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PHYSICAL CHARACTERIZATION OF NANOCLAY AND SGF POLYPROPYLENE COMPOSITES

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ABSTRACT

In recent year's polymer/layered silicate (PLS) nanocomposites have attracted great interest, both in industry and in academy, because they often exhibit remarkable improvement in materials properties when compared with virgin polymer or conventional micro and macro-composites. In this study the synergistic effects in PP+short glass fibre+nanoclay systems in physical characterization in injection mouldings were analysed. The materials used were a Polypropylene Homopolymer, Nanoclay (montmorillonite layer silicate) for Polyolefin Nanocomposites in percentages of 2%, 6% and 10% and a Polypropylene Homopolymer with content of 10% and 30% of glass fibre reinforced.

INTRODUCTION

The field of nanotechnology is one of the most popular areas for current research and development in basically all technical disciplines. This obviously includes polymer science and technology and even this field the investigators cover a broad range of topics (Paul and Robeson 2008). In Polymers, the nanoclays have been used to reinforced thermoplastics like Polypropylene to improve its properties. These improvements can include high moduli, increased strength and heat resistance, decreased gas permeability and flammability, and increased biodegradability of biodegradable polymers. However these properties are strongly influenced by how the clay is dispersed in the polymer. Many reserchers have been studied the effects of nanocomposites, specially nanoclays, in the properties and stiffness of thermoplastics materials.

EXPERIMENTAL

The samples were got by Injecton molding. The materials used were a Polypropylene Homopolymer, Nanoclay for Polyolefin Nanocomposites in percentages of 2%, 6% and 10% and a Polypropylene Homopolymer with content of 10% and 30% of glass fibre reinforced. Injected samples were characterized by Differential Scanning Calorimetry (DSC) and Dynamic Mechanical Analysis (DMA).

PHYSICAL CHARACTERIZATION

DSC was performed in a Perkin Elmer Pyris 1 device at a heating rate of 10ºC/min between -30°C and 200°C. Melting temperature (Tm) was determined as the peak temperature, and crystallization degree (x_c) was estimated as:

$$x_c = \frac{\Delta H_m}{\Delta H^0 (1-\phi)} 100 \quad (1)$$

Where ΔH_m is the apparent enthalpy of fusion per gram of material, ΔH^0 is enthalpy of fusion for totally crystalline material (209 J/g for PP), and ϕ is the relative amount of reinforcement.

DMA was performed in a Perkin-Elmer dynamic mechanical analyzer (DMA-7) at a fixed frequency at 1 Hz in a three-point bending mode, while increasing the temperature from -40 to 120ºC at a heating rate of 10ºC min^{-1}. Tg was obtained from tan δ peak and heat distortion temperature (HDT), defined as the temperature at which a 0.25 mm deflection occurs under 0.46 MPa, was measured by thermal mechanical analysis using the method developed by Scobbo (Scobbo 2000). This method translates the standardized load and deformation into modulus assuming approximately linear stress–strain behavior for small

loads and deformations typically specified in the standards. For the displacement of 0.25 mm and load of 0.46 MPa, this translates into log (modulus in Pa units) = 8.9.

RESULTS AND DICUSSSION

Typical DSC and DMA curves are shown in Fig. 1 and 2 and obtained properties are depicted in Table 1. It was observed that x_c diminished with the addition of nanoclay (nc). With the incorporation of glass fibre (gf), this diminishing disappeared irrespective of the presence or absence of nanoclay. On the other hand, Tg and HDT increased with the addition of nanoclay, reaching a maximum for 6%. The incorporation of glass fibre noticeable increased HDT, while Tg remained practically unaffected.

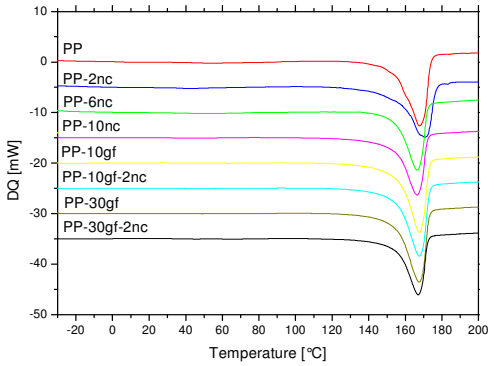

Figure 1: Typical curve of DSC

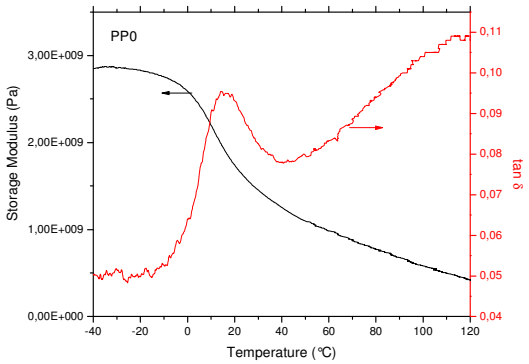

Figure 2: Typical curve of DMA

Table 1. Physical properties of studied materials.

Material	Tm [°C](1)	x_c (1)	Tg [°C] (2)	HDT [°C] (2)
PP	167.7	42.5	16.1	77.8
PP-2nc	170.7	41.1	17.5	79.3
PP-6nc	166.5	39.5	20.7	84.1
PP-10nc	165.6	34.4	15.5	63.4
PP-10gf	167.7	41.8	15.8	121.9
PP-30gf	167.6	40.0	16.5	123.5
PP-10gf-2nc	167.7	41.7	21.4	120.1
PP-30gf-2nc	167.2	44.1	19.7	129

(1) Determined by DSC
(2) Determined by DMA

CONCLUSIONS

It was observed that x_c diminished with the addition of nanoclay. The tan δ peak and HDT increased with the addition of nanoclay, reaching a maximum for 6%. The incorporation of glass fibre noticeable increased HDT, while tan δ peak remained practically unaffected.

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