THERMO-ELECTRICAL PROPERTIES AND THERMO-MECHANICAL BEHAVIOUR OF THE LDPE/CB SEMI-CONDUCTIVE COMPOSITES

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ABSTRACT

This work reports on the effect of medium-soft M3 wax and radiation-induced crosslinking on the morphology, thermal and mechanical properties, as well as electrical conductivity and thermo-switch properties of LDPE containing different amounts of carbon black (CB) or carbon black plus zinc metal as filler. Although the filler was generally well-dispersed in the polymer or polymer/wax blend, there were clear indications of the formation of conductive pathways. Different combinations of polymer, wax, CB and zinc filler and radiation-induced crosslinking gave rise to different extents of crystallinity and/or chain immobilization, which had an influence on the mechanical and thermo-mechanical properties, and on the electrical conductivity and thermo-switch behaviour. The switching shifted to higher temperatures with increasing CB content, whereas it remained the same when part of the CB was replaced with Zn. All the samples showed a drop in volume resistivity after the thermal ageing treatment (thermal cycling). However, the irradiated composites showed higher thermo-stability of electrical properties than their non-irradiated counterparts. Most importantly, the presence of wax, and CB and CB/Zn fillers, gave rise to decreased electrical resistance. The thermal expansion in the composites did not seem to play a significant role in obtaining larger values of the positive temperature-resistance coefficient (PTC). We found that the presence of a small amount of paraffin wax significantly increased the PTC coefficients of the LDPE-based (semi) conductive composites, and that gamma radiation-induced crosslinking provided the thermo-mechanical stability of the amorphous regions in LDPE needed to obtain a high PTC intensity, which would provide a cheap material with good thermo-switch functionality.