Rheological Properties of Poly(ethylene oxide)/Silica Nanocomposites

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The properties of polymers can be improved by the incorporation of nano-additives in a polymer matrix, forming nanocomposite materials that often possess innovative physicochemical properties compared to the initial materials and / or the respective conventionally filled systems. In this work, we report on the rheological behavior of different series of poly(ethylene oxide) / silica, (PEO/SiO_2) nanocomposites through oscillatory shear rheology measurements. More specifically, spherical SiO_2 nanoparticles of two different radii (7nm, 67nm), were dispersed in PEO of different molecular weights, in a range of compositions, in order to investigate the effect of the size and concentration of the additives, as well as the effect of the molecular weight of the polymer matrix on the mechanical properties of the nanocomposite material. The good dispersion of the nanoparticles was confirmed via Transmission Electron Microscopy (TEM) whereas the nanocomposite structure and morphology were investigated utilizing X-ray Diffraction (XRD) and Small Angle X-ray Scattering (SAXS). Dynamic frequency sweep tests were utilized to investigate the dynamic response of the material while its linear viscoelastic behavior has been verified by dynamic strain sweep tests. In these series of nanocomposites, the crystallinity of PEO has been found to depend on the spatial confinement caused by the nanoparticles in combination with their adsorption capacity. The effect of the size and concentration of the nanoparticles in conjunction with the different degree of entanglements due to the different polymer molecular weight is examined in an attempt to correlate the rheological response and morphological changes, in order to better understand the relationship between the structure and properties of these series of composite materials.

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