"Chemical design of nanocrystal based periodic and aperiodic metamaterials"

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Abstract

The synthesis of colloidal nanocrystals (NCs) with controlled crystal shape, structure and surface passivation provides ideal building blocks for the assembly of new thin films and devices. The NCs are "artificial atoms" with tunable electronic, magnetic, and optical properties. This talk will briefly outline some of the current "best practices" in preparation, isolation and characterization of semiconducting quantum dots and magnetic NCs. I will next discuss the organization of monodisperse NCs in to single component superlattices that retain and enhance many of the desirable mesoscopic properties of individual NCs. We will then explore how these novel building blocks can be integrated in to a range of electronic, magnetic and optical devices. The potential to design new materials and devices expands dramatically with the creation binary NC superlattices BNSLs. I will show how we synthesized differently sized PbS, PbSe, CoPt3, Fe2O3, Au, Ag, Pd and NaYF4:Re (Re= rare earths) nanocrystals and then these nanoscale building blocks into a rich array of multi-functional nanocomposites (metamaterials). We have also identified a novel method to direct superlattice formation by control of nanoparticle charging and by design of nanocrystal shape. Although modular nano-assembly approach has already been extended to a wide range of NC systems, we are confident that we have produced only a tiny fraction of the materials that will soon accessible. Progress in the assembly of quasicrystalline (aperiodic) packings of particles will be shared along with methods to characterize these novel materials. Devices based on these new multi-component nanoscale assemblies will be discussed along with some new research directions that focus on emergent physical phenomena in the NC assemblies.

Biographical sketch for Professor Christopher B. Murray

Dr. Christopher B. Murray holds the Richard Perry University Professorship in Chemistry and Materials Science at the University of Pennsylvania in Philadelphia PA where his research focuses on the preparation, characterization and integration of nanomaterials. Prior to joining Penn Chris was a staff scientist and Manager in the IBM Research from 1995 to 2006 where he lead the "Nanoscale Materials & Devices" department at The T. J. Watson Research Center. He received his B. Sc. degree with Honors in Chemistry from St. Mary's University in Halifax Nova Scotia Canada (1988) and spent a year as a Rotary International Fellow at the University of Auckland New Zealand studying Chemistry and Materials Science before going on to the Massachusetts Institute of Technology. In the Chemistry Department of of MIT, Chris' work on the synthesis and characterization of semiconductor quantum dots earning his Ph D. in 1995 and recognition with American Chemical Society's Nobel Laureate Signature Award for his Thesis work. Chris is a pioneer in the synthesis, characterization and integration of nanostructured materials has authored more than 100 scholarly articles, with contributions that are among highest cited and influential in the field of nanocrystal synthesis and self-assembly and he is an inventor on more than 25 patents in this area. Increasingly his research is focused on the application of nanotechnology and materials design to issues that impact energy, health and environmental sciences. Chris also contributes to broader scientific community in nanoscience and engineering by serving on numerous advisory boards for several national an international scientific centers, journals, conferences and professional organizations.