COLLOQUIUM

MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

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11:10AM-12:00PM
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Mechanical response of nanolayered composites: Strength, ductility, and fracture at the nanoscale

Past work on structural nanocomposites has shown that this class of materials shows yield strengths approaching the theoretical strength of the materials' constituents. However, for these materials to be used in engineering applications, other behavior such as ductility, fatigue resistance, and fracture toughness must be understood. In this work, Cu/Nb nanoscale multilayered composites show ultra-high strength as well as high ductility using a variety of mechanical test methods (nanoindentation, tensile testing, and micropillar compression). Individual layer thicknesses tested range from 100 nm to 5 nm, with flow stresses (5 nm Cu/Nb case) of nearly 3 GPa, and deformation during micropillar compression in excess of 20%. Through the use of Focused Ion Beam (FIB) milling, post-deformed microstructures of micropillars are examined via Transmission Electron Microscopy (TEM). Formation of shear bands, as well as homogeneous deformation of over 10% true strain is evident at individual layer thicknesses as low as 5 nm. The microstructure within the shear band exhibits large plastic deformation and grain rotation relative to the compression axis, and the layered structure remains continuous even after local strains in excess of 70%. Plastic behavior of these materials at large plastic strains will be discussed in terms of interfacial effects on dislocation motion. It was found that total plasticity to failure in nanoscale multilayered composites was limited by the onset of instability due to mechanical testing geometry.

Bio: Dr. Mara received his PhD from UC Davis in 2005, where his work focused on determining the structure/mechanicial behavior relationships of structural nanomaterials at elevated temperatures. From 2005 to 2008, he was a Director's Postdoctoral Fellow at the Los Alamos National Laboratory in the Center for Integrated Nanotechnologies researching plastic flow behavior in laminar nanocomposites. Since 2008, he has been a Staff Scientist at LANL, where his research interests have evolved to include synthesis of bulk structural nanocomposites and interfacial effects on material performance at mechanical and radiation extremes. The current work was funded by the Department of Energy, Office of Science, Basic Energy sciences.