

# Carnegie Mellon

## Materials Science and Engineering Seminar Series

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*“Directed assembly of block copolymer films on lithographically-defined chemically nanopatterned surfaces”*

**Friday, January 14, 2011  
11:30 AM Seminar in Scaife Hall 125**

Self-assembling block copolymers form dense periodic arrays with dimensions and spacing of domains from  $\sim 5$  to 50 nm. Using the domain structure of thin copolymer films to create templates for patterning is termed block copolymer lithography. Many important applications of this technology capitalize on creation and processing of dense periodic features of roughly uniform dimensions, albeit with many defects. In these applications, however, block copolymer lithography has only a superficial relationship to optical or electron beam lithography. Lithography, as currently practiced for nanomanufacturing of integrated circuits, for example, requires essentially defect-free patterns, control over feature dimensions and shapes with molecular-level tolerances, and precise placement of each patterned feature with respect to the features in the same and underlying and overlying layers. For block copolymers to have an impact in lithography by this definition, each block copolymer domain must be assembled so as to define individual device elements.

Here we experimentally and theoretically investigate the structure of the block copolymer film as a function of the interfacial energy between the blocks of the copolymer film and the regions of the lithographically-defined chemical pre-patterns. Assembly may be undertaken under conditions in which the density of features in the domain structure of the film is greater than that of the chemical pre-pattern. Using cylinder-forming polymers with the domains oriented perpendicular to the substrate, for example, we report the interplay between block-pattern interfacial energy, defects, density multiplication factor, material and pattern geometrical commensurability, and regularity of domain size and location. For lamellae-forming systems, many bulk- and non-bulk-like morphologies assemble as a function of block-pattern interfacial energy and pattern geometry. Under conditions in which domains are oriented perpendicular to the substrate and define grating structures, we elucidate the interfacial energy parameters for desired shapes and dimensions of the nanostructures. The results are presented in the context of fabrication strategies for bit patterned media and nanowire array field effect transistors.

**Paul F. Nealey** is currently the Shoemaker Professor of Chemical and Biological Engineering at the University of Wisconsin (UW), and is the Founding Director of the National Science Foundation-funded UW Nanoscale Science and Engineering Center in Templated Synthesis and Assembly at the Nanoscale. His research interests include nanofabrication techniques based on advanced lithography and directed self-assembly, development of imaging materials for alternative lithographic strategies, and dimension dependent material properties of nanoscopic macromolecular structures. He is a fellow of the American Physical Society, and has received the National Science Foundation Career Award, the Camille Dreyfus Teacher-Scholar Award, the University of Wisconsin Romnes Fellowship, and the Arthur K. Doolittle Award from the American Chemical Society.