

Physics Colloquium

Michigan Technological University

November 2, (Thursday) 2006, 4:00 to 5:00 pm
Room 139, Fisher Hall

New Experiments on Microplasticity: Large Fluctuations, Scale Invariance, and Long-Range Correlated Events

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Abstract

First experimental results obtained recently with novel high-precision instruments and *in-situ* fabrication technologies have revealed many unusual phenomena during plastic deformation. Plastic flow in micron-scale samples, nanoscale surface roughness, and acoustic emission in large deforming samples - all demonstrate signatures of stochastic correlated events. Current theoretical modeling of dislocation systems also confirms such collective emergent properties. These findings show that plastic deformation in real crystalline materials proceeds through the evolution of dynamically-driven complex fractional systems of networking interacting dislocations with long-range spatial correlations, self-affine characteristics, and large spatial and temporal fluctuations.

I consider in detail experimental techniques and first results obtained during my 2005-2006 sabbatical year in the University of Edinburgh, Scotland, and AF Research Laboratory, Dayton, OH. Among the most important findings are demonstration of exceptionally high stresses not very far from the theoretical strength in microsamples and long-range correlations with scale-free laws typical of critical phenomena, in both microsamples and macrosamples of such different solids as metals, intermetallics, metal alloys, ionic crystals, and ice.

These results show that the dynamical and statistical properties of dislocation systems are quite different than those assumed for a long time in conventional theories of uncorrelated dislocation systems and continuum plasticity. Rather, they are more similar to those observed in the study of phase transitions and critical phenomena.