128g Novel Polymer Nanocomposites Prepared through Supercritical CO2 Processing: Structure and Mechanical Properties

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Nano-clays, carbon nanotubes, and other nano-scale fillers can have a significant impact on the physical properties of polymers. The degree of enhancement in the properties depend largely on the degree of dispersion (or exfoliation) of the nanoscale fillers. Conventional approaches to achieving layer separation include chemical modification of the clay surface, and reaction polymerization of monomers mixed with clays. Even these approaches typically result in intercalated nanocomposites. Supercritical fluids (SCF) possess significantly reduced viscosities and increased diffusivities, in addition to enhancing the solubilities of polymers and nanofillers. Therefore, we are using supercritical carbon dioxide (scCO2) to achieve clay-clay separation by manipulating the processing conditions, resulting in largely intercalated or exfoliated nanocomposites. The scCO2 process appears to be economical, efficient, and environmentally friendly. The structure of these nanocomposites are investigated and confirmed with WAXD, TEM, and rheology.

We have prepared PS/clay, PVME/clay, and PDMS/clay nanocomposites using scCO2 and investigated the impact of clay morphology on their rheological properties and tensile properties. Compared to intercalated nanocomposites prepared by chemical modification of the clay surface, or solvent-mixed nanocomposites, the scCO2 nanocomposites appear to produce higher degree of clay dispersion, and significantly better mechanical property enhancements. Interestingly, the scCO2 process is efficient at dispersing even natural clay, which has been difficult to achieve by other processes. For example, the shear moduli of the PVME/Clay nanocomposites were enhanced by about a factor of two at high shear frequencies (50 rad/s), whereas at lower frequencies it showed a factor of 10 enhancement. The properties of the scCO2-prepared nanocomposites are being bench marked against those prepared by other techniques. Using rheo-optical techniques, the deformation response of the films are being investigated to understand the matrix polymer and clay orientation.