Semi-Solid State Deformation of Polyethylene Terephthalate/ Multiwall Carbon Nanotubes Nanocomposites

Mayoral Beatriz , McNally Tony, Hornsby Peter

One of the major challenges in the preparation of carbon nanotubes (CNT)/ polymer composites is to increase the level of dispersion of CNTs into the polymer matrix. If achieved and CNT properties can be optimally translated to polymer matrices this will lead to further improvement of MWCNT/polymer composite properties. Such materials will find widespread use on flexible electronics substrates and electromagnetic induction shielding. An investigation into semi-solid state deformation was carried out to study the effect on the dispersion of multiwall carbon nanotubes (MWCNT) in a Polyethylene Terephthalate (PET) matrix and on composite mechanical, thermal and electrical properties. PET/MWCNT composites were prepared through melt compounding in a twin-screw extruder. MWCNT formed a well-dispersed and highly interconnected structure in the PET matrix as observed by SEM, HRTEM and WAXD results. As the percentage addition of MWCNT to the PET matrix increased, the dispersion became more difficult to achieve and CNTs tended to form agglomerates. Uniaxial and biaxial stretching induced orientation of the CNTs in the stretching direction and improved their distribution and dispersion through the polymer matrix. A considerable improvement of mechanical, thermal and electrical properties of PET was achieved with the addition of low loadings of MWCNTs. A further increase of mechanical properties was obtained due to the dispersion improvement when the PET/MWCNT composites were uniaxial and biaxial stretched. An electrical percolation threshold was attained for a MWCNT loading of 1.6 wt%. As the stretch ratio increased, electrical conductivity decreased because the distance between CNTs was bigger than the minimum distance (1.8nm) required for electron hopping and the network pathways were interrupted. However, when the uniaxial stretched samples were annealed, the conductive network was recovered due to the relaxation of the CNTs.