MATERIALS & PHYSICAL CHEMISTRY SEMINAR

Thursday, Sept. 27, 2012

12:15 p.m. in Seminar Hall (1315

PROFESSOR TODD KRAUSS

UNIVERSITY OF ROCHESTER

"Fundamental Insights into Semiconductor Nanocrystals From Synthesis and Single Molecule Spectroscopy"

Semiconductor nanocrystals (NCs) are small inorganic particles that have potential for significant breakthroughs in biology, renewable energy, and medicine. The photoluminescence (PL) from NCs exhibits intermittent on/off intensity fluctuations, or "blinking", that severely limits their usefulness in applications requiring a continuous output of single photons. We will present single molecule optical studies of ternary core-shell CdZnSe/ZnSe NCs that exhibit continuous, non-blinking single NC photoluminescence. These NCs also have an unusual multi-peaked PL spectral line shape and a fluorescence lifetime four times shorter than typical CdSe NCs. To model the unusual photophysical properties of the CdZnSe/ZnSe NCs, we considered the recombination of a charged exciton (i.e. a trion) confined in a parabolic potential. In addition, while recent advances have enabled synthetic control of NC size, shape and composition, these syntheses are notoriously irreproducible, as is readily apparent in our synthesis of CdZnSe/ZnSe NCs. We will also present studies of the fundamental chemical reaction mechanism describing the general synthesis of metal chalcogenide NCs. We have utilized these findings to improve reaction yields for CdSe and PbSe NCs by over an order of magnitude, while producing NCs of exceptional quality with respect to control over size, size distribution, and fluorescence efficiency. In addition, understanding the NC chemical reaction mechanism has led to an unexpectedly good control over NC surface composition with a somewhat surprising dependence of the NC fluorescence properties on how the NC surface is constructed.