5th Annual AIChE Midwest Regional Conference

January 31st – February 1st, 2013
Organized by the Chicago Local Section of the AIChE
Hosted by the Illinois Institute of Technology, Chicago, IL

Session Th2B: 1:00pm -2:30pm, Thursday January 31, 2013 (Room 007)
Nanotechnology
Session Organizer: Steve Schade. URS
Session Chairs: Nabil A. Amro, Nanoink and Alak Bhattacharyya, UOP LLC, A Honeywell Company

1:00pm **Nanoscale Fabrication with Nanoparticle Based "Inks" Using Dip Pen Nanolithography**
Nabil A. Amro, Nanoink
In many areas of modern technology, from solid state device fabrication to biotechnology, 2-D patterning techniques are used to define structures and boundaries. These patterning techniques ultimately determine features size and density and thus unit performance and price. Much is developed upon the well known techniques of resist lithography yet to achieve extreme spatial resolution or chemical versatility; other techniques are better suited to control chemistry of surfaces on the 1-100 nm length scale. Dip Pen Nanolithography (DPN®) is a scanning probe-based lithography technique in which an atomic force microscope tip is used to deliver chemical reagents (from colloidal particles to metals ions, and from small organic molecules to biological polymers) directly to nanoscopic regions of a target substrate (from metals to insulators and modified-surfaces). This process has been recognized as a powerful and versatile tool for generating micron-, submicron-, and nanometer scale structures. The combination of resolution, registration, and direct-write capability offered by DPN® distinguish it from any alternative lithographic strategy and make DPN® a promising tool for patterning variety of nanostructures. In this talk we will present the fabrication of nanostructures at predefined position on surfaces using a variety of nanoparticles via DPN and their applications, as well as high throughput and large area fabrication of nanostructures using two-dimensional pen arrays. In addition we will give a brief background on nanoparticles manufacturing methods.

1:30pm **Nanoscience and Nanotechnology: From Energy Applications to Advanced Medical Therapies**
Dr. Tijana Rajh, Argonne National Laboratory
Future breakthroughs in nanoscience and nanotechnology rely upon the creation of new classes of functionally integrated hybrid materials that incorporate nanoparticles, three-dimensionally tuned nanoscale architectures, and biologically active molecules, offering opportunities for impact in diverse applications ranging from quantum computation, energy, and advanced medical therapies. Important elementary steps in energy relevant processes such as energy conversion, electronics and catalysis, occur at the nanoscale and require electron exchange within hierarchical structure. However, nanoscale materials absorb, propagate, and dissipate energy very differently than bulk materials. Within this framework, there is great opportunity to realize advances in the conversion, transfer, and storage of energy at the nanoscale. The exchange of electrons in these multiphase systems, designed and assembled to carry out a specific process, defines the functions of the system. Argonne, and the Center for Nanoscale Materials (CNM) in particular, has unique strengths in understanding how deliberate tailoring of materials on the nanoscale can lead to novel and enhanced functionalities. This strong core area has evolved and matured from breakthroughs in the study of elemental processes in the natural and artificial photosyntheis at Argonne that made pioneering contributions to the field of solar energy conversion. We developed hybrid biomolecule-semiconductor systems that use semiconductor nanoparticles for initial light-induced charge separation while using biomolecules for subsequent chemical/electrical conversion. In the same manner we use photoinduced charge separation in order to control and manipulate processes within living cells. Site selective redox processes occurring upon irradiation of hybrid systems are used to alter cell functioning. The main goal of this research is to achieve control of chemical processes of biomolecules and supramolecular entities within the living cells in order to develop new tools for advanced medical therapies.

2:00pm **Designing Industrially Useful Nanocatalysts**
Alak Bhattacharyya, UOP LLC, A Honeywell Company
Desulfurization of emissions from industrial sources has become an integral part of operating a plant. More and more stringent regulations have made this effort an ongoing challenge. Sulfur emissions may contain oxidized sulfur, such as SO_2 and SO_3 or reduced sulfur, H_2S. Desulfurization is also needed to purify a gas stream for further utilization as a chemical feedstock. We have designed a class of mixed metal oxide compositions, derived from hydrotalcite-type clays that can be used for effective abatement of oxidized and reduced sulfur. The primary factors for the effectiveness of these materials are compositions, nano-range crystallites, redox metals, and unique structural domains. If a metal oxide or a mixed metal oxide catalyst is used for the abatement of these pollutants, the material needs to have three functions: 1) chemisorption and transfer of "sulfur" from gas to solid, 2) retention of catalytic properties of the solid to perform other gas phase catalytic

reactions, such as the water gas shift reaction, and 3) effective release of the sulfur for the regeneration of the catalyst. This paper will discuss how these three functions were studied and enhanced by designing novel mixed metal oxide materials for effective desulfurization of hot gases from gasification units and refineries. US Patents 7,759,282; 7,811,474