University of Pittsburgh

Petersen Institute of NanoScience and Engineering Seminar

Speaker: **Professor Thomas Mallouk**
Department of Chemistry, Penn State University

Title: ***Nanostructural Design of Photocatalysts and Photoelectrochemical Cells***

Time/Date: **1:45 pm, Friday, April 18, 2008**
(refreshments at 1:45 - 2:00pm)

Place: **Kresge Conference Center, 1175 Benedum Hall**

Future solar energy conversion systems (solar cells and solar water splitting catalysts) must be both efficient and inexpensive in order to be competitive with fossil fuels. The dual challenge of high efficiency and low cost presents some interesting technical problems. Inexpensive polycrystalline semiconductor devices and photocatalysts are generally inefficient because of losses due to charge carrier recombination. This talk will describe some new strategies for addressing this problem. Nanocrystals and nanocrystal assemblies offer new ways to control the flow of light and the transport of electrons in photocatalysts and photoelectrochemical cells. Dye-sensitized TiO_2 cells are inexpensive devices for converting light to electrical energy, but their efficiency is low because they do not efficiently utilize the red part of the solar spectrum. By adding photonic crystal light scattering layers, the spectral response of dye sensitized TiO_2 cells can be extended significantly into the red. We have recently fabricated tandem cells from dye-sensitized TiO_2, which absorbs well in the visible, and single crystal Si, which is most efficient in the near-IR. By coupling molecular photosensitizers to nanoparticulate oxygen evolution catalysts, it is possible to make dye-sensitized solar cells that split water with visible light, albeit with low efficiency. This talk will also describe new photoelectrochemical cells based on "bed of nails" arrays of semiconductor nanowires (TiO_2, Si, CdSe), which allow one to separately control the length scales of light absorption and photochemical charge separation.

Biographical Sketch

Dr. Thomas E. Mallouk was born in New York and received an Sc.B. degree in 1977 from Brown University. He was a graduate student at the University of California, Berkeley, and a postdoctoral fellow at MIT. In 1985, he joined the Chemistry faculty at the University of Texas at Austin. In 1993 he moved to Penn State, where he is now DuPont Professor of Materials Chemistry and Physics. He is best known for his work on inorganic self-assembly, and on the chemistry of porous, lamellar, and nanoscale materials. His research has focused on the application of inorganic materials to different problems in solid state and surface chemistry,

including photochemical energy conversion, nanoscale electronics, catalysis and electrocatalysis, chemical sensing, nano- and microscale motors, superconductivity, and environmental remediation. He is the author of approximately 280 scientific publications, including a few good ones, and has also edited three books on chemical sensing and solid state chemistry. He is an Associate Editor of the *Journal of the American Chemical Society* and the director of the Penn State MRSEC, the *Center for Nanoscale Science*.