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Modification of Block Copolymers Using Surface-Functionalized Hard and Soft Nanoparticles

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Due to their wide range of available nanostructures, ordered block copolymers provide excellent templating media into which nanoparticles can be incorporated with precise spatial modulation for various nanotechnologies. Previous experimental and theoretical studies have demonstrated that the relative size and selectivity of surface-functionalized inorganic nanoparticles can be used to tune the position of the nanoparticles along interfacial regions or within microdomains. Using a combination of experimental and theoretical methods, we furthermore show that these parameters, in addition to nanoparticle concentration, can be used to controllably alter the phase stability of block copolymers. While nanoparticles typically reduce the order-disorder transition (ODT) temperature of ordered block copolymers, a limited window exists wherein the nanoparticles increase the ODT temperature and stabilize the copolymer nanostructure. This nanoparticle-mediated design is extended in this study to include "soft" nanoparticles composed of core-shell microgels (CSMG) particles, which can be envisaged as permanent micelles. Addition of CSMG particles to ultrathin films consisting of ordered block copolymers varying in morphology and molecular weight is investigated here by electron microscopy.