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John H. Dillon Medal Lecture: Magnetic Field Directed Self-Assembly of Block Copolymers and Surfactant Mesophases¹
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Molecular self-assembly of block copolymers and small molecule surfactants gives rise to a rich phase behavior as a function of temperature, composition, and other variables. We consider the directed self-assembly of such soft mesophases using magnetic fields, principally through the use of *in situ* x-ray scattering studies. Field alignment is predicated on a sufficiently large product of magnetic anisotropy and grain size to produce magnetostatic interactions which are substantive relative to thermal forces. We examine the role of field strength on the phase behavior and alignment dynamics of a series of soft mesophases, outlining the possibility to readily create highly ordered functional materials over macroscopic length scales. We show that magnetic fields as large as 10 T have little discernable impact on the stability of block copolymer systems considered, with shifts in order-disorder transition temperatures of roughly 5 mK or smaller. Consequently, directed self-assembly in these systems proceeds by nucleation of randomly aligned grains which thereafter rotate into registry with the field. We highlight the tradeoff between decreasing mobility and increasing anisotropic field interaction that dictates alignment kinetics while transiting from a high temperature disordered state to an ordered system at lower temperatures.

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