OP-3-114

Tuesday, May 10, 2011, 03:15-03:35 pm
Room: Ministres

THERMAL BEHAVIOUR OF POLYPROPYLENE/HALLOYSITE NANOTUBES NANOCOMPOSITES: WATER-ASSISTED EXTRUSION

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Polymer nanocomposites based on inorganic clay minerals still attract a great deal of attention and interest. Especially, polypropylene (PP) is extensively studied due to its low cost combined to its broad range of industrial applications. PP/clay nanocomposites are usually prepared by melt-compounding using compatibilizers like maleic anhydride grafted PP (PP-g-MA) to solve the difference in polarity between the hydrophilic clay and the hydrophobic PP.

Halloysite is a naturally occurring aluminosilicate ($Al_2Si_2O_5(OH)_4.2H_2O$) with a predominantly hollow tubular structure. Recently, halloysite nanotubes (HNTs) have been characterized by many research groups as potentially excellent nanofillers to improve the properties of nanocomposites such as mechanical performance, thermal stability and flame retardancy.

The water-assisted extrusion process was first used to prepare polyamide nanocomposites with untreated clay [1]. Liquid water is injected into the clay polymer blend during the melt-compounding and subsequently degassed. In the present work, PP/HNTs nanocomposites are obtained for the first time using similar water-assisted extrusion process.

In a first step, PP/HNTs nanocomposites were prepared at different HNTs loadings (4, 8 and 16 wt% HNTs) with and without water injection. In a second step, [PP/PP-g-MA]/HNTs nanocomposites were prepared in the same way by a one-step process. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were used to analyze the morphology of the composites and to compare it to the rheological behaviour measured by dynamic shear measurements. The thermal properties were investigated by thermogravimetric analyses (TGA) under air and nitrogen atmosphere conditions.

A high degree of dispersion of the HNTs in PP matrix is found only when compatibilizer and water injection are combined together (Figure 1b). Thermal analyses reveal two opposite effects of HNTs on the thermal behaviour of PP. A surface catalytic action of the halloysite speeds up thermal degradation of PP. However, this effect is dramatically reduced with improved HNTs dispersion, presumably via an entrapment mechanism of the decomposition products inside the lumens.

[1] Korbee, R. A. ; Van Geneen, A. A. U.S. Patent 6,350,805, February 26, 2002.