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Directed assembly of diblock copolymers as a means of achieving functional structures

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Block copolymers have tremendous potential for patterning and assembling functional material architectures at the nanoscale because their constituent, compositionally distinct blocks spontaneously form ordered structures (domains) with dimensions of 3 to 50 nm. The dimensions and shapes of the structures in the bulk represent a delicate balance of interfacial energy between blocks and the configurational entropy of the polymer chains. Unfortunately self-assembly results in the creation of features riddled with imperfection and non-uniformities. Intervention is required to overcome trapping of low energy defects. In our primary research approach, block copolymer films are equilibrated in the presence of chemical surface patterns that 1) have dimensions similar in size to individual domains, and 2) illicit differing interfacial interactions between the surface and the blocks of the copolymer film. By manipulating the geometry of the chemical patterns, and the magnitude of interfacial interactions, we can direct the block copolymer to assemble into two and three-dimensional architectures that have a high degree of perfection and uniformity of dimensions, and at resolution beyond that of traditional lithographic materials and processes. Specific applications of the assemblies will be discussed, including integrated circuits, patterned media, and electronic and photonic devices.