USE OF INORGANIC FULLERENE-LIKE WS_2 TO PRODUCE ADVANCED POLYMER NANOCOMPOSITES: STUDY OF CRYSTALLIZATION BEHAVIOUR BY DSC AND TIME-RESOLVED SYNCHROTRON X-RAY DIFFRACTION

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The use of polymers and polymer-based composites is very common in situations where a combination of good mechanical and tribological properties are required. Tungsten disulfide (WS_2) nanoparticles named as "Inorganic Fullerene-like materials (IF)" [1] are promising candidates for the preparation of advanced polymer nanocomposites [2]. In particular, inclusion of these nanoparticles with new structures in polymer matrices combines the flexibility of the polymer with the high modulus and low friction of this inorganic compound leading to improved mechanical properties of the polymer matrix, as it has been reported in a recent work using an epoxy resin and polyacetal [3]. However, to control the mechanical and various other properties of the nanocomposites during processing, it is essential to know the crystallization behaviour of polymer in detail (crystallization rate, overall crystallinity, size of crystallites, etc.) and also how it is affected in the presence of nanoparticles.

The main objective of this study is to understand the effect of the IF-WS_2 nanoparticles on the crystallization behaviour of polymer matrices based on one of the most interesting commodity thermoplastics (isotactic polypropylene) and high-performance engineering thermoplastics (polyphenylene sulfide, PPS). The iPP/IF-WS_2 and PPS/IF-WS_2 nanocomposites have been successfully prepared by melt blending without using modifiers or surfactants. The thermoplastic polymers used in this work were supplied by REPSOL-YPF (iPP) and Ticona (PPS, Fortran®), and IF-WS_2 nanoparticles were kindly provided by Nanomaterials commercialized as NanoLub™.

Study of crystallization behaviour based on DSC and time-resolved synchrotron X-ray diffraction (SAXS/WAXS) indicates that WS_2 has a remarkable influence on the crystallization behaviour of the nanocomposites depending of the composition and polymer matrix. For the iPP nanocomposites, IF-WS_2 act as a highly efficient nucleating agent for α-phase of iPP, increasing the crystallization rate of iPP. The nucleation efficiency reaches very high values (60-70%), the highest values observed hitherto for iPP nanocomposites.[2] Also, IF-WS_2 favors the perfection and stability of the iPP crystals and increases the size of the crystalline lamellae, as well as the crystallinity. However, in the case of PPS nanocomposites, all analyses reveal that the addition of IF-WS_2 alters the crystallization behaviour of PPS but in ways unexpected from polymer nanocomposites systems. IF-WS_2 shows no nucleation effect for PPS at low IF-WS_2 contents ($\leq$0.1%), which results in the reduction of the crystallization rate of PPS. A fundamental understanding of structure, morphology and crystallization behaviour are developed in order to optimize the end properties of these promising materials.

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Reference

1. Tenne, R.; Margulis, L.; Genut, M.; Hodes, H. *Nature* 1992, 360, 444-446.
2. Naffakh, M.; Martín, Z.; Fanegas, N; Marco, C; Gómez, M.A.; Jiménez, I. *J. Polym. Sci.: Polym. Phys.* Aceptado 2007.
3. Rapoport, L; Nepomnyashchy, O; Verdyan, A; Popovitz-Biro, R; Volovik, Y; Ittah, B; Tenne, R. *Adv. Eng. Mat.* 2004, 6, 44-48.