

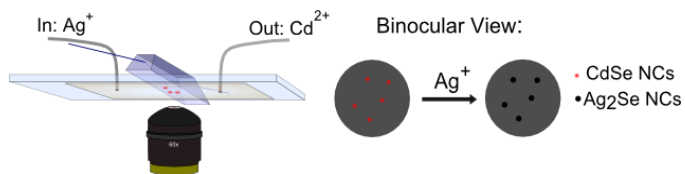
# NANO HOUR

Wednesday, March 12, 2014 3:00 pm  
Beckman Institute - Room 3269

## Watching Cation Exchange Nanocrystal-by-Nanocrystal

Aaron L. Routzahn, Chemistry

Graduate Student with Professor Prashant K. Jain



We are studying chemical transformations of nanocrystals, in particular cation exchange, at the single nanoparticle level. Cation exchange, the topotaxial replacement of the cation sublattice in a nanocrystal, is enabling the synthesis of novel structural and compositional nanoparticles. While

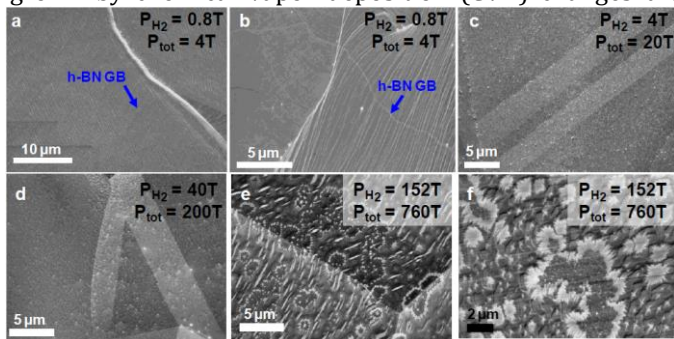
significant work has gone into understanding the scope and thermodynamically determined products of the reaction, the kinetic pathways of the reaction remain relatively obscure. Understanding of the mechanism of the exchange will enable more precise control of the reaction, for instance to post synthetically dope nanomaterials in a controllable manner, and also allow expansion of the ion exchange method to newer systems. Ensemble averaging, which typically smears out interesting kinetics, is overcome by following the reaction of individual nanoparticles by means of single nanoparticle-resolved fluorescence microscopy. Fluorescence intensity trajectories of individual CdSe nanocrystals undergoing ion exchange with Ag<sup>+</sup> has shown that individual nanocrystals rapidly transition to the Ag<sub>2</sub>Se phase rather than converting gradually in unison over the course of the reaction. The ensemble kinetics are composed of different nanocrystals making this rapid switch at distinct times. These distinct waiting times and rapid transitions for the conversion of individual nanocrystals suggest that a nucleation driven or cooperative mechanism is at play rather than the reaction simply being diffusion limited. A cooperative mechanism for the incorporation of nonnative cations into a nanocrystal hints that difficulties in doping such particles may result from the essentially all-or-nothing nature of these processes. We are currently attempting to characterize such unfavorably doped "transition states" through photoluminescence intermittency and spectra.

## Synthesis of Hexagonal Boron Nitride: Roles of Growth Pressure and Cu Substrate Crystallography

Justin C. Koepke, Electrical and Computer Engineering

Graduate Student with Professor Joe Lyding

The effort to develop wafer-scale graphene and transition metal dichalcogenide electronic devices on solid and flexible handles requires substrates that will not degrade the fundamental properties of those materials. Recent work has demonstrated that hexagonal boron nitride (h-BN) is an ideal substrate for these materials and can serve as spacer to enable vertical heterostructures of two-dimensional materials. While recent work has demonstrated growth of sub-monolayer to very thick h-BN films on transition metal substrates, the growth mechanisms on Cu are not well understood. We show that the layer number and defect density for hexagonal boron nitride (h-BN) films grown by chemical vapor deposition (CVD) changes dramatically with the growth pressure and the substrate



crystallography. Characterization of h-BN grown on Cu foil shows that h-BN grown by low-pressure CVD (LPCVD) yields more uniform, planar h-BN films than those grown by atmospheric-pressure CVD (APCVD). The APCVD-grown h-BN films are thicker and more nanocrystalline than their LPCVD-grown counterparts. Growths between the two extremes of LPCVD and APCVD show that the film thickness and nanocrystalline morphology increase with the growth pressure.

Coffee and cookies will be served

<http://nanohour.beckman.illinois.edu>