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First page example

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Step-scan DSC Study on the Melting Behavior of Polypropylene/Attapulgite Nanocomposites

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Keywords: Polypropylene, Attapulgite, Nanocomposites, Recrystallization, Melt

Abstract. Attapulgite(AT) was modified by grafting with butyl acrylate(BA) via polymerizations initiated by Gamma radiation. The polypropylene(PP)/AT nanocomposites were synthesized via melting extrude in a twin-screw extruder. The thermogravimetry(TG) and scanning electron microscopy (SEM) were used to assess the graft ratio of the hybrid materials and the dispersion of AT, respectively. Step-scan differential scanning calorimetry(SSDSC) was used to study the influence of AT on the crystallization and subsequent melting behavior. The results indicated that PP and PP/AT nanocomposites underwent multiple melting and secondary crystallization processes during heating. The melting behaviours of PP and PP/AT nanocomposites varied with the variation of crystallization temperature and AT content.

Introduction

Isotactic polypropylene (iPP) is a widely used, versatile, commodity polymer with a number of desirable properties, such as high melting temperature, high chemical resistance and its low cost. Polymer nanocomposites are of interest as they exhibit extraordinary properties compared with the base polymer. The properties of the composites are strongly influenced by the nature of the filler/matrix interface. It means that control and/or manipulation of the surface properties for the nanoparticles are of great importance [1-5]. As one of the effective methods, grafting polymer onto the surface of inorganic nanoparticles is a field of growing interests [6]. Gamma radiation is particularly useful because the polymerizations initiated by radiation are free from impurities such as chemical residues from initiators, a temperature control on the chemical propagation step which does not interfere with the initiation, and an immense choice of conditions of initiation [7].

Attapulgite (AT), a kind of natural fibrous silicate clay has drawn much attention in the preparation of polymer/AT nanocomposites due to its special morphology, surface properties, and low price. Wang et al had reported the preparation of polypropylene/AT nanocomposites by surface radical grafting polymerization and melting compound procedure [8-10]. However, no studies on the melting behavior of PP/AT nanocomposites, of which the surface of AT was modified by Gamma irradiation polymerization, are found.

Step-scan DSC (SSDSC), which is a type of temperature-modulated DSC (TMDSC) permits the separation of DSC results into thermodynamic (reversible) and kinetic (irreversible) components for better interpretation [11]. The essential procedure of a step-scan DSC experiment included utilizing a heating-isothermal (or cooling-isothermal) program comprising a periodic succession of short, heating rate and isothermal steps, where the isothermal segment continues for a set time and heat flow is decreased to within a predetermined set value (baseline criteria). The apparent thermodynamic response only occurs during the heating (or cooling) segment and reflects the reversing changes within the sample. The time-dependent response reflects the kinetic processes and is extracted from the isothermal baseline segment [12].

In the present study, a simple method was used to prepare PP/AT nanocomposites, which were synthesized by grafting polymerization of butyl acrylate (BA) monomer onto AT surface initiated by radiation first, and then melting blend with PP. The result of scanning electron microscopy (SEM)