

UNH Materials Science Seminar

11:10-12:00, Thursday, Feb. 21, 2008

Kingsbury Hall S145

University of New Hampshire

The Materials Machine: Nanostructure Growth from the Vapor Phase

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An ongoing challenge in materials physics is to arrange atoms in a controlled manner in order to design materials with desired physical properties. This requires the development of (1) tools that predict materials properties solely from their elemental composition and atomic arrangement and (2) synthesis methods which control the assembly on an atomic level. I will illustrate these two aspects of materials physics by discussing nanostructure growth from the vapor phase, focusing on transition metal nitrides. An atomistic understanding of growth is developed using a multiple length-scale and dimensionality approach which combines experimental and computational methods to investigate microstructural evolution of entire layers, surface roughening and island kinetics, and single atom and molecule diffusion and reaction processes. Atomic shadowing, anisotropic surface diffusion, and ion-surface interactions are exploited to create unique nanostructures, including nanopipes, nanostaircases, nanosprings, and nanorods, with potential applications as sensors, hard self-

lubricating coatings, and gas filtration. Mechanical, optical, vibrational, and electronic transport properties are determined experimentally and understood using *ab initio* electronic structure calculations. This understanding leads, in turn, to the controlled synthesis of novel semiconductors, superconductors, ultra-hard coatings, magnetic insulators, and conducting refractory compounds.

Daniel Gall is an assistant professor in the Materials Science and Engineering Department at RPI. He received his Diploma from the University of Basel, Switzerland, in 1994, and his Ph.D. from the University of Illinois at Urbana-Champaign in 2000. Prof. Gall has been a Visiting Scientist at the Frederick Seitz Materials Research Laboratory, Illinois, has served as Assistant Editor and Editorial Board Member for *Thin Solid Films*, and as Associate Editor for the *Journal of Vacuum Science and Technology A*. He is the elected secretary of the AVS Advanced Surface Engineering Division and serves as session chair, program committee chair, and proceedings editor for the International Conference for Metallurgical Coatings and Thin Films and the AVS International Symposium. Prof. Gall's research focuses on the development of an atomistic understanding for thin film growth, with particular interest in transition-metal nitride coatings, ion-surface interactions, and glancing angle deposition. He won the 2006 Alfred H. Geisler Memorial Award for "Outstanding Contributions in Education and Thin Film Growth Research," and the NSF Faculty Early Career Development (CAREER) Award.

Host: Professor James Harper