Nonclassical Ordered Nanostructures from Designed Block Copolymers

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The self-assembly of block copolymers provides a powerful platform for the fabrication of rich ordered nanostructures. From the aspect of practical applications, it is more useful to design block copolymers for desired ordered structures. In recent years, my group have been focusing on designing block copolymers to target some nonclassical ordered structures based on the calculations of self-consistent field theory (SCFT). The chain architecture of block copolymers with variable number of blocks and topology has been demonstrated as an important parameter controlling their self-assembly behaviors. Furthermore, blending different block copolymers together also offers an opportunity for stabilizing new phases. With AB-type block copolymers, complex Frank-Kasper spherical phases beyond the classical body-centered-cubic (bcc) phase, square-array cylindrical phase instead of the classical hexagonal phase, and perforated lamellar phase instead of the usual double gyroid phase are predicted. With ABC-type multiblock terpolymers, a large number of binary mesocrystal phases are predicted, including the prototypes of NaCl, CsCl, ZnS, BN, CaF_2, TiO_2, ReO_3, Al_2O_3, Li_3Bi, Nb_3Sn, and even interesting dodecagonal quasicrystalline approximants. The self-assembly mechanisms of these nonclassical phases are also instructive to other soft matter systems.

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