



MATERIALS DEPARTMENT & MRL
JOINT COLLOQUIUM
Friday, February, 15, 2013
4:00 PM, ESB 1001



LANGE LECTURER

LIGHT REFRESHMENTS WILL BE SERVED BEFORE THE SEMINAR AT 3:45
HOSTED BY: PROFESSORS ED KRAMER & MICHAEL CHABINYC



Professor Chinedum O. Osuji

Department of Chemical and Environmental Engineering,
Yale University

Research Interests

The physics and physical chemistry of soft matter - studying and elucidating self-assembly and basic structure-property relationships of colloids, liquid crystals, polymers and biological materials.

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

Abstract

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 electro spray 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. Finally, the prospect of realizing true single crystals of block copolymers by combining orthogonal fields or methods is discussed.