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Directed Assembly of Nanofilled Polymer Thin Films

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Facile directed self-assembly (DSA) of multicomponent thin films is important for potential technological applications. This requires a fine control of a complex interplay of processing parameters that need to be properly optimized for different organized structures. This talk will discuss some of our recent success towards realizing tunable DSA of soft matter multicomponent systems involving a dispersion of polymer-grafted nanoparticles in block copolymer or homopolymer matrices. DSA methods for such multicomponent films will be discussed. These include the use of zone-annealing with soft-shear to create highly anisotropic nanoparticle arrays, while direct immersion annealing (DIA) has been used to order nanoparticle filled films by dipping the films into controlled solvent quality solvent mixtures. A recently observed phenomena of confinement driven entropic order and phase segregation of polymer grafted nanoparticles in similar and dissimilar polymer matrices in melt state will be discussed. A high density of nano particles of different types ranging from metallic to inorganic to organic were patterned almost exclusively into channels via topographical soft confinement using entropic forces. Enthalpic interactions between the nanoparticle grafted layer and the polymer matrix could be used as a further handle to tune the directed assembly of the nanoparticles. The phenomena will be discussed in terms of confinement parameters, partition coefficient, free energy gain and entropic versus enthalpic interactions.