



NANOCLAYS IN POLYMER BLENDS

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KEYWORDS

Nanocomposites; Organoclay; Blending;
Compatibilization

ABSTRACT

The present work, investigates the dispersion of montmorillonite (MMT) in a polymer blend. Nanocomposites of PA/PP/clay (70/30/5, w/w/phr) and PA/PP/PP-g-MA/clay (70/30/5/5, w/w/phr/phr) containing either Cloisite C15A or C30B were prepared by melt blending in a co-rotating twin screw extruder under fixed operating conditions. Samples were collected and subsequent characterized by several techniques. SEM and TEM images provided a detailed view of morphology and nanoclay dispersion, which helps to clarify the eventual compatibilizing effect of the latter.

INTRODUCTION

Blending of polymers is an attractive method to obtain new polymeric materials. However, compatibilization is generally required to control the morphology and to improve the interfacial properties of immiscible polymer pairs [Machado et al 1999; Scaffaro et al 2008]. Compatibilization can be achieved by the “in situ” formation of a block or graft copolymer at the interface, or by the addition of a pre-synthesised block-copolymer. It is now well established that this graft or block copolymer induces a large decrease of the interfacial tension between the blend components and a decrease in the coalescence of the dispersed phase due to steric stabilization.

Nanoclays are very efficient in improving the physical and mechanical performance of polymer blends [Schaefer and Justice 2007; Yoo and Paul 2008]. Less understood is their possible additional compatibilizing effect. Thus, the present study aims to investigate the effect of the addition of nanoclays in polymer blends, both in terms of compatibilization and blend performance.

PA/PP/C15A and PA/PP/PP-g-MA/C15A (70/30/5, w/w/phr, and, 70/30/5/5, w/w/phr/phr, respectively) nanocomposites are prepared in a co-rotating twin screw extruder at a screw speed of 200 rpm, a throughput of 4 kg/h and a set temperature of 230 °C. The samples were analysed using X-ray diffraction, rheology, scanning and transmission electron microscopy.

The results showed a fine morphology for both blends.

MATERIAL AND EXPERIMENTAL PROCEDURE

Polyamide 6, PA, (DOMAMID 27), Polypropylene homopolymer, PP, (MOPLEN - HP502N), a commercial nanoclay, Cloisite 15A (C15A) consisting of MMT modified organically with quaternary alkylammonium salts and PP grafted with maleic anhydride, PP-g-MA (Orevac CA 100) were used. Table 1 shows the composition of the blends and nanocomposites prepared for this research. Before compounding, PA6 and the nanoclays were dried under vacuum at 80 °C during 12-16 hours, and then tumble-mixed with PP or PP-g-MA.

Table 1 – Blends composition

| Blends | PA (wt.%) | PP (wt.%) | PP-g-MA (phr) | Clay (phr) | |
|--------------------|--------------|--------------|------------------|------------|------|
| | | | | C15A | C30B |
| PA/PP | 70 | 30 | 0 | 0 | 0 |
| PA/PP/PP-g-MA | 70 | 30 | 5 | 0 | 0 |
| PA/PP/Clay | 70 | 30 | 0 | 5 | 0 |
| PA/PP/Clay | 70 | 30 | 0 | 0 | 5 |
| PA/PP/PP-g-MA/Clay | 70 | 30 | 5 | 5 | 0 |
| PA/PP/PP-g-MA/Clay | 70 | 30 | 5 | 0 | 5 |

Blends morphology was studied by scanning electron microscope (SEM), Leica Cambridge S 360, after fracture of the samples in liquid nitrogen and etching with hot xileno to remove the PP phase. Samples for TEM analysis were cryosectioned at a thickness lesser than 90 nm with a cryo-ultramicrotome at -45 °C. Samples were stained with a RuO4 solution and examined using a JEOL-JEM 1010 Transmission Electron Microscope (operating with a voltage of 100 kV).

