HAJIM SCHOOL OF ENGINEERING AND APPLIED SCIENCES
UNIVERSITY of ROCHESTER

Department of Chemical Engineering presents

Dr. Benjamin T. Diroll

Argonne National Laboratory

January 17, 2018
Gavett Hall 202 @ 3:25pm

"Manipulating Charges within Nanocrystals and Nanocrystal Superlattices "

Controlling the behavior of electrons and holes in materials is critical for engineering their chemical and optoelectronic behavior. This seminar will present two distinct approaches: (1) optical control of free electrons and holes within individual nanoparticles and (2) compositional control of the conductivity in solid periodic arrays of nanocrystal "artificial atoms" over macroscopic distances. (1) Semiconductor nanoparticles can be synthesized with high free electron or hole populations through tunable incorporation of dopant atoms or vacancies, resulting in materials with metal-like plasmas that have strong infrared absorption. IR excitation of these materials results in free carrier heating to electronic temperatures as high as 5000 K, dramatically changing their transmission and index of refraction on a subpicosecond time-scale, marking these materials as promising candidates for all-optical switching. (2) Analogous to the emergence of properties from periodic arrays of atoms (i.e. crystals), nanocrystal superlattices offer the possibility of emergent optical and electrical behavior from the assembly of millions to billions of individual nanocrystal building blocks into periodic arrays. The judicious choice of two nanoparticle building blocks of nearly identical size allows the formation of a substitutionally-doped superlattice structure in which a hexagonal close packed superlattice of semiconductor nanoparticles randomly incorporates metallic nanoparticles at variable concentrations, engineering changes of conductivity up to 7 orders of magnitude.