ABSTRACT

Polysulfone (PSU) and polyimide (PI) nanocomposites filled with different conductive nanofillers like multiwalled carbon nanotubes (MWCNTs) and carbon nanofibers (CNFs) were successfully prepared using solution mixing and in-situ polymerization techniques respectively. To enhance the nanofiller-polymer interfacial adhesion, nanofillers were thermally oxidized in the presence of air and some polar groups were generated on their surfaces without reduction of aspect ratio. The introduction of polar groups on the filler surface after air oxidation was confirmed by Fourier transform infrared (FTIR) spectroscopy as well as Raman spectroscopy. Nanocomposites were extensively characterized for morphology, mechanical, thermal and electrical properties. At the optimum filler loadings, both PSU and PI composites exhibited significant improvement in mechanical and thermal properties. At higher filler loading, these measured properties exhibited significant decrement, which may be due to the agglomeration of filler particles within the matrices. The activation energy (E_a) of the thermal decomposition was calculated from Kissinger-Akahira-Sunose, Flynn-Wall-Ozawa, and Kim-Park non-isothermal kinetic methods. The AC impedance and dielectric properties like permittivity, dielectric loss were investigated in the frequency range 10-10^6 Hz for all the composites. The electromagnetic interference shielding effectiveness (EMI SE) of these composites was studied in X-band frequency region (8-12 GHz). It was found that EMI SE mainly depends on the filler type, their concentration and the thickness of composites. Some mathematical correlations of EMI SE with composite thickness and conductivity were established. Both MWCNT/CNF showed very low percolation thresholds for PSU and PI nanocomposites. Compared to MWCNT, CNF provided higher EMI SE as well as lower percolation threshold to the composite, which was attributed to the higher aspect ratio of CNF. Different theoretical models on the composition dependent DC conductivity were applied to the composites to check their validity and limitations. The temperature dependent resistivity of these composites were investigated over high temperature (30 °C to the temperature slightly above the T_g of respective polymers), and also cryogenic temperature region (12-300K). At cryogenic temperature region, the resistivity for all the composites showed NTC effect, whereas at high temperature region both PTC (at low filler concentration) and NTC (at high filler concentration) were observed depending on the concentration of fillers. In order to understand the conduction mechanism, I-V characteristics and their fitment in power law for different composites were also studied.

Keywords: *Nanocomposite, Carbon nanofiller, Conductivity, Dielectric Properties, EMI SE, PTC, NTC*