THE JEROME B. COHEN DISTINGUISHED LECTURE SERIES IN MATERIALS SCIENCE AND ENGINEERING PRESENTS

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University of Pennsylvania

Monday, January 13 • 4 pm Tech LR2

Reception to follow | Willens Wing Atrium

Talk 1: The design of multifunctional nanomaterials and devices through nanocrystal self-assembly.

The synthesis of monodisperse colloidal nanocrystals (NCs) with controlled composition, size, and shape provides ideal building blocks for the assembly of new thin films and devices. These monodisperse colloidal NCs act as "artificial atoms" with tunable electronic, optical, magnetic properties that are allowing the development of a new periodic table for design at the Mesoscale. In this talk, I will briefly outline the current state of the art in synthesis, purification, and integration of single-phase NCs and core-shell (heterostructures) NCs emphasizing the design of semiconductor building blocks with tunable shapes (spheres, roads, cubes, discs, octahedra, etc. I will then share how these tailored NCs can be directed to assemble into single-component, binary, ternary NC superlattices providing a scalable route to the production of multifunctional thin films. The modular assembly of these NCs allows the desirable features of the underlying quantum phenomena to be enhanced even as the interactions between the NCs allow new delocalized properties to emerge. Synergies in the electronic and optical coupling between NCs will be emphasized as we pushing toward the realization of artificial solids with a new 3D and structure and high mobilities (>30 cm2V-1S-1) device integration. I will share specific case studies in thin-film transistors, thermoelectric materials, and solution-processable photovoltaic devices build with these strongly coupled nanocrystal solids highlighting the recent developments in wafer-scale NC superlattice deposition and patterning may provide a path to scalable fabrication. I will also share progress in microfluidic superparticle assembly approaches. Creating mesoscale structures that span 100s of nanometer to 10s of microns as the next scale of building units.

Tuesday, January 14 • 4 pm Tech L211

Talk 2: Nanocrystal design and self-assembly in service of heterogeneous catalysis

Colloidal nanocrystals (NCs) with tunable electronic, optical, properties and rich opportunities for surface functionalization are impacting many areas of heterogeneous catalysis. In this talk, I will briefly outline the current state of the art in synthesis, purification, and integration of single-phase NCs and core-shell (heterostructures) and heterodimer nanocrystals (Janus) NCs emphasizing the design of semiconductor building blocks with tunable shapes (spheres, roads, cubes, discs, octahedral in combination with transition metal NCs. Complimentary NC sizes and shapes will be used to create binary, ternary NC superlattices providing a scalable route to the production of multi-functional catalytic films. The modular assembly of these NCs allows the desirable features of the underlying quantum phenomena to be retained and enhanced even as the interactions between the NCs allow new photocatalytic applications and enhanced electrocatalytic behavior to emerge. Synergies in the electronic and optical coupling between NCs will be emphasized. The programing of metal and metal oxide NC architectures using dendron based surface ligands will be explored as a route to create new organic/inorganic hybrid materials that preserve accessibility for small reactants to active NC surface sites while the chemical affinity if the organic pocket in which the NC sits is modified.

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. Before joining Penn, Chris was a Staff Scientist and Manager in IBM’s Research Division from 1995 to 2006, where he led the "Nanoscale Materials & Devices" Department at the T. J. Watson Research Center. Chis received his BSc. 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 pursuing his PhD. in Chemistry at the Massachusetts Institute of Technology. While at MIT, Chris worked under the supervision of Prof. Moungi G. Bawendi, focusing on the synthesis and characterization of semiconductor quantum dots and quantum dot solids, completing his PhD. in 1995. The American Chemical Society recognized the pioneering contributions in Chris’ graduate thesis with the Nobel Laureate Signature Award. Chris has continued champion the development of materials chemistry by bringing together colloidal synthesis and nanoscale materials chemistry and with aspects of traditional top-down patterning and processing. He has expanded beyond semiconductors to explore opportunities in nanomagnetic, plasmonics, and catalysis. Increasingly his research is focused on the application of nanotechnology and materials design to issues that impact information technology, energy, and environmental sustainability and human health. Chris has authored more than 200 scholarly articles, holds over 25 patents, and has presented over 250 public lectures in the field of nanocrystal synthesis and self-assembly and on the engineering of nanomaterials and nanodevices. In 2011 he received an Honorary Doctorate from The University of Utrecht, The Netherlands recognizing contribution to the design of nanomaterials for energy sustainability, and in 2012 Chris was recognized as a Fellow of the Materials Research Society and in 2019 he was elected to the United States National Academy of Engineering (NAE). Chris also contributes to the broader scientific community in nanoscience and engineering by serving on numerous advisory boards for national and international scientific centers, journals, conferences, and professional organizations.