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How nanoparticle geometry affect the morphological evolution of block copolymers

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Block copolymer (BCP) containing nanoparticles has drawn much attention as novel advanced material in the recent years. However, some aspects of these nanostructured materials including the influence of nanoparticle geometry on the BCP structural development have not been fully understood. In this study, the role of nanoparticle geometry (multi-walled carbon nanotube/graphene nanosheet) on the microphase separation of BCP based nanocomposite material composed of cylindrical forming polystyrene-b-poly(ethylene-butylene)-b-polystyrene (SEBS) has been investigated by means of rheological technique. The results of temperature sweep experiments indicated an enhancing effect of nanoparticles on increasing the BCP microphase separation temperature and accelerating its kinetic which could be explained in terms of confinement of BCP segments. The resulting confinement can lead to domination of segmental enthalpic energy over entropic one which will, in turn, force the microphase separation to occur at higher temperatures. This was evidenced by greater enhancing effect of graphene nanosheets with higher geometrical confinement on microphase separation compared to multi-walled carbon nanotube. Moreover, transient viscoelastic analysis implied the retarding effect of nanoparticles on the orientation and also restructuring of BCP domains as well as nanoparticles whose extent was dependent upon the concentration and also type of nanoparticles. Furthermore, DMTA results indicated that the addition of nanoparticles reduces the interphase area in the favor of increasing the extent of microstructural evolution.

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