Abstract

3-D DC Conductivity of Polymer–Carbon Fibre Composites

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Although some investigators have reported the practical advantages of using carbon nanofibres in conducting composites, little has been done to understand the nature of the processing and the electrical behaviour of the polymer-nanofibre mixtures. In this study vapour-grown carbon fibres (VGCF) were mixed into a polypropylene (PP) matrix to make nanofibre composites by injection moulding in the form of a thin disk. Rectangular samples with one side along the flow direction were cut from disk at the same distance from the disk centre. As expected the DC conductivity versus filler volume fraction plots of both the systems show typical percolative behaviour in all three directions. However, the percolation threshold in the direction normal to the sample plane is higher than for the two other directions both for the PP/CCF and PP/VGCF composites. The conductivity data has been analysed using the single percolation type equation that has been successfully used to fit a wide number of continuum systems. This analytical method has revealed that the conductivity critical exponents for studied systems are similar in any direction. It has been found that the carbon fibres in both systems are highly oriented in the polymer flow direction and have an extremely low degree of disorientation with respect to the direction normal to the sample plane. Despite percolation theories predicting that there should be no anisotropy in percolation thresholds for infinitely large systems like the PP/VGCF composites such unexpected behaviour has been experimentally observed in this study. The anisotropy of percolation thresholds are discussed as a combined effect of the specific 3-D fibre orientation distribution and anisotropy of electrical conductivity in carbon fibres.

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