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Variable-Density Micelle Arrays in Block Copolymer Thin Films

JOHN PAPALIA, DOUGLAS ADAMSON, RICHARD REGISTER, Princeton University, PAUL CHAIKIN, New York University — Thin films of sphere-forming block copolymers are attractive templates for surface patterning and nanofabrication, offering control over both the sphere (micelle) diameter and their average spacing (areal density). Within a given film, these quantities are statistically uniform: that is, there has not previously been a way to vary the number density of spheres across the film. By contrast, films having a thickness gradient are straightforward to prepare; however, regions of the film whose thickness is not commensurate with an integral number of layers of spheres will spontaneously form micron-scale islands or holes (terraces) of commensurate thickness, and a uniform areal density. By blending the block copolymer with matrix homopolymer, this terrace formation can be suppressed, so that creating a gradient in film thickness will also produce a gradient in micelle density. We employ a polystyrene-polyisoprene diblock copolymer with block molecular weights of PS/PI 68/12 kg/mol, blended with PS homopolymer of varying molecular weights, in gradient films spanning thicknesses from 0-3 layers of spheres. At 50% PS homopolymer, terraces are still observed for homopolymer molecular weights in the “wet brush” region (9-50 kg/mol), but are completely suppressed when the homopolymer is excluded from the micelle coronae (110 kg/mol).

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