet), which limit scalability of these technologies. At the Combat Capabilities Development Command Army Research Laboratory, the Army's corporate laboratory, we are interested in defining the processing space for component scale manufacturing. To this end, we are experimentally exploring the effects of low magnetic field and developing computational methods for predicting microstructural evolution under a variety of fields. Experimentally, we have found that inexpensive, low strength permanent magnets (<0.5T) applied during electrodeposition result in grain boundary engineering (e.g. high twin boundary fractions), and changes in texture, grain size, and alloy content. Additionally, the extra convective forces resulting from magnetic and electric field coupling provide an avenue for increased composite loading for wear applications. Computationally, work to identify and develop the computational tools necessary to predict which metallic systems and processes are most responsive to low field strengths is ongoing. We are focused on several meso-scale modeling approaches, which include: Monte Carlo (microstructural and texture evolution), phase field (phase evolution and diffusion), and thermodynamic (shifts in equilibrium phases and phase boundaries). The computational tools developed will enable material design, selection, and process development.

Dr. Heather A. Murdoch obtained a B.S. in Materials Engineering from Purdue University (2008) and a Ph.D. in Materials Science and Engineering from the Massachusetts Institute of Technology (2013), devising novel methods for stabilization of nanocrystalline alloys. She is currently a materials engineer at the U.S. Army Research Laboratory (ARL) in the Metals Branch of the Weapons and Materials Research Directorate. She joined ARL in 2013 as an Oak Ridge Institute of Science and Education (ORISE) postdoctoral fellow and transitioned to a staff position in 2014. Dr. Murdoch currently leads two programs on exploring the application of magnetic fields to metals processing through both modeling and experimental approaches. Additional research includes process modeling for novel cermet binders and exploring the intersection of mechanical and corrosion response of aluminum alloys. Dr. Murdoch has also served as the civilian liaison to the ARL Postdoctoral Association and mentored two postdocs and several undergraduate students.

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