

ELECTRICAL CONDUCTIVITY OF THE MULTI-WALLED CARBON NANOTUBES/EPOXY NANOCOMPOSITES

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Introduction

Carbon nanotubes have excellent mechanical and electrical properties, and are also a good reinforcement material for composites. The recent theoretical and experimental investigations indicate that they have properties suitable for application in many fields. Their interesting mechanical and (axial Young modulus 1-5 TPa[1-3], high flexibility [4], bending fully reversible up to a 110° critical angle for SWNT [5], and physical metallic or semi-conducting character [6,7]. The CNT-based composites, which may be one of the most promising application, have been intensively studied using different matrix materials, polymers [8], ceramic [9-11] and metals [12-13]. In this study, the MWNTs/epoxy nanocomposites were fabricated and the electrical conductivity of the MWNTs/epoxy nanocomposites were obtained.

Experimental

Materials

The matrix used in this study was a 635 epoxy resin with viscosity 6 Ps purchased from US composites. Low viscosity of epoxy resin was chosen to give better wetting condition with fillers. The conductive filler was multi-walled carbon nanotubes (MWNTs) NC7000 purchased from Nanocyl, Belgium. The average diameter is 9.5 nm, and the length is 1.5 µm, with purity ≥90%, reported by manufacturer.

The epoxy and curing agent were poured into the container with ratio 3:1 in weight percentage wt%. The mixture was mixed using the mechanical mixer at 800 rpm for 20s. MWNTs with different concentration (2.5, 5.0, 7.5 and 10wt%) were added into epoxy and curing agent mixture, which was mixed again using mechanical mixer at 800 rpm for 3 min. Epoxy resin/MWNTs/curing agent mixture were poured into the mould. Finally, the mixture was cured in the vacuum oven at 80 °C for 2 hrs.

Apparatus

The mixture was cured in the vacuum oven (Napco model 5831).

The electrical conductivity of the MWNTs/Epoxy nanocomposite was measured by Jandel multi height four-point probe combined with a RM3 test unit.

The blend was mixed using the mechanical mixer model RW 20-IKA-WERK.

The fracture surface morphology were investigated with a field emission scanning electron microscope (FESEM, Model Supra 55/55VP) at an accelerating voltage of 30 kV.

Results and Discussion

The variation of electrical conductivity of epoxy nanocomposites as function of MWNTs types and loading concentration in weight percentage are shown in Fig.1. Non-conductive material of pure epoxy polymer becomes conductive as incorporated MWNTs. At low loading concentration of MWNTs at 2.5 wt%, MWNTs/epoxy nanocomposite plates already shown improvement of electrical conductivity. The electrical conductivity of epoxy nanocomposites are increased with increasing of MWNTs loading concentration. All results gave electrical conductivity exceeding 10⁻⁸ S/cm, therefore these specimens able to dissipate electrostatic charges for usage in various electric and electronic applications.

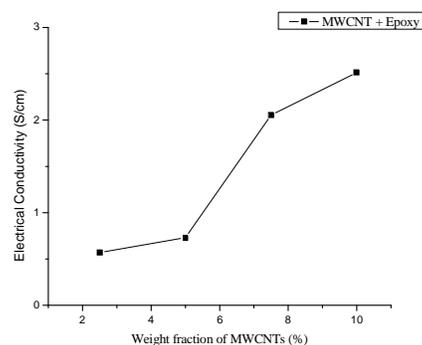


Fig. 1 Effect of MWNTs weight fraction on electrical conductivity of epoxy

Scanning electron microscopic (SEM) image of the MWNTs/epoxy nanocomposite specimen is given in Fig.2 Significant MWNTs agglomeration can be

observed on the fracture surface. However, CNTs used in this study is as produced MWNTs which easy to entangle and form agglomeration due to high aspect ratio of individual CNTs. CNTs observed to be embedded in polymer matrix and some had been pulled out from polymer matrix. Fig.3 Show that MWNTs has moderate wetting property with epoxy matrix.

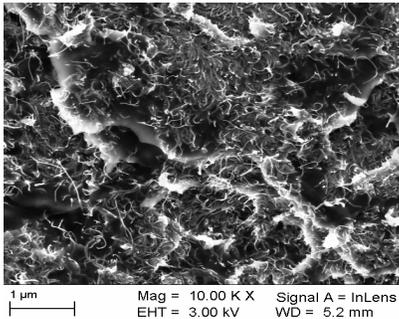


Fig. 2 FESEM images of the fracture surface for MWNTs/epoxy nanocomposites

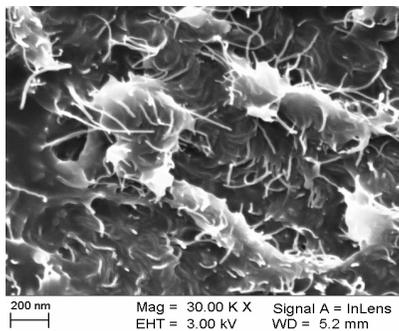


Fig. 3 Higher magnification of fig. 2

Conclusion

The electrical properties of MWNTs/epoxy nanocomposite have been investigated in an attempt to understand the influence of new material in these polymer composites. The electrical conductivity of MWNTs/epoxy nanocomposite is higher than 10^{-8} . Therefore it can be used for electrical applications.

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