**Materials Seminar**

Department of Materials Science & Engineering

# Thursday March 1, 2018

1:30 – 2:30 ~ 500 JDT

Faculty Candidate

"Manipulating Charges within Nanocrystals & Nanocrystal Superlattices"

**Speaker: Dr. Ben Diroll**   
Center for Nanoscale Materials



Argonne National Laboratory

Abstract:

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.

Biography:

Benjamin Diroll received his Ph. D. in chemistry from the University of Pennsylvania in 2015 for work focused on synthesis, self-assembly, and optical properties of colloidal particles. In 2015, he joined the Center for Nanoscale Materials at Argonne National Laboratory as a Director’s Postdoctoral Fellow, where he uses ultrafast optical techniques to study semiconductor materials for applications in energy conversion

This Seminar will be followed by Dr. Diroll’s vision for future research in MSE at 2:30. ***Please join us for refreshments at 3:00***