Characterization of clay dispersion in polymer nanocomposites by rheological and dielectric measurements

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Over the past decades, polymer layered silicate (clay) nanocomposites gained rapidly increasing interest due to their high performance. The clay seems to be favorable for mechanical reinforcement or formation of barrier structure which reduces the diffusive transport of gases or vapors. In this study, polypropylene (PP) /clay composites were investigated in terms of rheological and dielectric properties to define the heterogeneity of clay dispersion in polymer matrix. Clay dispersion was controlled by applying the electric field. The non-terminal behavior in the storage modulus at low frequency was gradually increased with increasing the strength of electric field. And the characteristic peak in X-ray diffraction also disappeared with electric field. Dielectric relaxation analysis showed that different mechanisms originate from different charge distributions of bound ions attached to the clay surfaces. When the clay dispersion increased, the electrode polarization increased in the real part of the complex dielectric (e') constant due to the contribution of ionic conduction. And the conductivity relaxation time decreased with increasing clay dispersion in imaginary part of the electric modulus (M"). The degree of symmetry in M" was found to be related to conductivity relaxation time distribution. Distribution of conductivity relaxation time became narrow as the clay morphology changed from partially intercalated dispersion to exfoliation. Finally, we related clay dispersed morphology in TEM images with dielectric modulus.