RESULTS AND DISCUSSION

SEM revealed a large reduction in domain size when both organoclays were used, yielding a finer dispersed phase (figure 1), although distinct dispersion and compatibilization mechanisms seem to exist.

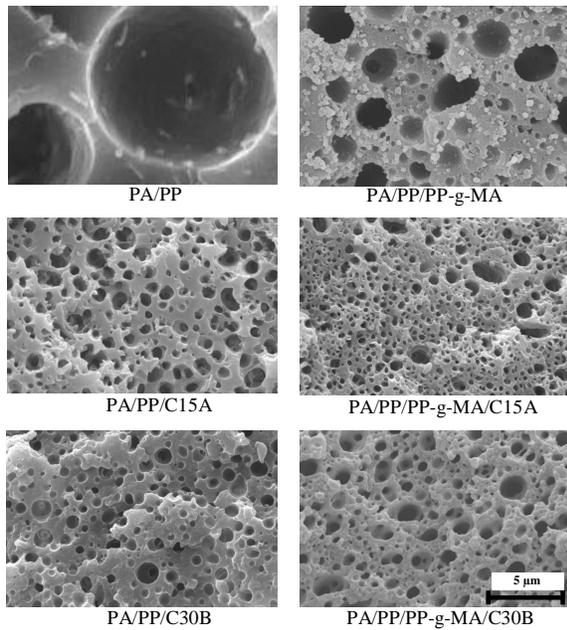


Fig. 1 SEM micrographics at die of blends PA/PP, PA/PP/Clay and PA/PP/PP-g-MA/Clay

TEM results showed that the silicate layers were located at the interface and in the PA phase (figures 2 to 5). Despite of the enhanced level of exfoliation reached with Cloisite C30B, blends with Cloisite C15A seemed to exhibit a higher compatibilization level.

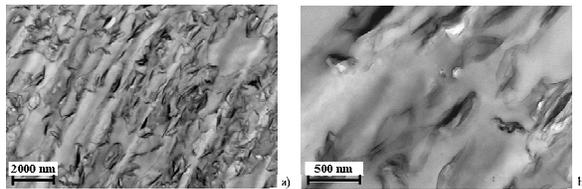


Fig. 2 TEM micrographs of PA/PP/C15A blends at different magnifications

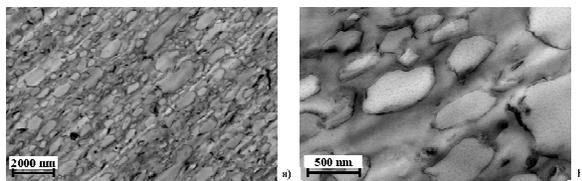


Fig. 3 TEM micrographs of PA/PP/PP-g-MA/C15A blends at different magnifications

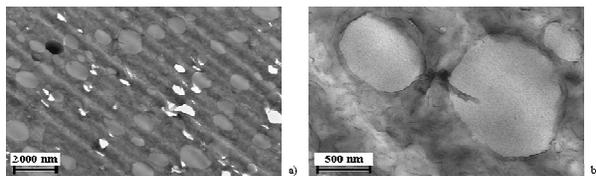


Fig. 4 TEM micrographs of PA/PP/C30B blends at different magnifications

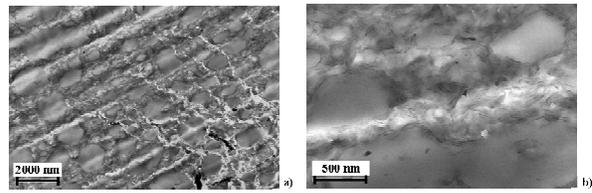


Fig. 5 TEM micrographs of PA/PP/PP-g-MA/C30B blends at different magnifications

CONCLUSIONS

It was shown that both nanoclays and the PP-g-MA act as compatibilizers. However, the compatibilization effect is different, which can be correlated with the dispersion of the nanoclay in polymer matrix.

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