ABSTRACT

Multiwalled carbon nanotubes (MWCNTs) with unique combination of dimension, structure and topology are estimated to impart high degree of reinforcement to various elastomers and elastomeric blends. However, their high tendency for aggregation remains the most critical challenge in achieving their homogeneous dispersion necessary for effective reinforcement. As a result, MWCNT is subjected primarily to covalent functionalization, non-covalent modification, and ionic liquids. In recent years, alternative efforts have also been made to improve the dispersion of the nanotubes in the elastomeric matrices by using 3D fillers obtained by hybridization of 1D and 2D fillers. Such 3D structures get homogeneously dispersed throughout the elastomeric matrix resulting in high contact area with polymer which ensures effective stress transfer from filler to polymer matrix.

The present thesis is focused on MWCNT based 3D hybrid fillers from the simple combination of unmodified 1D carbon nanotubes and 2D clay or layered double hydroxide platelets. In view of this, MWCNT/MMT (HMM), MWCNT/Hectorite (HMH) and MWCNT/MgAl-LDH (HML) hybrids were prepared by mixing the constituent fillers in 1:1 ratio (by weight) in co-dispersion and dry grinding methods respectively. Subsequently, these hybrid fillers were used in fabrication of commercially important EVA, SBR elastomers and NBR/EVA elastomeric blend nanocomposites by solution intercalation method. This is followed by their detailed characterization and analysis of their mechanical, thermal, dynamic mechanical and dielectric properties.

Our analysis confirmed extraordinary improvement in mechanical and dielectric properties of EVA/HMM nanocomposite with substantial enhancement in thermal stability. This is attributed to homogeneous dispersion of constituent fillers and high degree of synergy between them towards reinforcement. Similarly, EVA/HMH and EVA/HML nanocomposites displayed enhanced mechanical, thermal and dielectric response owing to improved degree of filler dispersion. SBR/HMH nanocomposites showed enhancement only in mechanical properties with nominal improvement in dielectric response. However, NBR/EVA/HMH blend nanocomposites displayed improved mechanical as well as dynamic-mechanical properties on account of homogeneous dispersion of 3D hybrid fillers throughout the compatible blend matrix. Significant rise in polymer-3D hybrid contact area and degree of dispersion are the primary reasons for improved polymer-filler interfacial interaction and hence reinforcement.

Keywords: Hybrid filler, MWCNT, MMT, Hectorite, MgAl-LDH, EVA, SBR, NBR/EVA, Blend, Nanocomposite, Reinforcement, Synergy