

Organoclay reinforced compatibilized nanocomposites of polypropylene with an amorphous polyamide

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Polymer blending offers a cost effective way to produce new commercially successful polymeric materials. However, compatibilization of the blends is often necessary to achieve the desired property combination due to the immiscibility of most polymers [1,2]. The compatibilization of polymer blends promotes a morphology improvement while facilitating the interfacial adhesion between the components, both leading to improved overall properties [3]. Blends of polypropylene (PP) and polyamides (PA) have been extensively studied because they offer the combination of low cost, good mechanical performance, high barrier properties to moisture and easy for processing of the PP with the excellent mechanical and thermal properties of the polyamides. The compatibilization of PP/PA blends has been obtained by the addition of a third component that consists of a polypropylene chain grafted with functional groups which can react with terminal amine groups in the PA.

For the last years, polymer/organoclay nanocomposites have been widely studied because of the ability of the clay platelets to enhance different properties such as mechanical properties, thermal stability, barrier properties or flame retardancy, at low clay contents. The properties improvement of the nanocomposites lies in the high aspect ratio and rigidity of the dispersed and well-exfoliated individual silicate layers into the polymer matrix [4]. The affinity between the polymer matrix and the organoclay is one of the most important factors in achieving good exfoliation; to a certain extent, affinity can be enhanced by optimizing the structure of the organoclay for a given polymer matrix. For polyamide nanocomposites, montmorillonite (MMT) modified with a quaternary ammonium salt containing one long alkyl tail has been seen to be the best achieving a good dispersion. The highest exfoliation levels have been observed in polyamide-6/organically modified montmorillonite nanocomposites, while nanocomposites with high degrees of dispersion have been obtained with other polyamides, such as PA66, PA12, PA11 or amorphous polyamides (aPA).

Recently, research attention has focused on polymer/polymer/clay ternary nanocomposites because they can combine the advantages offered by polymer blends and conventional nanocomposites [5,6].

In this work, we analyze the effects of the addition of an octadecylamine-modified MMT (OMMT) on the morphology, and the mechanical and thermal properties of efficiently compatibilized blends of PP with an amorphous polyamide (aPA) in 75/25 and 60/40 (PP/aPA) compositions. The compatibilizer was a maleic anhydride-grafted PP (PP-g-MA).

The PP/aPA/OMMT ternary nanocomposites (Figure 1) showed a biphasic structure, regardless of the PP/aPA composition and the OMMT content. The organoclay was found solely inside the aPA particles due to its higher affinity for this component and it showed an exfoliated nanostructure.

The addition of the organoclay to the blends promoted an increase in the average particle size of the aPA dispersed phase and an interfacial adhesion decrease between the components, which was more noticeable at increasing OMMT concentration. This behaviour was in part attributed to the competition between the OMMT surfactant and the aPA to interact with the MA groups of the PP-g-MA compatibilizer, which leads to a decrease of the compatibilization efficiency and to the observed morphological response.

The Young's modulus of the ternary nanocomposites (Figure 2) increased linearly with the OMMT concentration. The addition of 10% OMMT to aPA led to a modulus increase of 20% comparing to that of the unreinforced blend, both in the 75/25 and 60/40 compositions. The yield stress, the ductility and the impact strength were affected by the exclusive location of the OMMT inside the dispersed phase and, also, by the compatibilization efficiency decrease induced by its addition.

Acknowledgements

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References

- [1] Paul, D. R.; Bucknall, C. B. *Polymer Blends*, Wiley, New York (2000).
- [2] Datta, S.; Lohse, D. J. *Polymeric Compatibilizers*, Hanser, Munich (1996).
- [3] Manning, S. C.; Moore, R. B. *Polymer Engineering and Science*, **39** (1999) 1921.
- [4] Utracki, L. A. *Clay-Containing Polymeric Nanocomposites*, Rapra Technology, Shropshire (2004).
- [5] Motamedi, P.; Bagheri, R. *Materials and Design*, **31** (2010) 1776.
- [6] Gahleitner, M.; Kretzschmar, B.; Pospiech, D.; Ingolic, E.; Reichelt, N.; Bernreitner, K. *Journal of Applied Polymer Science*, **100** (2006) 283.

