Abstract

Ethylene vinyl acetate (EVA) nanocomposites were prepared using modified natural graphite, expanded graphite (EG), multiwalled carbon nanotubes (MWCNTs) and carbon nanofibers (CNFs). Various nanofillers were chemically modified by amine, acid and silane treatments to generate polar groups to make them compatible with the polar polymer matrix. CNFs were also treated with high energy electron beam and gamma radiations at different doses to generate surface defects and polar groups. Unmodified and modified nanofillers were characterized by X-ray diffraction, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy, transmission electron microscopy, scanning electron microscopy, atomic force microscopy and thermogravimetric analysis. Various nanocomposites were also extensively characterized for morphology, mechanical, dynamic mechanical, thermal and electrical properties. Generation of surface polar groups after various modifications was confirmed from morphological as well as elemental analysis. Degree of disorder increased and crystallite size decreased after high energy irradiations and acid treatment. The surface modification using irradiation, amine and silane functional groups led to better dispersion of nanofillers in EVA and better composite properties. Acid treatment degraded the outer layers and shortened both the MWCNTs and CNFs, which in turn weakened the resulting composites. At optimum nanofiller loadings, the EVA nanocomposites exhibited significant improvement in various properties. At higher loading, the measured properties exhibited significant decrement, which may be due to the agglomeration of filler particles within the matrix. The silane treated MWCNTs and CNFs provided maximum property enhancements. Compared to EG and MWCNTs, CNFs provided highest electrical conductivity as well as lowest percolation threshold to the composite, which was attributed to the higher aspect ratio of the CNFs. The enhancement in properties with the incorporation of various nanofillers was higher for EVA having vinyl acetate content above 50%, due to the availability of large free volume in the matrix. The thermal degradation of the nanocomposites showed more dependence on the type of nanofiller rather than on the vinyl acetate content of EVA. This work probably paves the path for preparing stronger and lightweight EVA based nanocomposites for use as advanced composites.

Keywords: Nanocomposite, EVA, Carbon nanofiller, Surface modification, Physico-mechanical properties, Elastomer