Department of Electrical and Computer Engineering

Center for Integrated Bio and Nano Systems
Friday, September 22, 2017
11:15 a.m. (Refreshments served at 12:15 pm)
Room: CBB 104

Directed Self-Assembly (DSA) Methods for Block Copolymers and Nanoparticles Thin Films: Fundamentals and Applications

Alamgir Karim
Dow Chair Professor
Department of Chemical and Biomolecular Engineering
University of Houston, TX 77004

Abstract Facile directed self-assembly (DSA) of multicomponent thin films is important for potential technological applications, from nanophotonics for light harvesting to membranes for purifying water. DSA requires fine control of a complex interplay of processing parameters that need to be properly optimized for different organized structures. This first part of the talk will give an overview of some of our successes towards realizing tunable DSA approaches to soft matter multicomponent thin film systems involving a host of thin film phenomena – dewetting, phase separation, and crystallization amongst others. In the latter part, there will be more focused discussions on how two DSA methods developed in-house are applied to create unique nanostructured material films. The use of zone-annealing with soft-shear (ZA-SS, from creating highly anisotropic nanoparticle arrays to ordered lamellar PS-PMMA diblock copolymer films with capacitive energy storage comparable to industry standard bi-axially oriented polypropylene (BOPP) will be presented. Another DSA technique developed in-house, direct immersion annealing (DIA) has been used to order nanoparticle filled block copolymer films by dipping the films into controlled solvent quality mixtures. The addition of nanoparticles to polymer films is a strategic approach to enhance film properties such as optical, thermal, hardness, conductivity, permeability etc. For its applications in roll-to-roll polymer processing, the "annealing" of block copolymers while immersed directly in a chamber of solvent is examined in-situ by neutron scattering. Ordering of such highly loaded nanofilled block copolymer films can occur in as little as 30s, with added advantage of sharper interface than melt annealing, and with half domain spacing! Finally, a recently observed phenomena of confinement driven entropic order and nanopatterning of polymer grafted nanoparticles (PGNP) in similar and dissimilar polymer matrices in melt state will be discussed (PNAS, in-press). A high density of nanoparticles of different types ranging from metallic to inorganic to organic were patterned almost exclusively into channels via topographical soft confinement using entropic forces. Enthalpic interactions between the nanoparticle grafted layer and the polymer matrix could be used as a further handle to tune the directed assembly of the nanoparticles. The phenomena will be discussed in terms of confinement parameters, partition coefficient, free energy gain and entropic versus enthalpic interactions.

Bio: Alamgir Karim obtained his Ph.D. in Physics from Northwestern University in Illinois in 1992 under the guidance of Drs. Tom Russell and Gian Felcher. He did a post-doc with Profs. Matt Tirrell and Frank Bates in Chemical Engineering at University of

Minnesota from 1992-1994, before joining the Polymers Division at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland. He was Group Leader of Polymer Blends, Combinatorial Methods and Nanomaterials Group at NIST (Director of the NIST Combinatorial Methods Center from 2000-2004), and the Nanomaterials Group. In 2008, he was appointed Goodyear Chair Professor of Polymer Engineering, and till 2015, Co-Director, Akron Functional Materials Center at University of Akron, while holding administrative positions of Associate Dean of Research and Institute Director. He joined University of Houston in September 2017 as Dow Chair and Director of Doctoral Materials Program in Department of Chemical and Biomolecular Engineering. His areas of interest and research include polymer blends, polymer nanocomposites, elastomers, block copolymers, as well as polymer thin films and processing methods for functional applications in energy, water and sustainability. He has published over 200 papers (h-index 56) and edited several books in these areas of polymer research, and organized several international conferences on these topics. He is a Fellow of the American Physical Society (APS) as well as Fellow of American Association for the Advancement of Science (AAAS) and recipient of Keck Foundation Award.

Contact Prof. Yan Yao (yyao4@central.uh.edu) if you would like to arrange for a time to meet with Dr. Karim