Study of Polymer/Clay Nanocomposite Morphology: A Rheological and Electron Microscopic Approach

Banerjee Saikat, Joshi Mangala, Ghosh Anup K

Understanding of the complex mechanism of dispersion and exfoliation of the clay tactoids may allow us to better control the final morphology and the homogeneity of clay nanocomposites and thus their macroscopic properties. Melt rheology is an important tool to characterize polymer–clay nanocomposites. In the present study, shear-induced clay dispersion in polypropylene matrix was ascertained from the changes of rheological properties under intermediate and large-amplitude oscillatory shear fields as well as by using transmission electron microscopy (TEM). PP-g-MA compatibilizer and Cloisite 15A were melt blended with polypropylene in a co-rotating twin screw extruder at selected screw speed and temperature profile. The effect of ratio of the compatibilizer to the organo-clay (1:1, 2:1, 3:1, 4:1 compositions) on the dispersion was studied. The dispersion behaviour of organoclay in the polymer matrix under oscillatory shear field was assessed through a change in complex viscosity and both the dynamic modulii. It was further supported by frequency dependent viscoelastic spectra, thermal analysis, dielectric spectroscopy and TEM. The main utility of the TEM methodology is to quantify the exfoliated or intercalated clay morphology with small number of layers with stacks. A new methodology was applied to determine the dispersion parameter, based on the measurement of the free-path spacing distance between the single clay sheets from the transmission electron microscopic images. Among all these compositions, the 3:1 compatibilizer to organo-clay ratio showed a better exfoliated morphology.