

THERMAL PROPERTIES OF POLYPROPYLENE NANOCOMPOSITES WITH ORGANOCLAY AND DISCARDED BOND PAPER

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Abstract

This work concerns the study of the effect of discarded bond paper on the thermal behavior of the polypropylene/organophilic clay nanocomposite. A brown polycationic bentonite from state of Paraíba, Brazil, was treated industrially with sodium carbonate to transform it into a bentonite which swells in water and then treated with ammonium chloride hexadecyltrimethylammonium to turn it into a swellable organoclay in organic liquids. Polypropylene with 3 % polypropylene graft compatibilizer (PP-g-AM) was mixed with 1 % and 2 % by weight of discarded bond paper and with 1%, 2% e 5 % by weight of organophilic clay using a twin-screw extruder. The specimens were prepared by the injection process. The nanocomposite specimens were characterized by XRD, SEM, and thermal analysis (ATG and DSC). The nanocomposites showed improved thermal properties compared with the polymer without filler.

Introduction

There has been increasing interest in preservation of the environment and sustainability of resources. So, the use of natural fibers is receiving renewed attention as an alternative to inorganic counterparts in materials technology. Particular consideration has been paid to cellulose fibers, which are the most abundant biomass resource on Earth [1].

The utilize of natural cellulosic fibers in composites have attracted the attention of researchers, manufactures and user agencies due to the consequence of exploitation of non-renewable resources and management of agro-industrial wastes leading to environmental and ecological balances. Certainly, natural cellulosic fibers are rapidly emerging as novel low cost materials for several industrial applications [2].

Natural fiber reinforced polymer composites have various applications, such as use in automotive industry, furniture, packaging and building construction fields. The main constituent of natural fiber is cellulose, which contains a huge number of polar hydroxyl groups that would lead to a highly hydrophilic property of fiber and a very poor interface between the natural fiber and polymer matrix. Compared with synthetic fibers, the advantages of using natural fiber in

composites are their low specific gravity, cheaper, renewability, biodegradability, and environmentally friendly [3-4].

Polymeric nanocomposites have attracted substantial scientific interest and developments over the last two decades with an enormous market opportunity especially for the automotives and packaging industries. It was based on layered silicates, principally montmorillonites (nanoclays), are the most commonly utilized reinforcing additives in thermoplastic polymers due to their nanoscale features giving rise to unique and superior combination of properties achievable at low loading, normally 1-5 %, compared to around 30-40 % in conventional polymer composites [5].

Polymer nanocomposites are polymers that have been reinforced with little quantities of nano-sized particles (nanofillers). These materials represent a radical alternative to conventional filled polymers. In contrast to conventional composites, where the reinforcement is on the order of micrometres, polymer nanocomposites are exemplified by discrete constituents on the order of a few nanometres. An important class of nanofillers involves nanoclays belonging to the smectite group, such as montmorillonite. Montmorillonite belongs to the family of 2:1 layered silicates. Its structure involves layers about one nanometer thick, each of which consists of two tetrahedral silica sheets fused to an edge-shared octahedral sheet of aluminium/magnesium oxide/hydroxide. To produce nanocomposite materials with best properties and performance, these nanoclays must be intercalated with the polymer matrix and also totally exfoliated [6].

The study of polymer organoclay nanocomposite due to its superior properties compared with pristine polymer has attracted main research and commercial interests. The inclusion of small concentrations of nanoparticles in polymers (< 5 wt. %) can have a significant impact on material properties. The increase in mechanical properties such as tensile strength and modulus, solvent resistance barrier properties and flame retardant are a couple of selected examples of the advantages provided by this new class of materials. But, to fully use this increase, it is necessary to achieve a relatively uniform dispersion of the clay nanoparticles within the polymeric host matrix [7-8].

During nanocomposites preparation by melt compounding initially an intercalation process of the polymer macromolecules into the interlayer spaces occurs and finally clay mineral exfoliation in the polymer matrix. This process is diffused control and requires a balance between shear rate and residence time to reach complete exfoliation. However, these requirements have some drawbacks, since polymer degradation can also take place [9].

Polypropylene/montmorillonite (PP-MMT) is one of the most frequently utilized nanocomposites to obtain property improvements produced in different forms and applications by means of a range of manufacturing processes at a relatively low cost. There is ample evidence that PP-MMT formed by melting processing is the most preferred method to produce nanocomposites for commercial use. The improvement on final properties usually depends on the degree of exfoliation, delamination, and clay dispersion [10].

A great extent of exfoliation is even more difficult to achieve in polypropylene (PP) than in other, more polar polymers. Nanocomposites cannot be prepared successfully from PP and an organophilic silicate (OMMT), a compatibilizer agent, usually a functionalized polymer like