

Polymer Mediated Interaction between Grafted Nanosheets

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Abstract : Polymer-particle interactions can be effectively utilized to produce composites that possess physicochemical properties superior to that of neat polymer. The incorporation of fillers with dimensions comparable to polymer chain size produces composites with extra-ordinary properties owing to very high surface to volume ratio. The dispersion of nanoparticles is achieved by inducing steric repulsion realized by grafting particles with polymeric chains. A comprehensive understanding of the interparticle interaction between these functionalized nanoparticles plays an important role in the synthesis of a stable polymer nanocomposite. With the focus on incorporation of clay sheets in a polymer matrix, we theoretically construct the polymer mediated interparticle potential for two nanosheets grafted with polymeric chains. The self-consistent field theory (SCFT) is employed to obtain the inhomogeneous composition field under equilibrium. Unlike the continuum models, SCFT is built from the microscopic description taking in to account the molecular interactions contributed by both intra- and inter-chain potentials. We present the results of SCFT calculations of the interaction potential curve for two grafted nanosheets immersed in the matrix of polymeric chains of dissimilar chemistry to that of the grafted chains. The interaction potential is repulsive at short separation and shows depletion attraction for moderate separations induced by high grafting density. It is found that the strength of attraction well can be tuned by altering the compatibility between the grafted and the mobile chains. Further, we construct the interaction potential between two nanosheets grafted with diblock copolymers with one of the blocks being chemically identical to the free polymeric chains. The interplay between the enthalpic interaction between the dissimilar species and the entropy of the free chains gives rise to a rich behavior in interaction potential curve obtained for two separate cases of free chains being chemically similar to either the grafted block or the free block of the grafted diblock chains.

Keywords : clay nanosheets, polymer brush, polymer nanocomposites, self-consistent field theory

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