

Thermodynamics and kinetics of block copolymer assembly on chemically patterned surfaces
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Critical research questions that remain to be fully addressed in the development of materials and processes for directed self-assembly (DSA) relate to the fundamental understanding of the origin of defects, and quantitative determination of the three-dimensional structure in the assembled films. Thermodynamic analysis of DSA yields valuable information about 1) the nanoscale structure of block copolymer films that assemble in the presence of directing templates, for example chemical patterns of differing geometry and chemistry, and 2) the theoretical limit of expected numbers of defects. For templates in DSA that result in materials architectures that are useful for pattern transfer, the thermodynamic analysis predicts a theoretical limit of zero defects. Kinetic analysis of DSA yields valuable information about the evolution of structure during processing, and the likelihood of kinetically trapping metastable defective states as a function of materials properties and boundary conditions, and the time frame for assembly. Here we will present the thermodynamic and kinetic analysis of DSA processes being implemented in manufacturing relevant settings at IMEC and at HGST, a Western Digital Company. The discussion will focus on the potential for those processes to meet the constraints for semiconducting manufacturing and fabrication of nanoimprint templates for bit patterned media. Finally, we will describe exciting new developments in advancing our fundamental understanding of DSA based on x-ray scattering techniques to capture the details of the three-dimensional structure of assembled block copolymer films.