

CHEMICAL ENGINEERING

DISTINGUISHED YOUNG SCHOLARS SERIES



YEKATERINA ROKHLENKO

Monday, July 17, 2017

Graduate Student
Yale

Magnetic Field Alignment of Coil-Coil Block Copolymers and Blends via Intrinsic Chain Anisotropy

ABSTRACT: Block copolymers, macromolecules in which one or more homopolymer chains are covalently bonded together, possess a rich phase behavior as a function of readily tunable variables such as constituent chemistry, relative block composition, and temperature. Due to the immiscibility of the 'blocks' that make up block copolymers, they can self-assemble into various geometries with periodic length scales of 5-100 nm. The accessibility of these small length scales coupled to continually improving synthetic capabilities make block copolymers an attractive class of materials for both existing and emerging technologies. Some promising applications include membranes for size and chemo-selective transport, templates for synthesis, organic photovoltaic devices and next-generation lithography.

Most applications of block copolymers require their periodic features, such as cylindrical or lamellar microdomains, to be oriented uniaxially over macroscopic areas. This need has led to broad interest in studying the fundamental physical processes involved in driving and directing their self-assembly. Thus, there has been extensive work using a variety of methods for orienting block copolymer features, including, but not limited to, solvent-vapor annealing, application of shear, electric,

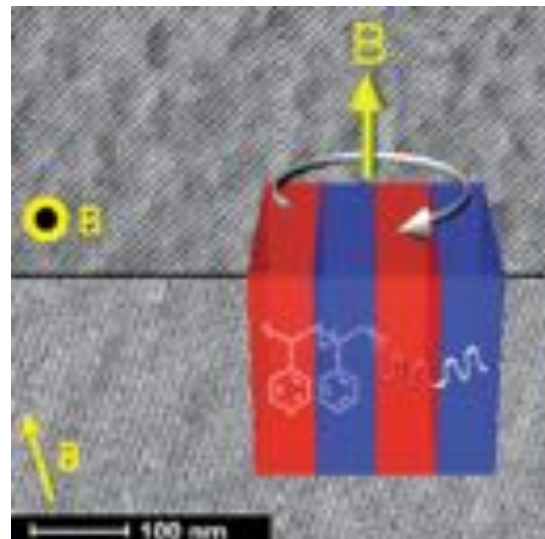


Figure 1 Cartoon (foreground) and transmission electron microscopy images (background) of a PS-*b*-P4VP block copolymer which has been aligned in the magnetic field

and magnetic fields, and chemical and topological patterning. In this work, we focus on magnetic field driven self-assembly, which does not require direct contact with the material and allows for arbitrary field orientations relative to the sample over large areas.

Magnetic field alignment of block copolymers has typically relied on the presence of liquid crystalline (LC) or crystalline assemblies to provide sufficient magnetic anisotropy to drive alignment. In our recent work, we show that alignment is also possible in poly(styrene-*b*-4-vinyl pyridine) (PS-*b*-P4VP), a simple coil-coil block copolymer due to intrinsic chain anisotropy. In this talk, I will introduce and rationalize these novel results in terms of the thermodynamic driving force for field alignment, discussing the roles of field strength, cooling rate, grain size, and constituent chemistry¹. Expanding upon our original result, we can now leverage intrinsic chain anisotropy to magnetically direct the self-assembly of many non-LC systems, including other coil-coil block copolymers like PS-*b*-PDMS and PS-*b*-PMMA, blends of block copolymers of disparate morphologies and molecular weights, and blends² of block copolymers with homopolymers. This is noteworthy as blends of PS-*b*-P4VP with poly(ethylene)glycol (PEG) provide a route to form functional materials such as nanoporous films by dissolution of PEG, and aligned ion conduction materials. We survey these various systems using in-situ X-ray scattering and transmission electron microscopy to study the phase behavior and temperature-, time- and field- dependent dynamics of alignment, highlighting fundamental insights and opportunities for novel applications.

BIOGRAPHY: Yekaterina Rokhlenko is a 5th year PhD student in Chinedum Osuji's group at Yale University. She received a B.A. in Chemistry from Cornell University in 2012 and then worked for 9 months at NYU as a researcher studying oxidative DNA damage. Her research interests have since diverged, and she is currently studying the physical phenomena which drive magnetic field alignment of block copolymers. Outside the lab, she regularly swims and plays volleyball, and competes in the occasional triathlon.

LECTURE 4:00 - 5:00 (PAA) A110
Happy Hour in Benson Hall Lobby Following

W **CHEMICAL ENGINEERING**
UNIVERSITY of WASHINGTON
Knowledge and solutions for a changing world