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Disordered nanoparticle interfaces for defect-tolerance in the self-assembly of block-copolymers KEVIN YAGER, ALAMGIR KARIM, Polymers Division, National Institute of Standards and Technology, ERIC AMIS, Materials Science and Engineering Laboratory, National Institute of Standards and Technology
— Directed self-assembly is a promising route to controlling the nanostructure and surface properties of coatings. We describe a general and robust strategy for controlling the self-assembly of thin films by tuning the film-substrate interaction, using an inherently defective nanoparticle layer. These tunable surfaces exhibit hierarchical and controllable roughness via spin-coating conditions (20 nm silica nanoparticle solutions), and tunable surface energy via selective oxidation. Independent manipulation of these parameters enables control of self-assembled order for coatings cast on these tunable substrates. In particular, we demonstrate control of the orientation of lamellae in poly(deuterated-styrene-block-methyl methacrylate), with expression of the vertical lamellae orientation under certain conditions. Moreover we demonstrate that the lamellae orientation depends upon film thickness in a periodic manner in the range from 30 nm to 240 nm, which provides insights into the fundamental driving forces in this self-assembly. The proposed assembly orientations are compared with theory and validated by complementary neutron reflectivity and small-angle neutron scattering measurements.

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