College of Engineering
Department of
Mechanical & Industrial Engineering

The Robert W. Courter Seminar Series

3:00-4:00pm, Friday, November 15, 2024

1206 Patrick F. Taylor Hall

Resilience of Stabilized Nanocrystalline Metals Against Multi-Energy Degradation in Extreme Environments

by Dr. Kris Darling

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The absorption of various energy forms—such as intense heat, ionizing radiation, mechanical loading, and high electric fields—can degrade materials through rapid defect formation and microstructural changes, ultimately leading to failure. Each energy type interacts with materials differently: thermal energy increases kinetic activity, resulting in vacancies and phase transformations; ionizing radiation induces atomic displacements that cause hardening and swelling; mechanical energy transfer through shock or fatigue leads to dislocation movement, crack formation, and phase changes; and high electric fields drive electromigration and grain boundary migration. In extreme environments, such as aerospace and nuclear applications, materials often face combined energy inputs, accelerating degradation. Recent advancements in stabilized nanocrystalline (NC) metals present a transformative approach, offering resilience across diverse energy forms and extending material durability. Unlike traditional materials designed to resist specific energies, stabilized NC metals provide a unified strategy against multiple damage mechanisms, enhancing performance in extreme environments. This breakthrough has broad implications for industries demanding materials that endure high-stress, multi-energy exposures.

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 over 20 years of experience in the fabrication, consolidation, testing and characterization of nanocrystalline metals and alloys. Dr. Darling has published ~ 155 articles in this area of research.