

POLYMERS CRYSTALLIZATION: MICRO- AND NANO- FILLERS EFFECTS ON IPP

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Since the characteristics of semicrystalline polymers depend on the morphology, studies on effect of fillers on the composites crystallization are of great interest. Fillers are incorporated into polymeric materials in order to improve their qualities or to produce new chemical and physical properties and nanocomposites are a new class of composites, for which at least one dimension of the dispersed particles is in the nanometer range.

Studying the effects of different micro- and nano- fillers on the iPP crystallization behavior, both in quiescent and in flow induced conditions, is the aim of this work.

Two types of isotactic polypropylene (iPP) were mixed with maleic anhydride grafted polypropylene (PPgMA) as compatibilizer and various micro- (talc, carbon fibres) and nano- (cloisite, carbon nanofibres and carbon nanotubes) fillers. To have the same matrix, the systems were prepared by increasing the filler loading at fixed iPP/PPgMA ratio.

Structural characterization was carried out by means of X-ray diffraction (XRD) and scanning electron microscopy (SEM) analyses and material behavior in the molten state was studied conducting rheological measurements in small-amplitude oscillatory shear (SAOS) with rotational rheometer.

DSC was employed to investigate the crystallization in quiescent conditions of the prepared micro- and nano- composites. Both the quiescent and flow induced crystallization were analysed using SAOS techniques (dynamic time sweep tests).

SEM images show the presence of some aggregates of micrometric dimensions suggesting a poor nano- fillers dispersion within the polymer matrix while, in the case of micro- fillers, one can see only microaggregates.

In the molten state, the effect of nano- fillers addition is a general increase of moduli at all frequencies. As the particle loading increases, elastic and also loss moduli increase. The change is more evident for G' : a filler network is generated by the strong interactions (steric or Van der Waals interactions) among particles. The effect of micro- fillers addition is a general rise of moduli and viscosity, but the network doesn't appear.

The main parameters examined to check the fillers influence on crystallization are the half crystallization time (defined as the time required to reach 50% of the complete crystallization, depending on overall crystallization rate, i.e. nucleation and growth) and the induction time (the time required to induce nucleation, depending only on nucleation).

The DSC and SAOS results show that the addition of nano- filler has a large effect on the induction time while the effect on the half crystallization time is less pronounced. The traditional nucleation agents (i.e. talc) appear to be more efficient in this respect.

As kinetics of space filling degree is described by the Avrami equation, the possible change in slope of G' during the time sweep tests performed for all materials, both in quiescent and applied flow conditions, suggests a structural changes in crystallites morphology.