University of Pittsburgh

Petersen Institute of NanoScience and Engineering Seminar

Speaker: **Professor Christopher Murray**
Departments of Chemistry and Materials Science and Engineering,
The University of Pennsylvania

Title: ***Preparation and Properties of Multicomponent Nanocrystal Superlattices***

Time/Date: **12:00 noon, Monday, March 3, 2008**
(refreshments at 12:00noon - 12:15pm)

Place: **Kresge Conference Center, 1175 Benedum Hall**

The synthesis of colloidal nanocrystals with controlled crystal shape, structure and surface passivation provides a rich family of nanoscale building blocks for the assembly of new solid thin films and novel devices. The tunability of the electronic, magnetic, and optical properties of the nanocrystals has lead to them being compared to a set of "artificial atoms"[(1)]. This talk will briefly outline some of the current "best practices" in preparation, isolation and characterization of semiconducting quantum dots and magnetic nanoparticles[(2,3)]. I will next discuss the organization of monodisperse nanocrystals into single component superlattices that retain and enhance many of the desirable mesoscopic properties of individual nanocrystals. The potential to design new materials expands dramatically with the creation of binary nanoparticle superlattices BNSLs[(4)]. I will show how we synthesized differently sized PbS, PbSe, $CoPt_3$, Fe_2O_3, Au, Ag and Pd nanocrystals and then these nanoscale building blocks into a rich array of multi-functional nanocomposites (metamaterials). Binary superlattices with AB, AB_2, AB_3, AB_4, AB_5, AB_6 and AB_{13} stoichiometry and with cubic, hexagonal, tetragonal and orthorhombic packing symmetries have been grown. We have also identified a novel method to direct superlattice formation by control of nanoparticle charging. Although modular nano-assembly approach has already been extended to a wide range of nanoparticle systems, we are confident that we have produced only a tiny fraction of the materials that will soon accessible.

Abstract references:

(1) "Synthesis and Characterization of Monodisperse Nanocrystals and Close-Packed Nanocrystal Assemblies," C.B. Murray, C.R. Kagan and M.G. Bawendi, *Annual Reviews of Materials Science* 2000, Vol. **30**, pp. 545-610.

(2) "Designing PbSe Nanowires and Nanorings Through Oriented Attachment of Nanoparticles" K.S. Cho, D.V. Talapin, W. Gaschler and C.B. Murray. *J. Am. Chem. Soc.* **127** (19): 7140-7147 May 18, 2005.

(3) "Monodisperse 3d Transition Metal (Co, Ni, Fe) Nanoparticles and Their Assembly into Nanoparticle Superlattices," C.B. Murray, S. Sun, H. Doyle and T. Betley, *MRS Bulletin*, **26** (12): 981-+, Dec., 2001.

(4) "Structural Diversity in Binary Nanoparticle Superlattices" E.V. Shevchenko, D.V. Talapin, N.A. Kotov, S. O'Brien and C.B. Murray. *Nature* **439**, 55-59 (Jan 5, 2006).

Biographical Sketch

Dr. Christopher B. Murray holds the Richard Perry University Professorship in Chemistry and Materials Science at the University of Pennsylvania in Philadelphia PA where he is developing a world class effort in the preparation, characterization and integration of nanoscale materials. Prior to joining U. Penn. Chris was a staff scientist at IBM"s T. J. Watson Research Center in Yorktown Heights NY from 1995 to 2000 and managed the "Nanoscale Materials and Devices Department" there from 2000 to 2006. Chris received his B. Sc. degree in 1989 for Saint Mary's University in Halifax Nova Scotia and spent a year as a Rotary International Fellow at the University of Auckland New Zealand. Chris earned his Ph D. in chemistry from the Massachusetts Institute of Technology in 1995. This thesis work on semiconductor nanocrystals was recognized with the American Chemical Society's Nobel Laureate Signature Award as the top graduate contribution in chemical sciences in the United States and Canada. He is a pioneer in the solution phase chemicals synthesis, characterization and integration of nanoscale materials and is recognized for the establishment for the discovery of key methods in nanomaterials synthesis that have been widely adopted. His current work has focuses on exploration of finite size effects in nanoscale semiconductors, magnets, high dielectric oxides, ferroelectrics and in complex nanoscale assemblies. Chris, and the teams he has lead are recognized among the community of researchers, for the effectiveness and reproducibility of their methods. He was selected as the 2004 Debye Chair Professor, University of Utrecht, Utrecht the Netherlands and the R.B. Woodward Fellow, at Harvard University in 2004**.**