April 18,2013

Interplay between microstructural size and heterogeneity and its effect on the mechanics of nanocrystalline metals

Abstract: In recent years, there has been tremendous research interest in understanding the mechanical behavior of nanoscale materials. Most of these studies have focused primarily on the size effect (either the grain size or specimen size) on mechanical properties. In this talk, I will show how the interplay between microstructural size and heterogeneity (distribution of grain size and orientation) at the nanoscale leads to unusual mechanical behavior that cannot be explained solely by size effects. Specifically, I will show that a) nanocrystalline metals, unlike their coarse grained counterparts, recover a substantial fraction (50 to 100 %) of *plastic strain* after unloading, and b) ultrafine grained metals show a pronounced early Bauschinger effect even at high tensile stresses during unloading. I will then present evidence from in situ transmission electron microscopy and x-ray diffraction experiments that strongly indicate that the strain recovery and early Bauschinger effect are a direct consequence of microstructural heterogeneity. Finally, I will show that when the microstructure of nanocrystalline metals is made more homogeneous these unusual phenomena are substantially diminished. These experiments suggest that a purely size-centric description of nanocrystalline metals is inadequate and emphasize the need to take both the microstructural size and heterogeneity into account in describing their mechanical behavior.

Jagannathan Rajagopalan

Assistant Professor

Dept. Mechanical and Aerospace Engineering

Arizona State University

Tempe, AZ 85287

Biography: Dr. Jagannathan Rajagopalan received his B. Tech. and M. Tech. degrees from the Indian Institute of Technology (IIT) Madras in 2004 and his Ph. D. from the University of Illinois at Urbana-Champaign (UIUC) in 2009. In his doctoral thesis, he studied the mechanical behavior of nanocrystalline metals using MEMS based tensile testing devices. His post doctoral work at UIUC focused on understanding the mechanics of living cells (neurons) using BioMEMS force sensors. He is currently an Assistant Professor in the Mechanical and Aerospace Engineering Department at Arizona State University, where his research encompasses nanostructured materials, MEMS/ BioMEMS and in situ electron microscopy. Dr. Rajagopalan was a recipient of the Mavis Memorial Fellowship at UIUC in 2007 and his publications include articles in Science, Biophysical Journal and Acta Materialia.