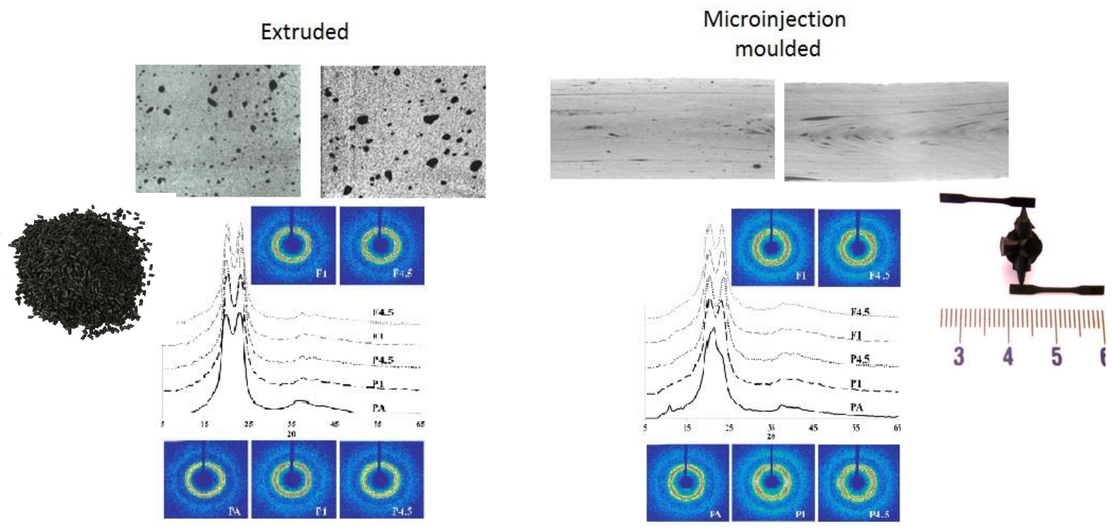
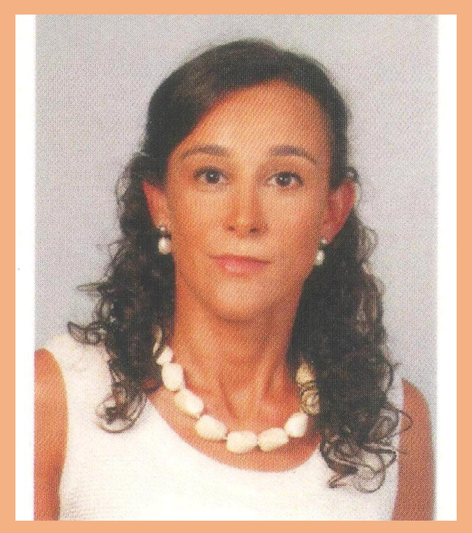
MICROINJECTION MOULDING OF POLYAMIDE 6 AND POLYAMIDE 6/CARBON NANOTUBES COMPOSITES





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Objectives

- Dispersion of carbon nanotubes (CNT) in polyamide 6 (PA6) by melt mixing in a twin screw extruder, and preparation of nanocomposite microparts by microinjection moulding (μIM) ;
- Analysis of the CNT dispersion (using as received and functionalized CNT) in the PA6 matrix after extrusion and after μIM [1].
- Analysis of the PA6 morphology induced by the processing method and by mixing the CNT [2].

Methods and techniques

Nanocomposite samples with 5 μm thickness were cut with along the flow direction of the extruded samples and in the central region of the μP and observed by optical microscopy. Samples were cryo-fracturated and analysed by SEM. (fig. 1)

The morphology of the extruded and μIM samples was analyzed by differential scanning calorimetry (DSC) and by wide angle X-ray diffraction (WAXD). DSC was performed under N_2 (g) flow at heating rate of 10 ºC min^{-1}. Diffraction patterns were acquired for extruded and μIM samples, across the specimen thickness and across its inner region (after removing a surface layer with approximately 50 μm thickness).

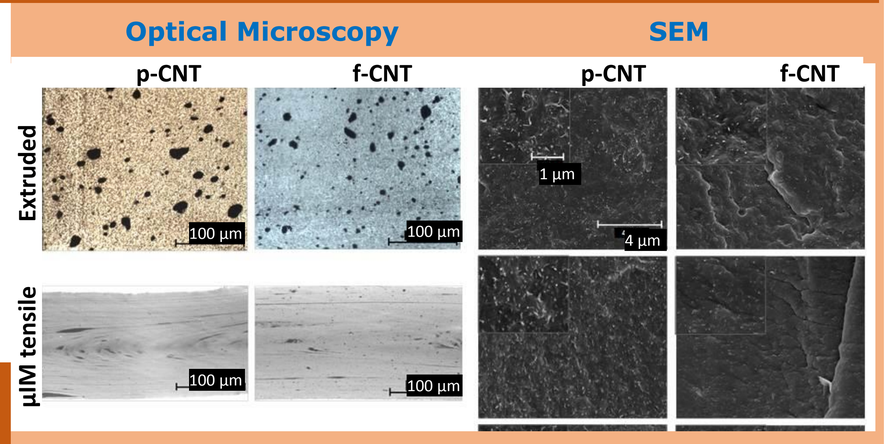

Fig. 1 – Optical microscopy (left) and SEM (right) micrographs of the composites with 4.5 wt.% CNT, obtained after extrusion and μIM.

