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Control of Ordering Kinetics and Morphology using Zone Annealing of Thin Block Copolymer Films[1] ALAMGIR KARIM, BRIAN BERRY, RONALD JONES, NIST — A primary limitation of block copolymer (BCP) films as directed templates for advanced lithography or nanoporous membranes for energy storage is the prohibitively long times required for thermally directed self-assembly. We explore the use of zone annealing as a method to control both the kinetics of ordering as well as the resulting morphology in thin block copolymer films. Inspired by earlier results of Hashimoto and co-workers, films are processed by a moving hot-cold temperature gradient zone, hot being below the order-disorder transition temperature but above the glass transition temperature. A significant increase in the ordering kinetics of the BCP was observed, where morphologies characteristic of anneal times approaching a day using isothermal annealing are created in minutes using a moving thermal front. Surface topology persists even when sample velocities are ca. 500 micrometers/second. The mechanisms driving such rapid morphological evolution and the resulting low concentration of defects are explored through a combination of temperature gradients, zone velocity, and surface chemistry. Results from tomographic small angle neutron scattering and scanning probe microscopy demonstrate the relationship of zone velocity and thermal gradient on the formation mechanisms in BCP films.

[1]Control of Ordering Kinetics and Morphology using Zone Annealing of Thin Block Copolymer

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