

Dr. Jennifer Cha
IBM Almaden Research Center

Tuesday, February 26, 2008

Barus & Holley Room 190

1:00 – 2:00 pm

Exploring the Bio-Nano Interface for Recognition and Assembly of Electronic Materials

As nanoelectronic device features shrink towards a critical limit, new research directions have been sought to resolve the resultant technological issues in a cost-effective manner. The ability of Nature to synthesize and assemble materials with high fidelity and precision has provided a potential means of overcoming these formidable challenges. Over the past few years, there have been numerous and extensive efforts to both understand the biological mechanisms for building inorganic and organic architectures and use biological systems to assemble nanoscale materials. New applications of current genetic engineering techniques have also been developed to overcome the difficulties of interfacing biology with non-biological substrates, enabling the use of biomolecular systems for addressing particular challenges in nanoelectronics. The first part of this talk will highlight some of the mechanisms of biomineralization and will in particular focus on the way biosilicates are both synthesized and assembled in Nature. One of the inherent reasons to understand how inorganic materials are produced in living systems is that all of these processes occur under ambient conditions, even those materials that are produced industrially under high temperature and pressure or at extreme pH. I will describe the mechanism by which one biological organism synthesizes highly ordered silica structures at neutral pH and how one can apply these mechanisms to biomimetic approaches using synthetic block copolymers. The understanding of how to chemically control both nucleation and growth of oxides at the nanometer scale led to the synthesis of highly-ordered, two-dimensional nanopatterned ceramic thin films that were used as nanoscale etch masks for producing nanoparticles of phase change materials. A significant amount of research at IBM has also been devoted to exploring nanowires and single walled carbon nanotubes (CNTs) as alternatives to silicon technology. Despite the unique electronic and physical properties of CNTs, however, there exist numerous technological challenges; in particular, the production of entirely semiconducting CNTs of a single or narrow range of band-gaps. The second part of this talk will focus on our recent efforts at the use of DNA to disperse CNTs and bio-combinatorial libraries to discover unique amino acid sequences that can bind a subset of dispersed CNTs. Specific biomolecular recognition of particular nanomaterials that demonstrate unique physical characteristics may impact applications ranging from nanoelectronics to nanomedicine.

Bio: Jennifer Cha received a BS in developmental cell biology from the University of CA, Berkeley and a Ph.D. in materials chemistry from the University of CA, Santa Barbara in 2001. Her thesis work, under the guidance of Professors Galen Stucky, Dan Morse and Tim Deming investigated the biomineralization processes of a marine biosilicate and the findings were later applied to biomimetic syntheses of ordered silica structures. Following her doctoral studies, she worked for a year as a postdoctoral researcher for Prof. Paul Alivisatos at UC Berkeley where she investigated methods to assemble discrete nanoparticle arrays using DNA and proteins. She joined the IBM Almaden Research Center in 2004 as a research staff member, where she began an interdisciplinary program working at the interface between biology and electronic based materials. Her main research interests are the synthesis and assembly of nanoscale materials using both bio-mediated and bio-inspired approaches.