142f Polyolefin-Organoclay Nanocomposites: Properties, Morphology, and Applications

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Polymer-layered silicate nanocomposites formed from the organically modified clay mineral montmorillonite and related materials have attracted a great deal of technological and scientific interest in the past decade. These composites offer the promise of greatly improved properties over those of the matrix polymer owing to the nanoscale reinforcement and constraints of the polymer caused by dispersing the one nanometer thick, high aspect ratio aluminosilicate layers. However, the key to achieving these benefits is dispersing the organoclay into the polymer matrix to generate high aspect ratio particles. Many factors are involved in achieving a high level of dispersion, or ultimately full exfoliation, but one of the most important is the complex interaction of the polymer matrix with the organoclay. Polyamides exhibit a high level of compatibility with organoclays and as a result, they seem to be one of the few polymer types which readily form well-exfoliated nanocomposites. However, the majority of commercial interest lies in the formation of nanocomposites from low cost polyolefins. Unfortunately, polyolefins seem incapable of exfoliating the organoclays by themselves due to their hydrophobic nature and lack of suitable interactions with the polar aluminosilicate surface of the clay.

Several ways to resolve the difference in polarity between the polyolefin and the clay have been proposed. One of the strategies is to add a small amount of a maleic anhydride grafted polyolefin that is miscible with the base polyolefin as a ‘compatibilizer' between the matrix and filler. This approach has been very well developed for polypropylene based systems, including some commercial applications. Another approach is to copolymerize the olefin monomer with polar monomers like methacrylic acid or acrylic acid. Ionomers, where some of the acid groups of such acid copolymers are neutralized to form sodium, zinc or magnesium salts offer an extension of this option. Optimization of the structure of organoclay is an additional way to increase favourable polyolefin-organoclay interactions. Structural aspects of the organic modifier (surfactant) are known to have a significant effect on exfoliation in nanocomposites based on nylon 6.

This work examines the effects of organoclay structure, matrix modification, and processing conditions on the morphology and properties of nanocomposites prepared from polyethylene type matrices. Nanocomposites prepared from maleic anhydride grafted polyethylene, poly(ethylene-co-methacrylic acid) and poly(ethylene-co-methacrylic acid) ionomers are prepared using a variety of organoclays under a wide range of processing conditions. These are compared to similar nanocomposites prepared from unmodified polyethylene. The potential of such nanocomposites for barrier film applications, high pressure pipes, and injection molded components is also explored.