Thermal and antibacterial behaviour of polypropylene-silver nanocomposites compatibilized with PPgMA

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INTRODUCTION

The use of silver particles in textile industry is well known for its antimicrobial properties because it can remove more than 650 bacteria, virus and fungi. Nanosilver in comparison with other antimicrobial methods has more durability and efficiency and can be used in many particular applications like sport and hygienic clothing, military industries...

In this research work we have evaluated the multifunctional properties of composites based on the use of a polypropylene matrix and different nanosilver particles as additives for antibacterial purposes; but we have to take into account that together with antibacterial and/or antifungal behaviour other properties are improved with nanosilver particle addition such as electrical conductivity, magnetic isolation, self-cleaning effects, … thus allowing to obtain new high performance textile fibres, with multifunctional properties, for different uses in high technological content textile engineering applications [1-3].

EXPERIMENTAL

Several types of compounds containing nanosilver were used in this work. Nanosilver covered with PVP (NanoGap); Ag Pure Wax 5.1 (copolymer of EVA with silver particles); and Pure nanosilver S2-30 and S2-80 with purity of 99,9% (NanoDynamics).

PP/Ag-nanocomposite compounding containing 2 wt% of silver, PP (MOPLEN HP561 S) and compatibilizer PPgMA (Sigma Aldrich) were premixed. This previous mixture was processed and mixed with nanosilver in a co-rotating twin-screw extruder. During processing a thermal reduction of the silver salt into elemental silver nanoparticles occurs causing a yellow-brownish colour of the extruded strands.

The dispersion of the Ag was followed using X-ray diffraction (XRD) with a Seifert diffractometer JSO-DEBYEFLEX 2002 using the λ Cu = 1,540598 Å. The scan was performed in the 20-80º (2θ) with a step of 0.05º and the applied voltage was 40 kV with a current intensity of 40 mA.

Thermal characterization of the polypropylene-Ag system was carried out using differential scanning calorimetry (DSC) with a Mettler-Toledo 821 e (Mettler-Toledo Inc., Schwerzenbach, Switzerland). Mass weight for DSC analysis varied in the 3-5 mg range and it was used an air atmosphere with a heating ramp from 30 up to 350 ºC at a heating rate of 5ºC·min-1.

RESULTS AND DISCUSSION

The size, morphology and structure of the PP-AG nanocomposites were investigated by X-ray diffraction (XRD).

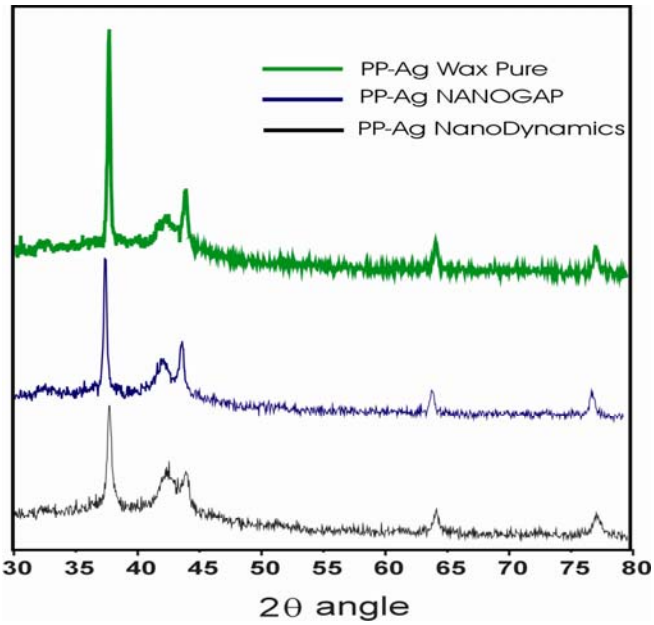

Figure 1.- XRD of Ag/PP nano-composite films loading of Ag nanoparticles:
(a) PP-Ag Wax Pure 2%; (b) Ag NanoGap 2%.; (d) PP- Ag NanoDynamics 2%.

The XRD pattern of PP-Ag shows that in the polymeric matrix containing silver, the peaks of PP are shifted to angle lower values which indicated that the crystallinity of the PP was slightly influenced by the presence of nanoparticles.

The X-ray diffractogram are well in agreement with the literature values for silver nano-particles [3]. All the prominent peaks at 2θ values of about 38º, 44.44º, 64.54º and 77.38º representing the (1, 1, 1), (2, 0, 0), (2, 2, 0) and (3, 1, 1) Bragg's reflections of fcc structure of silver [3-5].

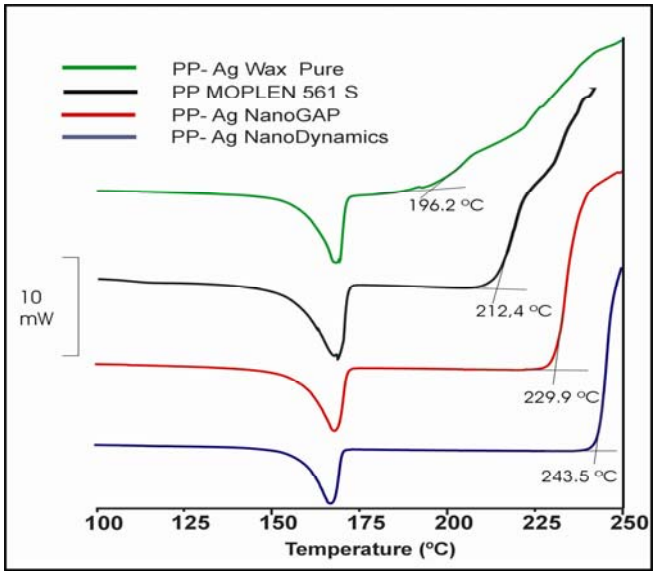

Figure 2.- DSC analysis of Ag/PP nano-composites with loading of Ag nano-particles: (a) PP-Ag Wax Pure 2%; (b) PP Moplen; (c) PP- Ag NanoGap 2%.; (d) PP- Ag NanoDynamics 2%.

PP-Ag NanoDynamics offers the best results in thermal stability of the material. The increase of the oxidation temperature in comparison with polypropylene is significant.

CONCLUSIONS

It is thus understood that the particle size does not vary with respect to concentration of silver but there is slight change in the lattice spacing when the loading is maximum.

Pure Silver (S2-30 and S2-80) offers the major dispersion in the matrix, and the best thermal stability and antibacterial behaviour.

Nevertheless, at this moment the high price of the material supposes an important limitation for industrial uses.

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