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Directed assembly of block copolymer containing materials on chemically nanopatterned substrates: a platform for two and three-dimensional nanofabrication

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Directed assembly often refers to fabrication strategies that involve the organization of one or more materials on substrates through specific interactions with patterned activated regions. Based on engineered interfacial interactions between lithographically-defined chemically nanopatterned substrates and block copolymer thin films, the domain structure of the films can be directed to assembly into defect free periodic and non-regular structures over large areas, with each structure registered with the underlying substrate. Advantages of integrating self-assembling materials into the lithographic process, particularly for the fabrication of nanoelectronic devices, include sub 1 nm control over feature dimensions, reduced line edge roughness, and the opportunity to scale the approach to pattern at dimensions of 10 nm and below. Exciting opportunities exist to extend the use of self-assembling materials in conjunction with two-dimensionally (2D) patterned activate surfaces for the fabrication complex three-dimensional (3D) materials. Arrays of functional nanoparticles, for example, can be directed to assemble using block copolymer/particle nanocomposites or in a hierarchical process using chemically functional polymers followed by in situ particle synthesis. 3D bicontinuous morphologies in which the two phases of the assembly are readily addressable, a geometrically complex structure, can be created using materials that normally form lamellae and directing them to assemble on chemically patterned surfaces consisting of square arrays of spots. The principal concept of this work is that high value added 3D structures can be created from simple 2D templates, retaining the lithographic properties of perfection and registration for applications where input and output connections to the structures are required.