

University of Pittsburgh

Petersen Institute of NanoScience and Engineering Seminar

Speaker: Professor Paul Weiss

Department of Chemistry, Penn State University

Title: *Designing, Measuring and Controlling Molecular- and Supramolecular-Scale Properties for Molecular Devices*

Time/Date: 12:00 noon, Thursday, September 4, 2008
(refreshments at 12:00noon - 12:15pm)

Place: Kresge Conference Center, 1175 Benedum Hall

We use molecular design, tailored syntheses, intermolecular interactions and selective chemistry to direct molecules into desired positions to create nanostructures, to connect functional molecules to the outside world, and to serve as test structures for measurements of single or bundled molecules. Interactions within and between molecules can be designed, directed, measured, understood and exploited at unprecedented scales. We look at how these interactions influence the chemistry, dynamics, structure, electronic function and other properties. Such interactions can be used to advantage to form precise molecular assemblies, nanostructures, and patterns, and to control and to stabilize function. These nanostructures can be taken all the way down to atomic-scale precision or can be used at larger scales. We select and tailor molecules to choose the intermolecular interaction strengths and the structures formed within the film. We employ some of these approaches in directed assembly to enable bioselective and biospecific binding. We also selectively test hypothesized mechanisms for electronic switching by varying molecular design, chemical environment, and measurement conditions to enable or to disable functions and control of these molecules with predictive and testable means. Critical to understanding these variations has been developing the means to make tens to hundreds of thousands of independent single-molecule measurements in order to develop sufficiently significant statistical distributions, comparable to those found in ensemble-averaging measurements, while retaining the heterogeneity of the measurements. We quantitatively compare the conductances of molecule-substrate junctions. We demonstrate the importance of these junctions in conductance switching of single molecules. We now apply these strategies to photo-driven, electrochemically-driven, and chemically-driven motion in single molecules and assemblies. This enables us to address how concerted nano-scale motions can be used to drive motion at larger scales. The atomic-scale details provide surprising and useful insights into the limitations and opportunities of cooperative motion.

Biographical Sketch

Dr. Paul S. Weiss was born in Ithaca, NY. He received his S.B. and S.M. degrees in chemistry

from MIT in 1980 and his Ph.D. in chemistry from the University of California at Berkeley in 1986. He was a post-doctoral member of technical staff at Bell Laboratories from 1986-1988 and a Visiting Scientist at IBM Almaden Research Center from 1988-1989. He is currently Distinguished Professor of Chemistry and Physics at the Pennsylvania State University, where he began his academic career as an assistant professor in 1989. He is also a member of Penn State's Huck Institutes of the Life Sciences, Institute of Neuroscience, and Materials Research Institute. His interdisciplinary research group includes chemists, physicists, biologists, materials scientists, electrical and mechanical engineers, and computer scientists. Their work focuses on the atomic-scale chemical, physical, optical, mechanical and electronic properties of surfaces and supramolecular assemblies. He and his students have developed new techniques to expand the applicability and chemical specificity of scanning probe microscopies. They have applied these and other tools to the study of catalysis, self- and directed assembly, physical models of biological systems, and molecular and nano-scale electronics. They work to advance nanofabrication down to ever smaller scales and greater chemical specificity in order to connect, to operate, and to test molecular devices. He has published over 200 papers and patents, and has given over 350 invited and plenary lectures.

Since coming to Penn State, Weiss has been awarded a National Science Foundation Presidential Young Investigator Award (1991-1996), the Scanning Microscopy International Presidential Scholarship (1994), the B. F. Goodrich Collegiate Inventors Award (1994), an Alfred P. Sloan Foundation Fellowship (1995-1997), the American Chemical Society Nobel Laureate Signature Award for Graduate Education in Chemistry (1996), a John Simon Guggenheim Memorial Foundation Fellowship (1997), and a National Science Foundation Creativity Award (1997-1999). He was elected a Fellow of: the American Association for the Advancement of Science (2000), the American Physical Society (2002), and the American Vacuum Society (2007). He received Penn State's University Teaching Award from the Schreyer Honors College (2004), was named one of two Nanofabrication Fellows at Penn State (2005-), and won the Alpha Chi Sigma Outstanding Professor Award (2007). He was a Visiting Professor at the University of Washington, Department of Molecular Biotechnology from 1996-1997 and at the Kyoto University, Electronic Science and Engineering Department and Venture Business Laboratory in 1998 and 2000. Weiss has been a member of the editorial boards of *Review of Scientific Instruments* (2000-2005) and other journals, the American Vacuum Society Nanoscience and Technology Division Executive Committee (2001-2003) and the U.S. National Committee to the International Union of Pure and Applied Chemistry (2000-2005). He is the Technical Co-chair of the Foundations of Nanoscience Meetings, and the Chair of the next International Meeting on Molecular Electronics. He was the Senior Editor of *IEEE Electron Device Letters* for molecular and organic electronics (2005-2007), and was recently named the founding Editor-in-Chief of *ACS Nano* (2007-).