

Effect of clay contents on Morphology, Thermal and Mechanical properties of Polypropylene Nanocomposites.

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Introduction

Nanoclay becomes a commercially available in The United States, Europe, and Japan. It is mostly used like an additive added to several commodity polymers to obviously modify their properties to become high performance polymers, so call polymer-clay nanocomposites or polymer layered silicate nanocomposites (PLS). The improved properties are, for example, gas barrier, thermal resistance, reinforcement, clarity, and flame retardancy.

It is found that Thailand has several bentonite beds that could create its commercial value if water swelling property can be obtained. This present work aims to use local bentonite clay compared with commercial montmorillonite clay and process them to be organoclay via cation exchange method and to disperse in polypropylene which is a versatile polymer leading to several consumer products e.g. packaging films, bags, and fibers. The effect of organoclay contents on the morphology, thermal and mechanical properties of nanocomposites were studied.

Experimental

Na-bentonite and Na-montmorillonite were swollen in distilled water then organomodified with common surfactants, namely Hexadecyltrimethylammonium [$C_{16}H_{33}N^+(CH_3)_3$] bromide. Once the modified clays were precipitated showing their hydrophobicity, then they were filtered, washed several times with distilled water and dried in vacuum oven at 100 °C. After that they were ground into powder, and finally screened through a 325-mesh sieve. The nanocomposites of polypropylene were prepared by melt intercalation in a co-rotating twin screw extruder at various contents of organomodified clays (1, 2, 3 and 5 wt %) and PP-g-MA (15 wt %) as a compatibilizer. The polypropylene nanocomposites were characterized by X-ray Diffraction (XRD) to study the morphology and nanocomposites structure. Scanning electron microscopic (SEM) was used to study the dispersion of organoclays particle in matrix polymer. The degradation temperature and the melting and crystallization behaviors were investigated by mean of Thermogravimetric (TGA) and Differential scanning calorimeter (DSC) respectively. The mechanical properties were also studied by using the Instron universal testing machine according to ASTM D 638.

Results and discussion

1. Morphology of nanocomposites:

The morphological structures of two organomodified clays nanocomposites were analyzed by using XRD in order to clarify the types of nanostructure, the result showed in Fig. 1. The XRD curves of organomodified bentonite Fig. 1 (a), at 2 and 5 wt% showed a shift of shoulder peak toward lower angles that corresponding to the d-spacing (d_{001}) = 3.91 and 3.42 nm respectively. On the other hand, at 1 and 3 wt%, the peak at lower angles was not observed. This result, suggested that the polypropylene molecules were positioned between silicate layers and hence an intercalated nanocomposite was produced. For the organomodified montmorillonite in Fig. 2 (b), the lower angles peak was not observed for all compositions of the nanocomposites. These results implied that the silicate layers were nearly exfoliated dispersion in the polypropylene matrix.

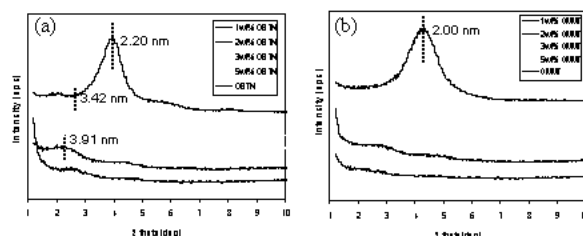


Figure 1. XRD patterns of PP/organomodified bentonite(a), and montmorillonite (b) nanocomposites.

2. Thermal properties of nanocomposites:

The thermal degradation temperature of both organomodified clays were showed in Fig. 2 (a) and (b) respectively. The TGA curves of both nanocomposites shift to higher temperature compared to that of pure PP and their degradation temperatures increase with increasing organoclay contents. This concludes that the incorporation and the good dispersion of organoclays can improve the thermal stability of nanocomposites.

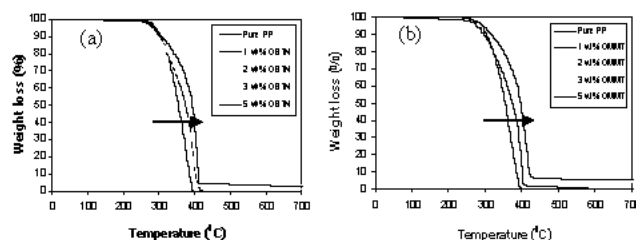


Figure 2. TGA thermograms of PP/organomodified bentonite (a), and montmorillonite (b) nanocomposites.

3. Mechanical properties of nanocomposites:

The tensile strength and modulus of both organomodified clays nanocomposites were showed in Fig 3 (a) and (b). The tensile strength and modulus of organomodified montmorillonite was greater than pure PP and increase with increasing organoclay contents. In case of organomodified bentonite, tensile strength and modulus are optimized at 1 wt% then slightly decrease when organoclay contents increase up to 5 wt%. However, the tensile strength and modulus of both were greater than pure PP.

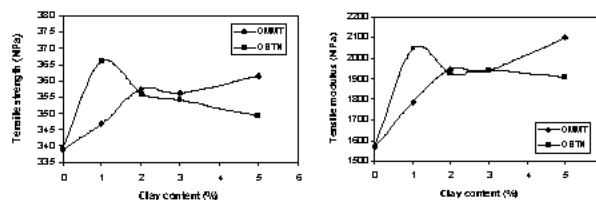


Figure 3. Tensile strength and modulus of PP/organomodified bentonite (a), and montmorillonite (b) nanocomposites.

Conclusions

The preparation of polypropylene/ clay nanocomposites by using two different sources of clays, the intercalated nanocomposite was obtained when using organomodified bentonite and the silicate layers has a nearly exfoliated dispersion in the PP matrix when using organomodified montmorillonite. The incorporation of organoclay particles can enhance the thermal stability of PP/clay nanocomposites about 20%. Tensile strength and tensile modulus were also improved.

References

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