



Block Copolymer Thin Films as Nanofabrication Templates

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Microphase separation in block copolymers is at the heart of their utility as thermoplastic elastomers (melt-processable rubbers), and it is well known that the topology of the nanodomain structure—spheres, cylinders, or lamellae of the hard block—has a profound impact on mechanical properties. But the facts that these nanodomain structures can be highly regular (i.e. a body-centered-cubic packing of near-monodisperse spheres), and that the characteristic dimension of these domains can easily be tuned through the block copolymer molecular weight, are rarely exploited. We use block copolymer thin films as templates, where the block copolymer's nanodomain structure is faithfully reproduced in an inorganic material. For example, we have fabricated dense arrays of 20-40 nm metal or semiconductor particles (dots, from block copolymers which form spherical nanodomains) or lines (wires, from cylinder-formers), all with a size and spacing set through block copolymer molecular weight. The polygrain structure that these nanodomains normally form can be transformed to a single-crystal texture, over macroscopic areas, by a simple shearing process. We have used this approach on cylinder-forming block copolymer monolayer films to fabricate centimeter-scale arrays of parallel metallic nanowires, which due to their small size can polarize an exceptionally broad range of wavelengths extending down into the ultraviolet. Shearing can also align bilayers of a sphere-forming block copolymer, which can be further processed to yield ordered arrays of metal dots.

Richard A. Register is Professor and Chair of the Department of Chemical Engineering at Princeton University, and just completed a term as Director of the Princeton Center for Complex Materials, a broad-based Materials Research Science and Engineering Center funded by NSF. His research interests revolve around micro- and nanostructured polymers, such as block copolymers, polymer blends, semicrystalline polymers, and ionomers, ranging across their physics, synthesis, characterization, and applications. He was named a Fellow of the APS in 2001, and received the Charles M.A. Stine Award from the AIChE in 2002. He chaired the APS's Division of Polymer Physics in 2004-2005, served as a Director of the AIChE's MESD (2004-2006), and was a Volume Organizer for the Materials Research Society's MRS Bulletin in 2007.