Stevens Institute of Technology

Nanotechnology Graduate Program

Nature Inspired Materials Science

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Materials Scientists more and more are looking to nature for clues on how to create highly functional materials with exceptional properties. The fog harvesting capabilities of the Namib Desert beetle, the beautiful iridescent colors of the hummingbird, and the super water repellant abilities of the Lotus leaf are but a few examples of the amazing properties observed in the natural world. Nature also makes extensive use of the pH-dependent behavior of weak functional groups such as carboxylic acid and amine functional groups. This presentation will explore synthetic mimics to the nano- and microstructures responsible for these fascinating properties. For example, we have demonstrated a pH-induced porosity transition that can be used to create porous films with pore sizes that are tunable from the nanometer scale to the multiple micron scale. The pores of these films, either nano- or micropores, can be reversibly opened and closed by changes in solution pH. The ability to engineer pH-gated porosity transitions in heterostructure thin films has led to the demonstration of broadband anti-reflection coatings that mimic the anti-reflection properties of the moth eye and pH-tunable Bragg reflectors with a structure and function similar to that found in hummingbird wings. In addition, the highly textured honeycomb-like surfaces created by micron-scale pores are ideally suited for the creation of superhydrophobic surfaces that mimic the behavior of the self-cleaning lotus leaf. The development of synthetic “backbacks” on immune system cells that may one day ferry drugs to disease sites will also be discussed.

Michael F. Rubner is the TDK Professor of Polymer Materials Science and Engineering within the Department of Materials Science and Engineering at MIT. He has also been the Director of MIT’s Center for Materials Science and Engineering, one of the largest NSF supported Materials Research Science and Engineering (MRSEC) programs, for ten years. Rubner received his Ph.D. from the Department of Materials Science and Engineering at MIT (1986). While pursuing his undergraduate and graduate degrees he worked as a full-time staff member in GTE Laboratories, accruing a total of over twelve years industrial experience before accepting a faculty position at MIT in 1986. Rubner has received all of the major teaching awards given at MIT and was named a MIT MacVicar Teaching Fellow in 1996. He has given more than 200 invited lectures including the Robert Maddin Lecture in Materials Science at Penn (2010), the GE Distinguished Lecture at RPI (2009), the Bayer Distinguished Lecture at the University of Pittsburgh (2005), and the Dow Distinguished Lecture at Northwestern (1995). He has published more than 200 technical papers, including five 1995-1999, he was US Editor of Supramolecular Science. He currently serves on the Board of Directors for the Materials Research Society, and the Advisory Boards of the Brookhaven National Lab and the ACS Chemistry of Materials Journal. His research contributions have played an important role in defining and shaping the fundamental and technological landscape of this area and have resulted in the development of new PEM-based technologies. His current interests include investigations of molecularly assembled PEM thin films as multifunctional coatings that provide new capabilities in the areas of thin film optics, extreme surface wetting behavior and biomaterial interface design.

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