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Effects of Substrate Interactions on Out-of-Plane Order in Thin Films of Lamellar Copolymers[1] INDRANIL MITRA, NIKHILA MAHADEVAPURAM, University of Houston, ALONA BOZHCHENKO, Rice University, JOSEPH STRZALKA, Argonne National Laboratory, GILA E. STEIN, University of Houston — Block copolymer (BCP) thin films are widely studied and applied for low cost, large area nanopatterning of semiconductor devices and has a very low tolerance for both in-plane or out of plane defects. Here we study, defects in lamellar diblock copolymers as a function of film thickness and the types of interactions at the substrate interface. Thin films of poly (styrene-b-methyl methacrylate) (PS-PMMA) with equilibrium periodicity 46nm were prepared and annealed on silicon substrates that were functionalized with a random copolymer P(s-r-MMA) brush. The resulting structures were evaluated with optical, scanning force and, scanning electron microscopy, along with grazing-incidence small-angle X-ray scattering (GISAXS). The in-plane correlation length (OCL) increased with brush grafting density, and increased with distance from the substrate interface. Out-of-plane order improved with brush grafting density, but thick films always contain a high density of mis-oriented domains. Based on these findings, we propose that (1) substrate pinning either induces or traps the mis-oriented domains, and (2) out-of-plane orientation defects are difficult to remove, from a thick film, because the energetic penalty for bending a "tall" domain is very low.

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