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Orientation and Lateral Order in Block Copolymer Thin Films
MATTHEW J. MISNER, SEUNG HYUN KIM, THOMAS P. RUSSELL, University of Massachusetts-Amherst, Department of Polymer Sciece and Engineering — Diblock copolymers self-assemble on length scales of a few tens of nanometers into several morphologies. By solvent casting or solvent annealing thin films of polystyrene-b-poly(ethylene oxide), we have demonstrated methods to produce diblock copolymer films with highly oriented, close-packed arrays of nanoscopic cylindrical domains with a high degree of long-range lateral order with few defects. The solvent imparts a high degree of mobility in the microphase-separated copolymer that enables a rapid removal of defects and a high degree of lateral order. Moreover, lateral confinement by topographically patterned surfaces has been utilized to improve long-range order and direct the grain orientation macroscopically. Additionally, we have observed large effects on microdomain orientation expressed by varying relative humidity and salt concentrations. At very low humidity the copolymer exhibits parallel orientation relative to the substrate and at moderate to high humidity perpendicular orientation is observed. Similar results were observed by increasing the salt concentration on the order of a few ions per chain such that at relatively high salt concentrations perpendicular orientation is observed over a full range of humidity.

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