The 2010 Jerome B. Cohen Distinguished Lecture Series

Dr. Joanna Aizenberg
Professor, Harvard University

Actuated "spiny" surfaces à la echinoderms: En route for adaptive materials

Wednesday, May 12, 2010 **4 :00 p.m.** **Tech, Lecture Room 3**

The ability of organisms to respond to various stimuli provides an inspiration for a modern engineering and science that seek to develop a new generation of materials with dynamic, adaptive properties. I will describe the synthesis, fabrication and characterization of new hybrid nano/micro-structures that mimic the echinoderm skin. We demonstrate that these spiny surfaces can be reversibly actuated and assembled into a variety of previously unseen structures with uniform, periodic or chiral nano/micro-patterns. The application of these structures in the context of new materials with reversible optical and wetting properties, as a multifunctional platform for controlling cell differentiation and function, and as an efficient particle-trapping and adhesive system will be discussed.

Creatures that see through their bones and illuminated glass houses of the deep: Lessons in optics and mechanics from marine organisms

Thursday, May 13, 2010 **4:00 p.m.** **Tech, Ryan Auditorium**

Even the most advanced designs made by humans are often primitive relative to the systems that have evolved in Nature. I will describe two natural optical structures – microlens arrays formed by brittlestars and waveguides formed by deep-sea glass sponges. We believe that these unique biological materials, whose hierarchical architecture and hybrid character are optimized for both mechanical and optical properties, offer invaluable lessons in the design of advanced, multifunctional materials and devices. Several bio-inspired architectures will be discussed.

Bio-Inspired Approaches to Crystal Design

Friday May 14, 2010 **4:00 p.m.** **Tech, Lecture Room 2**

Nature produces a wide variety of exquisite mineralized tissues fulfilling diverse functions, and often from simple inorganic salts. Organisms exercise a level of molecular control over the physico-chemical properties of inorganic crystals that is unparalleled in today's technology. This reflects directly or indirectly the controlling activity of biological organic surfaces that are involved in the formation of these materials. Biomineralization occurs within specific microenvironments, which implies stimulation of crystal formation at certain interfacial sites and relative inhibition of the process at all other sites. Our approach to artificial crystallization is based on the combination of the two latter concepts: that is, the use of organized organic surfaces patterned with specific initiation domains on a sub-micron scale to study and orchestrate the crystallization process. This bio-inspired engineering effort made it possible to achieve a remarkable level of control over various aspects of crystal nucleation and growth, including the precise localization of particles, nucleation density, crystal sizes, morphology, crystallographic orientation, arbitrary shapes, microstructure, stability and architecture. The ability to construct large, defect-free, micropatterned single crystals with controlled microporosity, periodic arrays of uniform, oriented crystals or films presenting patterns of crystals offers a new synthetic methodology to materials engineering.

Joanna Aizenberg, Amy Smith Berylson Professor of Materials Science; Professor of Chemistry and Chemical Biology and Radcliffe Professor at Harvard University, pursues a broad range of research interests that include biomineralization, biomimetics, self-assembly, smart materials, crystal engineering, surface chemistry, nanofabrication, biomaterials, biomechanics and biooptics. She received the B.S. degree in Chemistry in 1981, the M.S. degree in Physical Chemistry in 1984 from Moscow State University, and the Ph.D. degree in Structural Biology from the Weizmann Institute of Science in 1996.

Prior to her appointment at Harvard, Aizenberg was at Bell Labs/Lucent Technologies. She made several pioneering contributions, including the development of new biomimetic approaches for the synthesis of ordered mineral films with highly controlled shapes and orientations; and the discovery of unique optical systems formed by organisms (microlenses and optical fibers) that outshine their technological analogs.

Aizenberg's selected awards include:

- Fred Kavli Distinguished Lectureship in Nanoscience, Materials Research Society 2009;
- Van't Hoff Award Lectureship, Dutch Royal Academy, 2009;
- Ronald Breslow Award for the Achievement in Biomimetic Chemistry, ACS 2008;
- Industrial Innovation Award, American Chemical Society 2007;
- Lucent Chairman's Award, 2005;
- New Investigator Award in Chemistry and Biology of Mineralized Tissues, 2001;
- Arthur K. Doolittle Award, American Chemical Society 1999;
- Award of the Max-Planck Society in Biology and Materials Science, 1995.

Aizenberg is a AAAS Fellow; she has served at the Board of Directors of the Materials Research Society and at the Board on Physics and Astronomy of the National Academies. She is serving on the Advisory Board of *Langmuir* and *Chemistry of Materials*.