Epoxy resin composites reinforced with carbon-based nanomaterials for electromagnetic interference (EMI) shielding applications

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ABSTRACT

With the widespread use of portable electronic and wearable devices, there is an increasing need for efficient, low cost EMI shielding materials. Epoxy resin is one of the most important thermosetting polymer due to its high mechanical properties, chemical resistance, low cost, ease of processing and low weight. Many studies have been carried out to prove its performance as an ideal matrix for the fabrication of EMI shielding materials with carbon-based nanoreinforcers [1,2].

In this work, epoxy resin composites with commercial multi-walled carbon nanotubes (MWCNTs) and graphene nanoplates (GP) as well as nanocarbons derived from the metallothermic (MTH) CO_2 reduction method[3] were prepared via solution mixing. In addition, hybrid composites with 50:50 w/w MWCNTs/GP were also examined.

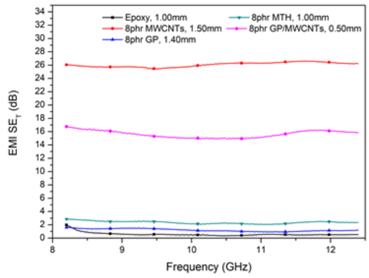

Figure 1. EMI shielding effectiveness of epoxy resin composites.

Characterization of EMI shielding effectiveness revealed that epoxy resin composites reinforced with MWCNTs presented the best performance. Composites with the same content of graphene and MTH nanocarbons exhibited much lower shielding results. As confirmed by electrical conductivity measurements, this outcome can be explained by the fact that the electrical percolation threshold in the composites reinforced with MWCNTs was already achieved while the conductive network in the composites with graphene and MTH nanocarbons was not completely developed.

Analysis of the mechanisms that contribute to EMI shielding for each type of specimens showed that, in the case of MWCNTs composites, the main mechanism that determines the response of the material is reflection rather than absorption. It was also observed that by increasing the MWCNTs content the shielding efficiency of the composites is enhanced. In the case of graphene and MTH nanocarbon composites, absorption and reflection are kept at low levels, resulting in high transmission and therefore poor shielding. Regarding the examined hybrid composites, it seemed that MWCNTs content controls their shielding performance (MWCNTs:GP, 50:50 w/w).

KEYWORDS: Epoxy resin, EMI shielding, multi-walled carbon nanotubes, graphene, nanocarbons, CO_2 metallothermic reduction

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