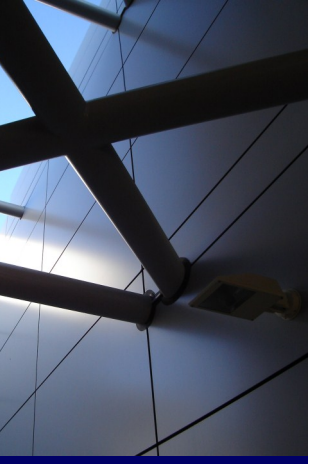

JOINT COLLOQUIUM
MECHANICAL ENGINEERING &
MATERIALS SCIENCE & ENGINEERING

The Department of Mechanical Engineering and the Materials Science & Engineering Program present:

Sandeep Kumar, Ph.D.

Assistant Professor, Mechanical Engineering Department
University of California Riverside

Friday, October 5, 2012
11:10AM-12:00PM
Bourns Hall A265

Nanomechanics and Multi-physics of Nanoscale Thin Films

Abstract

Thin films are used prevalently in micro-electronics, data storage, sensors and actuators, energy conversion and micro-electro-mechanical systems, where they experience deformation during device fabrication and operation. Design, performance and reliability of these devices depend on our understanding of the mechanics and physics of thin films. However, when film thickness is below a critical length scale, not only single domain (mechanical, electrical, thermal) behavior is different from the bulk, also strongly coupled.

To understand the mechanics and multi-physics of nanoscale thin films, we developed a nanofabricated experimental setup with high-resolution in-situ microscopy, so the deformation mechanisms can be seen while the properties are measured. In the first part of this talk, we will discuss the length-scale effects on fracture and fatigue properties of thin films while correlating the quantitative data to underlying deformation mechanisms. We found that at nanoscale material tend to become “Flaw Tolerant” similar to naturally occurring biomaterials (a small crack in human bone will not result in brittle fracture).

In the second part of the talk, we will discuss a novel multi-physics study, where we utilized the current in-situ TEM experimental setup to quantify the coupling between mechanical, thermal and electrical domains. We utilized the 3ω method for freestanding thin films to measure thermal and electrical properties while simultaneously applying mechanical strain to the thin film. We found strong mechanical strain dependence for thermal and electrical properties in case of 100 nm aluminum thin films, which will be explained in terms of grain rotation as a dominant deformation mechanism.

Biography

Sandeep Kumar received the B.Tech. degree in mechanical engineering from the Regional Engineering College, Kurukshetra, India, and the M.S.(research) degree from the Indian Institute of Technology, Delhi, India. He completed his Ph.D. degree at Pennsylvania State University, University Park under the guidance of Prof. Aman Haque. His doctoral research explored in situ TEM (transmission electron microscope) studies on mechanical properties and deformation mechanisms in nanoscale thin films and multilayer hard coatings. His current research interests include thermo-electro-mechanical coupling in thin films at nanoscale, performance issues with Li-ion battery electrodes and high temperature material characterization. His publishing credits include thirteen peer reviewed journal papers, three peer reviewed conference papers and nine technical conference presentations.