

Michigan State University
Science at the Edge
Engineering Seminar

October 24th, 2014

11:30 a.m.

Room 1400 Biomedical and Physical Sciences Building

Refreshments served at 11:15 a.m.

Richard A. Register

Department of Chemical and Biological Engineering

Princeton University, Princeton, NJ

Block Copolymer Thin Films:

Structure, Shear Alignment, and Applications in Nanofabrication

Abstract

Block copolymers have been extensively studied for their ability to self-assemble into microdomain morphologies such as spheres, cylinders, and lamellae, with typical periodicities of 20-60 nm. Similar structures form when block copolymers are deposited as thin films on substrates; these films can serve as excellent templates for nanofabrication, where the block copolymer's nanodomain structure is faithfully reproduced in an inorganic material—but the final array of inorganic objects is, at best, only as good as the structure of the film from which it was derived. Consequently, we have worked intensively to develop methods to manipulate the structure of the films. For example, the polygrain structure normally formed by these nanodomains can be transformed to a single-crystal texture, over macroscopic areas, by a simple shearing process. Shear can also realign the domain orientation locally in films with an otherwise macroscopic orientation; create complex orientation patterns on the millimeter scale; and even transform spheres into cylinders. We have employed these thin, substrate-supported block copolymer films to fabricate dense arrays of 20-40 nm metal or semiconductor particles: dots (from sphere-forming block copolymers) or lines (wires, from cylinder-formers), all with a size and spacing set through block copolymer molecular weight. Such shear-aligned thin-film templates can also be stacked to produce square, rectangular, or rhombic grids. As a particular example, we have used this approach on shear-aligned films containing in-plane cylinders to fabricate centimeter-scale arrays of parallel nanowires; due to their fine pitch, such wire grids can polarize an exceptionally broad range of wavelengths extending down into the deep ultraviolet (for 193 nm photolithography), with 90% or better efficiency.

Bio

Richard A. Register is Eugene Higgins Professor and Chair of the Department of Chemical and Biological Engineering at Princeton University, where he previously served as Director of the Princeton Center for Complex Materials, a broad-based Materials Research Science and Engineering Center funded by the National Science Foundation. His research interests revolve around micro- and nanostructured polymers, such as block copolymers, polymer blends, semicrystalline polymers, and ionomers, ranging across their physics, synthesis, characterization, and applications. He was named a Fellow of the American Physical Society in

2001; received the Charles M.A. Stine Award from the American Institute of Chemical Engineers in 2002; was honored with the Graduate Mentoring Award from Princeton University in 2008; and was named a Fellow of the American Chemical Society in 2012.

For further information please contact Prof. Christina Chan, Department of Chemical Engineering and Materials Science at krischan@egr.msu.edu

Persons with disabilities have the right to request and receive reasonable accommodation. Please call the Department of Chemical Engineering and Materials Science at 355-5135 at least one day prior to the seminar; requests received after this date will be met when possible.