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Structuration, selective dispersion and compatibilizing effect of (nano)fillers in polymer blends

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Abstract

Hybrid ternary blends comprising two polymers and one mineral (nano)filler are increasingly studied because they are starting to be widely used to respond to industrial issues. The objective of this review is to gather information on these particular systems. Concerning first thermodynamic effects of fillers on the phase separation of an immiscible polymer blend, Flory-Huggins theory demonstrate stabilization. This theory was particularly taken up and developed for the case of two polymers and one filler by Lipatov and Nesterov in the 90's. More recently, Ginzburg generalized this theory to the case of unfavorable enthalpic interactions between a particle and the two polymers. They showed that the amount of particles had to attain a certain threshold to stabilize the system and the lower the particle radius, the higher the stable zone area. Generally speaking, all the phenomena regarding the morphology of polymer blends are governed by thermodynamics and/or kinetic effects, as well as the localization of nanoparticles. The main discussed thermodynamically controlling parameter of the localization is the wetting parameter ω_{AB} . However, because of the viscosity of the system, the equilibrium dictated by ω_{AB} may never be reached. Hence, concerning the kinetic effects, the final localization of fillers in a polymer pair is guided by the sequence of mixing of the components, the viscosity ratio, the composition, the temperature, the shear rate and the time of mixing. When the particles are placed at the interface between two polymers, coalescence can be suppressed or/and interfacial tension can be reduced. In that case, particles are known to play the role of a compatibilizer. In a ternary system, (i) the shape of the particle (spheres, rods or "onions-shape") (ii) the particle radius (R_p) versus the radius of gyration of the polymers (R_g) (iii) and the surface chemistry of the particles affect the final localization of the particles (thus, the compatibilizing effect) and the final properties of the material, such as mechanical, conductive, magnetic and thermal properties. This review details recent works for which those four above mentioned properties are improved by incorporating different kind of fillers in polymer blends.

Keywords

Polymer blends, nanoparticles, compatibilization, thermodynamics effects, kinetics effects, wettability

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