GRADUATE COLLEGE

PH.D. THESIS PROPOSAL

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Surface Morphology Dynamics During Energetic-Beam Deposition

Sputter Deposition (SD) and Pulsed Laser Deposition (PLD) processes are classified as energetic beam deposition, in that they incorporate atomic, molecular, and ionic species with energies ranging from 10 to 1000 eV. Energetic species play an important role in determining the nucleation characteristics, film growth dynamics, final surface morphologies, and microstructures. The motivation for this work is thus to study the surface morphology dynamics, to investigate the underlying roughening and smoothing mechanisms during the energetic beam deposition (SD and PLD), and to understand the role of the energetic species in the growth of amorphous and crystalline thin films. This is achieved through carrying out real-time growth studies with a custom-built ultra-high vacuum chamber using synchrotron-based x-ray scattering.

Studies on sputter-deposited amorphous WSi_2 films at different Ar pressures reveal that the surface changes from smooth to rough, and that the transition occurs at 6 mTorr. Real-time Grazing-Incidence Small-Angle X-ray Scattering (GISAXS) shows the evolution of the surface during roughening (when film deposited at high pressures on an initially ultra-smooth surface) or smoothing (when film deposited at low pressures on an initially rough surface). Modeling based on linear growth models is compared with the data. White noise promotes roughening, while two different smoothing mechanisms determine the surface evolution below and above 6 mTorr, based on the q – dependence of x-ray diffuse scattering.

In PLD processes, the time-of-flight spectra determined by Langmuir probe show that the energy distributions of the energetic ions are peaked strongly in the forward direction. Preliminary studies on the surface structure evolution in epitaxial growth by PLD on Ge (001) suggest that the energetic nature of PLD introduces surface strain in the epitaxy layer of thickness of several monolayers. New instrumentation has been developed that will allow us to vary the energy distribution of particles reaching the growth surface, which will allow us to investigate these effects in future work.

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2:30 PM
Room A442 Cook Physical Science Building

Refreshments available at 2:00 PM in Cook A429