BIG energy seminar series

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"Magnetic Fields and Soft Matter - Functional Materials for Energy Applications by Directed Self Assembly of Block Copolymers, Nanowires and Surfactant Mesophases"

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Location: Duane Physics D142

Abstract:
The ability to transform matter that displays novel physics and properties into useful materials and devices is indivisibly linked to the ability to reliably control structure on length scales of interest. While this has been well advanced in hard materials, by contrast, the generation of self-assembled soft matter with arbitrary orientations on length scales beyond 1 mm remains surprisingly challenging. An important goal in this context is the development of approaches that enable reliable control of morphology in thin films of microphase separated block copolymers (BCPs) and polymer nanocomposites. For a broad spectrum of applications ranging from separations membranes to photovoltaics, the need in particular is for control over the out-of-plane ordering of the system, such as in the production of vertically aligned nanostructures. Under appropriate conditions, magnetic fields offer a simple route to directing self-assembly of purely diamagnetic soft matter systems over large length scales in the above described manner. Here I discuss the interaction of magnetic fields with various soft mesophases and the conditions which enable effective alignment. Key points are addressed including degeneracy of alignment and overcoming interfacial effects. The role of magnetic fields on order-disorder transitions in block copolymers is examined using novel in-situ scattering studies of systems under high fields. Examples of functional material systems for energy generation and water purification are highlighted.

Biosketch:
Chinedum Osuji is an Associate Professor in the Department of Chemical and Environmental Engineering. Prof. Osuji received his B.S. in Materials Science and Engineering from Cornell University with a senior thesis on the use of random copolymers for polymer interface reinforcement supervised by Prof. Edward J. Kramer. He received his PhD in Materials Science and Engineering from MIT in 2003 for studies of structure-property relationships and self-assembly of liquid crystalline block copolymers, supervised by Prof. Edwin L. Thomas. After leaving MIT, Prof. Osuji spent 2.5 years working as a Senior Scientist at a start-up company, Surface Logix Inc., where he conducted research on the use of soft lithography, microfluidics and surface patterning for the fabrication of cell-based assays, planar waveguides and other applications. Prof. Osuji conducted post-doctoral work on shear induced structure formation and dynamics of colloidal gels with Prof. David A. Weitz in Applied Physics at Harvard from 2005-2007.

In 2007, he joined the faculty at Yale University. He leads an experimental research group focused on structure and dynamics of soft matter and complex fluids. Topics of interest include structure-property relationships in ordered soft materials, directed self-assembly of block copolymers and other soft mesophases, rheology and slow dynamics of disordered systems, and the role of particle deformability on suspension rheology. Highlights of ongoing work include the development of self-assembled polymer nanocomposites for use as active layers in hybrid organic solar cells, fabrication of polymer membranes for selective transport by directed self-assembly, the design of microfluidic mimics of vascular structures for model studies of red blood cell mechanics, and elucidation of shear thickening and shear-induced structuring in particulate suspensions. These efforts have important implications in energy generation, water purification, the design of microfluidic assays for cell health and the handling of particulate laden complex fluids, as relevant in the manufacture of many consumer products such as shampoos, toner inks and cosmetics. Prof. Osuji is the recipient of the CAREER award of the National Science Foundation (2008) and the Arthur Greer award of Yale College. He received the Office of Naval Research's Young Investigator award and 3M Nontenured Faculty awards in 2012.

Prof. Osuji is from Trinidad and Tobago and completed his schooling there before coming to the US for college. He represented his country in Taekwondo at the Olympic Games in Athens in 2004, before retiring from international competition in 2007. Apart from Taekwondo, Prof. Osuji enjoys playing chess and keeping up with technology.

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