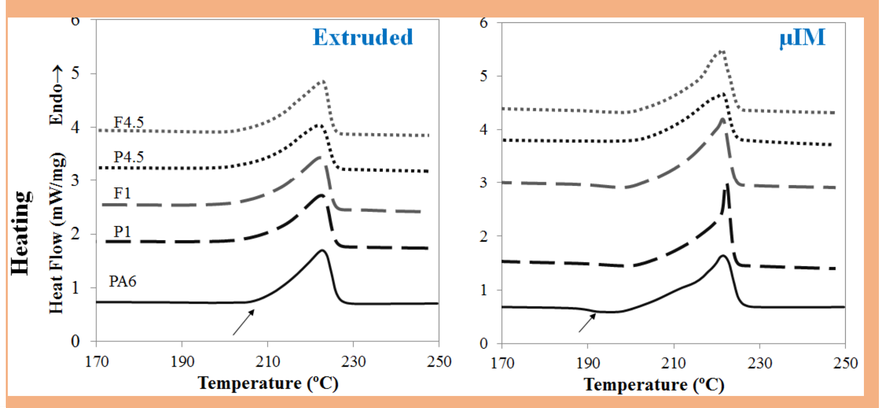

Fig. 2 - DSC thermograms of PA6 and PA6 with p-CNT and f-CNT for extruded and μIM nanocomposites, (1 and 4.5% w/w) under controlled heating.

Results

• Extruded and μIM nanocomposites show good CNT dispersion, although overall the μIM samples present smaller CNT agglomerates compared to extruded composites. The SEM micrographs showed that f-CNT present better adhesion to PA6 (fig. 1).

• DSC analysis showed that μIM samples with low CNT content presented a secondary crystallization process at a temperature just below the onset of the melting peak, which was not observed for the extruded materials and for the μIM composites with high CNT content (fig. 2).

• WAXD results show that skin region of the PA6 μIM contains mostly γ crystalline form and the PA6 extruded material and all composites presented a larger contribution of the α form (fig. 3 and 4). The overall crystallinity was considerably higher for the extruded materials than μIM, and the main contribution to this difference was the larger amount of α phase crystallinity. Molecular orientation was observed only for μIM samples (fig. 3).

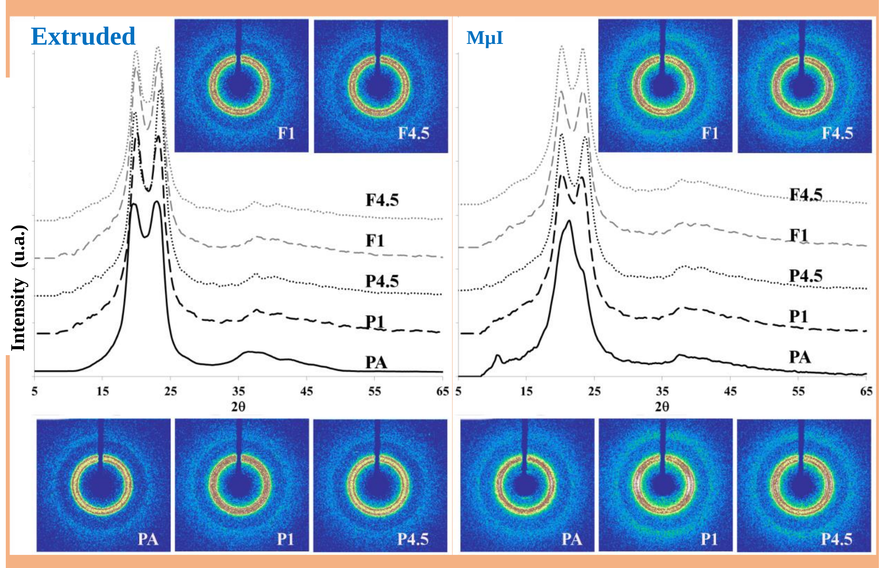

Fig. 3 - WAXD patterns and integrated intensity profiles of extruded and microinjection moulded samples.

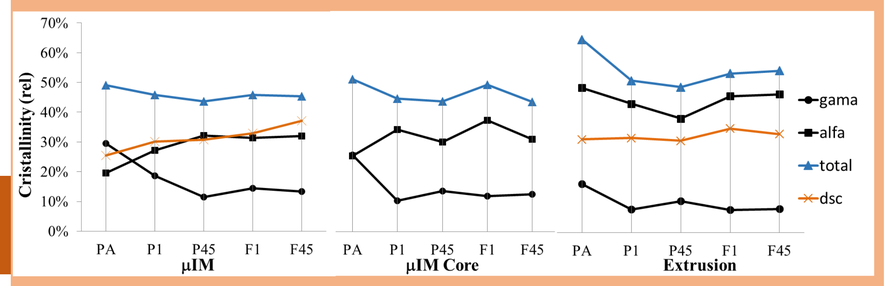

Fig. 4 - Overall crystallinity of α and γ-phase content data obtained from WAXD results..

Publications

1 - Ferreira T, Paiva MC, Pontes A, Dispersion Of Carbon Nanotubes In Polyamide 6 For Microinjection Moulding, *J Polym Res* 2013, 20, 301.

2 - Ferreira T, Lopes PEC, Pontes AJ, Paiva MC. Microinjection Moulding of Polyamide 6 – Polym. Adv. Technol. (2014). DOI: 10.1002/pat.3322

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