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INSTITUTE FOR NUCLEAR ENERGY SYSTEMS

Presents:
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Controlling Deformation Mechanism Transitions in Nanocrystalline Alloys through Grain Boundary Engineering

Abstract: Stable nanocrystalline metals employing solute enriched grain boundary phases are being realized in a myriad of alloy systems and driving extraordinary advances in the design, processing, and technological applications of bulk nanocrystalline materials. However, augmenting the chemical and structural state of grain boundaries to achieve adequate thermal stability also has marked impacts on the mechanical behavior. In this presentation, we will explore two such effects – stabilization against stress-assisted grain growth and grain boundary segregation strengthening. First, molecular dynamics simulations of surface nanoindentation on nanocrystalline Ni and Ni-P are employed to quantify the role of competing mechanisms during stress-assisted grain growth. We attribute microstructural evolution in nanocrystalline Ni to grain boundary mediated deformation involving boundary migration and grain rotation. The addition of phosphorous stabilizes the boundaries against these mechanisms, in turn eliminating stress-assisted grain growth and promoting grain boundary mediated dislocation plasticity. Second, the role of segregated solute on strength is explored in nanocrystalline Al-Mg alloys. We find that grain boundary plasticity is again suppressed by solute enrichment producing more stable interfacial configurations. The onset of grain boundary mediated dislocation plasticity is also delayed to larger strains, which manifests as an increase in strength far exceeding classical Hall-Petch scaling. Using high energy mechanical milling and tailored heat treatment profiles, we demonstrate this effect experimentally in nanocrystalline Al-Mg alloys and produce one of the strongest lightweight metals to date with a compressive yield strength approaching 1 GPa.

***Biography*:** Dr. Jason Trelewicz is an Assistant Professor of Materials Science and Engineering at Stony Brook University with a joint appointment in the Department of Materials Science and Chemical Engineering and the Institute for Advanced Computational Science. His research explores the science of interface engineered alloys using in situ and analytical characterization tools coupled with large-scale atomistic simulations to design materials for extreme environment applications. Professor Trelewicz received his Ph.D. in Materials Science and Engineering from the Massachusetts Institute of Technology in 2008. Prior to joining the faculty at Stony Brook University, he spent four years as Research Director at MesoScribe Technologies, Inc. responsible for managing the development of harsh environment sensor technologies produced by additive manufacturing processes. Professor Trelewicz is a recipient of the 2017 DOE Early Career Award and 2016 NSF Faculty Early Career Development (CAREER) Award. He was also selected as the Inaugural Recipient of the Fusen and Yijen Chen Prize for Innovative Research in 2018, received the 2015 TMS Young Leader Professional Development Award, and was selected as a TMS representative for the 2014 Emerging Leaders Alliance Conference. Professor Trelewicz is an active member of the Materials Research Society (MRS), The Minerals, Metals, and Materials Society (TMS), and ASM International.

Tuesday, 4/24/2018
4:00 PM, ERB 106