Layered Silicate-Polymer Nanocomposites

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Natural clays are composed of oxide layers whose thickness is about 1 nm and cations existing between the layers. A number of these layers makes primary particles with a height of about 8~10 nm and these primary particles make aggregates with a size of about 0.1~10 μm. When layered silicate was made to be organophilic, by exchanging the interlayer cations with organic cationic molecules, the matrix polymer can penetrate between the layers to give a nanocomposite, where 1 nm-scale clay layers exist separately in a continuous polymer matrix. These nanostructured hybrid organic-inorganic composites have attracted the great interest of researchers over the last 10 years. They exhibit improved performance properties compared with conventional composites, because their unique phase morphology by layer intercalation or exfoliation maximizes interfacial contact between the organic and inorganic phases and enhances interfacial properties. Since the advent of nylon-6/montmorillonite nanocomposite developed by Toyota Motor Co., the studies on layered silicate-polymer nanocomposites have been successfully extended to other polymer systems. They greatly improved the thermal, mechanical, barrier, and even the flame-retardant properties of the polymers.

Polyurethanes have been widely used in coatings for textiles, leathers, papers, metal and the like, due to their advantageous properties such as their good chemical resistance, abrasion resistance, toughness, and elasticity. In recent years, one of the main environmental concerns in coating technology is how to reduce or totally eliminate the volatile organic compounds currently used in coating compositions. Waterborne polyurethane coating have received increased attention in recent coatings technology development due to such concerns. However, most of these waterborne polyurethane coating systems are less resistant to water or solvent attack, and are substantially more expensive than solvent based systems. Some of these defects of water borne polyurethanes can be improved by hybridizing with other materials.

We prepared the first examples of waterborne polyurethane-layered silicate nanocomposites and observed the properties of the nanocomposites. That is, the nanocomposites of waterborne polyurethane based on poly(hexamethylene carbonate) diol reinforced by organophilic clay was prepared. Exfoliation of silicate layer in polyurethane was confirmed by X-ray diffraction pattern and transmission electron microscopy. Reinforcing effect of clay was examined by observing dynamic mechanical properties, tensile properties, and shore A hardness. The modulus increased as the content of clay in polyurethane matrix was increased, and this increase was more evident when the polyurethane matrix becomes soft at the temperature range above the glass transition temperature. Water swell was decreased and thermal resistance was increased as the content of clay was increased. Reduction of transparency by added clay was marginal.