Physical Chemistry Seminar

Tuesday, March 12, 2013 | **11:00 am** | **Room 1315 Chemistry Building**

Directed Self-Assembly of Block Copolymers Using Magnetic Fields and Electrospray Deposition on Controlled Surfaces

Professor Chinedum O. Osuji

Dept. of Chemical & Environmental Engineering
Yale University

Host: Professor Mahesh Mahanthappa

Block copolymers provide easy access to nm-scale features by self-assembly. Coupled with their readily tunable physical, chemical and biological properties, this suggests broad technological utility in areas ranging from optical devices to energy generation and separations membranes. Many of these applications however have consistently remained out of reach of polymer science. This is largely due to the inability to reliably control block copolymer self-assembly over large areas with arbitrary choice of alignment. We consider two promising approaches for overcoming this challenging issue. The first entails the use of high magnetic fields for aligning appropriately functionalized block copolymers. The field interaction with the block copolymer occurs via the magnetic anisotropy of mesogenic species bound to the polymer backbone. We identify regimes where alignment can be achieved with high fidelity and propose frameworks to rationalize the physical response of various systems. Examples of functional materials are highlighted, including aligned semiconducting block copolymers, nanoporous membranes and ion conducting films. In the latter two cases, we address the key issue of tortuosity reduction and its impact on transport properties relative to expectations based on theoretical treatments. The second approach involves delivery of sub-attoliter droplets by electrospray to grow ordered films with morphologies dictated by the nature of the growth surface. This process effectively serves as an approximation of physical vapor deposition for polymers, with growth rates in the range of 0.5-5 nm/min. We examine the role of substrate selectivity, temperature and other process parameters on the block copolymer microstructure. We show that carefully engineered surfaces can be used effectively to tune morphology, even in thick films, provided that deposition is conducted under substrate-equilibrated conditions.

Refreshments will be available prior to the seminar at 10:45 a.m. outside room 1315

Graduate Students may meet with the speaker at 1:00 p.m. in Room 8335