CSU PHYSICS COLLOQUIUM

Real-Time X-Ray Investigations of Nanoscale Surface Processes

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Colorado State University
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Refreshments at 3:45 PM
Location: 120 Engineering (Hammond Auditorium)

Abstract

In recent years the available brightness of x-rays has increased at an incredible pace – faster than Moore’s Law. Among other things, this opens up important new opportunities to investigate temporal processes on surfaces and I describe two examples.

Remarkably, the stochastic ion bombardment of materials can lead to spontaneous surface smoothening or to the formation of self-organized nanoscale structures. Despite much work, however, many questions remain about what drives these processes. Our real-time x-ray studies carefully measure the amplification factor $R(q)$ characterizing the surface instability/relaxation in elemental semiconductors to compare with fundamental theory. Additional information to inform this comparison comes from separate wafer curvature measurements of stress evolution.

As a second example, third generation synchrotron sources and free-electron x-ray lasers enable coherent x-ray scattering studies. We have been using x-ray photon correlation spectroscopy to investigate the fundamental dynamics of kinetic roughening during amorphous thin film growth. In the late stage, kinetic surface roughening reaches a dynamic steady state in which the intensity autocorrelation function $g_2(q,t)$ becomes stationary. The surface dynamics we observe is complex, but is consistent with dynamical scaling hypotheses. We also observe a novel heterodyning that is sensitive to the relationship between subsurface defects in the growing film and the surface itself.
Biographical Sketch

Karl Ludwig is currently Chair and Professor in the Department of Physics at Boston University (BU) and also a faculty member in the Division of Materials Science and Engineering. He joined BU in 1988, following undergraduate and graduate studies at Cornell and Stanford respectively, and a postdoctoral appointment at the IBM T.J. Watson Research Center. Ludwig’s research primarily develops synchrotron-based x-ray techniques to investigate the nanoscale kinetics/dynamics of growth and phase transition processes in materials. He has served on a number of professional, review and conference organizing committees. He was the Chair of the New England Section of the American Physical Society in 2005 and is currently the Spokesperson for the In-Situ Resonant (ISR) Beamline Advisory Team at the National Synchrotron Light Source-II at Brookhaven National Laboratory.