Materials Science and Engineering Department

Winter Seminar Series

The Stable Response of Nanocrystalline Metals

Dr. Kris Darling
Army Research Laboratory

February 8, 2023
3-4PM | Hill Seminar Room (LeBow 240)

Although an understanding of the bulk mechanical response of nanocrystalline metals have been pursued intensely for over three decades, much remains a mystery with respect to their true mechanical response. The simultaneous occurrence of extensive, rapid grain growth with deformation results in uncertainty in the knowledge of how these materials would respond if there were no microstructural coarsening. This handicap becomes exponentially problematic as exposure to testing conditions become more and more extreme; and the already unstable nanocrystalline microstructures become obliterated under the drastically intensified driving force to rearrange and grow. The difficulty in decoupling the influence of grain growth from their mechanical response has been such a challenge that the inability to do so has given rise to common stigmas (misconceptions), which limit the perceived expectations with regard to the performance capabilities of these new materials by the community. This mind state however, provides a new frontier for fundamental discovery where opportunities exist to get beyond the perceived mechanical limits which have been called out in this discipline of science. This is most typified when considering the mechanical behavior of nanocrystalline metals under extreme and/or far from equilibrium conditions. This topic along with thermodynamic and practical aspects of mechanical alloying as they pertain to developing stable nanocrystalline alloys will be presented. The immiscible Cu-Ta system will be used to highlight these aspects.

Dr. Darling completed his bachelors, masters and PhD from the North Carolina State University, Raleigh, NC, USA under the guidance of Carl Koch and Ron Scattergood. He completed his PhD in 2009 and joined as a postdoctoral fellow at the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD. He has recently joined as a permanent staff in of ARL in 2010. Since at ARL he has worked to develop scientific and engineering programs to explore and develop the processing-structure-property relationships in novel structural metals, with particular emphasis on the unique properties that emerge at the nano scale. His recent area of research has concentrated on the thermodynamic and kinetic stabilization of nanocrystalline metals and alloys for defense applications. However, Dr. Darling has 19 years of experience in the fabrication, consolidation, testing and characterization of nanocrystalline metals and alloys. Dr. Darling has published ~ 160 articles in this area of research.

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Email: kn52@drexel.edu

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