Figures

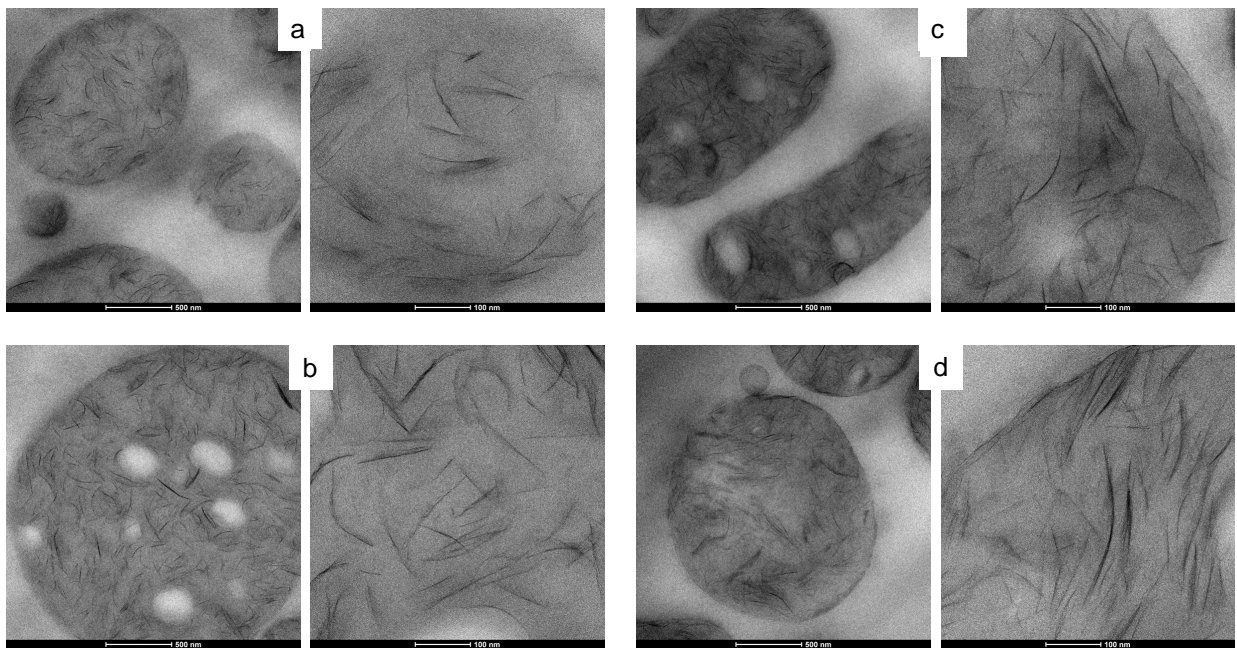


Figure 1. TEM micrographs of 75/25 PP/aPA blends with 5% OMMT (a) and 10% OMMT (b) and 60/40 PP/aPA blends with 5% OMMT (c) and 7% OMMT (d).

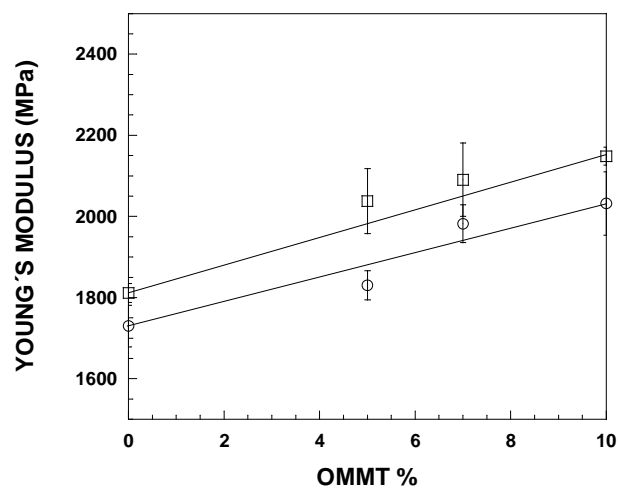


Figure 2. Young's modulus of 75/25 (○) and 60/40 (□) PP/aPA composition blends as a function of the OMMT content.