Thermal and rheological behavior of linear low density polyethylene nanocomposites

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Abstract

Nanocomposites, based on two different linear low density polyethylene matrices (zLLDPE & mLLDPE), reinforced with multi-walled carbon nanotubes (CNTs), at various CNT loadings, have been prepared and studied by scanning electron microscopy (SEM), differential scanning calorimetry (DSC), and dynamic mechanical analysis (DMA). The materials were prepared by a melt-mixing procedure at 140°C, and hereafter were compression molded using a thermopress. The CNTs dispersion was analysed by SEM, and a fine dispersion was detected. By DSC testing from -100°C up to 160°C, the glass transition temperature Tg, the heat capacity jump ΔCp at Tg, the melting region and the heat of fusion were evaluated. It was found that Tg is not affected by CNTs loading, whereas ΔCp appears to have an increment with CNTs content. The heat capacity jump increment reveals that more polymeric chains participate in the glass transition providing an evidence of LLDPE-CNTs interaction. The melting temperature remains unaffected and the heat of fusion or crystallinity content increases with increasing CNTs loading. Dynamic mechanical analysis experiments were performed at a single cantilever mode of deformation, from -100°C up to 70°C, at a heating rate of 3°C/min. Four frequencies, 1, 5, 10 and 20Hz were examined and the storage and loss moduli curves versus temperature were evaluated. The application of time-temperature superposition (TTS) principle was shown to work adequately, since the master curves of storage and loss moduli were constructed with the same shift factors and at a good overlapping. The reinforcing effect of CNTs on the LLDPE matrix was confirmed. Analyzing the master curves of the dynamic moduli, the existence of a strong local structure, i.e. a filler-filler or filler-polymer network, has been revealed.