The role of graphite nanoplatelets and carbon nanotubes on the enhanced fracture toughness and electrical conductivity of polypropylene composites

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Abstract

In recent years, materials researchers have focused their interest on polymer nanocomposites[1], being carbon-based nanostructures envisioned as promising nanofillers, due to its outstanding mechanical, electrical and thermal properties[2,3].

In this work, commercially available carbon nanotubes (CNT) and graphite nanoplatelets (GNP), composed by multiple graphene layers stacked together by van der Waals forces, have been used to produce polypropylene (PP) nanocomposites. This materials were manufactured following an industrial approach as it is the masterbatch technique[4,5].

The CNT/PP composites, shows a significant increase in the electrical conductivity for the nanocomposites with 5 and 10 wt.% of CNT. A processing-induced anisotropy[6,7] is observed in the electrical conductivity, being different in the three directions of the injection-moulded bars.

The fracture toughness has been determined applying a single-specimen technique, the S_{pb} parameter method[8]. For the nanocomposites manufactured, the fracture mechanism has been identified as void nucleation and growth, by scanning electron microscopy. This is also the fracture mechanism that takes place in the neat PP. The manufactured nanocomposites presents an improved fracture toughness with loadings up to 10 and 2.5 wt.% of CNT and GNP, respectively. The results obtained by the strain field analysis around the crack tip, performed by digital image correlation, indicates that this may be explained in terms of variation of size of the deformation zone ahead the crack tip.

Finally, in this work it has been demonstrated how an scalable machine and an industrial masterbatch compounding approach can be applied to a thermoplastic, in order to obtain nanocomposites with improved fracture toughness and electrical conductivity, opening the way to a wider industrial utilization of these materials.

References

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