Abstract

The present thesis comprises the dispersion and distribution of various carbonaceous fillers in thermoplastic elastomer and elastomeric blend matrices to unveil the structure-property relationship of composites for improved mechanical and thermal stability. The study is focused on electromagnetic interference shielding effectiveness (EMI SE) of the formed composites. To achieve superior EMI SE, variable amount of fillers like particulate specialty conductive carbon black (Vulcan XC-72), short carbon fiber (SCF), carbon nanofiber (CNF) and *in-situ* reduced graphene oxide (IRGO) have been incorporated within matrices by employing conventional melt blending in brabender plasticorder internal mixer. Dispersion and distribution of fillers were investigated in neat poly(ethylene-co-methyl acrylate) (EMA), as well as blend of poly(ethylene-co-methyl acrylate) and carboxylated acrylonitrile butadiene rubber (XNBR) (EMA/XNBR) matrices. The variation of mechanical property, dynamic mechanical stability and thermal behaviour due to incorporation of such fillers in to the composites has been studied. Electrical conductivity of composite greatly depends on the formation of interconnected conductive network structure. Therefore, the mode of dispersion of filler in pure polymer and blend composites has been investigated. Blending of polymers to achieve tailor made properties for specific application have been widely applicable. Since the viscosity of polymer plays an important role to control the dispersion behaviour of fillers and formation of conductive network architecture we have fabricated "Technologically compatible blend" of EMA/XNBR depending on their different viscosity to achieve improved DC electrical conductivity by retaining the properties of individual components. DC conductivity of all composites was evaluated against filler concentration and percolation threshold was calculated from power law equation to find out the formation of interconnected conductive network architecture. EMI SE of the composites has been studied over X-band frequency range of 8.2 – 12.4 GHz and systematic study reveals that interconnected conductive network attenuates harmful electromagnetic radiation by absorbing the incident electromagnetic waves on composites and the effectiveness is influenced by various factors, like, filler loading, degree of mixing, dispersion and distribution of filler through polymer, filler-polymer interaction as well as thickness of the sample. Detail investigation has been performed to study the effect of aspect ratio of fibrous filler (SCF, CNF) on the mechanical, thermal, electrical property and EMI SE of EMA/short carbon fiber (EMA/SCF), EMA/carbon nanofiber (EMA/CNF) and EMA/XNBR/CNF (EXCF) composites with increasing filler loading. This work demonstrates that very high temperature and shearing action converts graphene oxide (GO) to partially reduced graphene oxide by in-situ melt blending of GO in EMA and EMA/XNBR blend system by increasing the temperature of the system for the synergistic effect of high temperature and frictional heat produced in polymer matrices from shearing action. This study highlights on the reduction mechanism of GO, where effectiveness significantly depends on the methodologies, chemistry of polymer and processing conditions. Thorough morphological characterization has been performed to elucidate the dispersion of filler within matrices. This reveals that formation of segregated morphology by the construction of 3D conductive network enhances the electrical conductivity by lowering the percolation threshold to very lower extent of

1.98 phr and results very high EMI SE with adjustable mechanical property and thermal stability. Systematic study reveals that fabrication of blend composites divulges an effective method to prepare cost-effective, robust, light weight, flexible superior EMI shielding material by lowering the percolation threshold to significant extent. This illustrates the improved dispersion of fillers either in the individual blend element or at the interfaces of constituent blend element also reduces the thickness of material to offer improved shielding effectiveness.

Keywords: *Polymer composites, Electrical conductivity, Percolation threshold, Electromagnetic interference, Mechanical properties, Thermal stability, Morphology, Filler loading.*