SYNERGY EFFECTS IN EPOXY RESIN COMPOSITES FILLED WITH CARBON NANOTUBES AND MAGNESIUM OXIDE NANOPARTICLES

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Polymeric composites are widely used as materials which not only have desired properties of polymers such as the flexibility, ease of manufacture, lightness, resistance to fractures, but can also be given additional ones like the electrical conductivity. Huge electrical conductivity in composites can be achieved with only a small addition of carbon nanotubes (CNT) [1]. Reducing the required amount of CNT to achieve such properties is very desirable since currently CNTs are expensive and take a long time to be produced. Using dielectric spectroscopy in this work were investigated hybrid epoxy resin composites filled with CNT and the electrically insulating and thermally conductive [2] MgO nanoparticles (mean diameter 40 nm) in order to find the synergetic effects and possible positive enhancement of dielectric properties.

The epoxy resin composite samples were of constant 0.46 % CNT volume (vol.) concentration, while MgO concentrations were: 0, 0.5, 1, 2 vol. %. The selected CNT concentration is slightly above the percolation threshold required for the CNT to connect into a pathway for electrical current. The measurements were performed in the 20 Hz – 1 MHz frequency and 33 – 500 K temperature ranges.

Composites with 0.46 % CNT in addition to any amount of MgO nanoparticles showed increased values of the dielectric permittivity, DC conductivity and critical frequency. The highest conductivity values were observed for samples with the lowest 0.5 vol. % concentration of MgO, while increasing MgO content above this value showed the conductivity together with dielectric permittivity decreasing.

These results imply that during the preparation of composites a low concentration (about 0.5 vol. %) of MgO works as an agent which promotes better dispersion of CNT inside epoxy resin, which overall has a strong positive effect on the formation of an electrical percolation network.

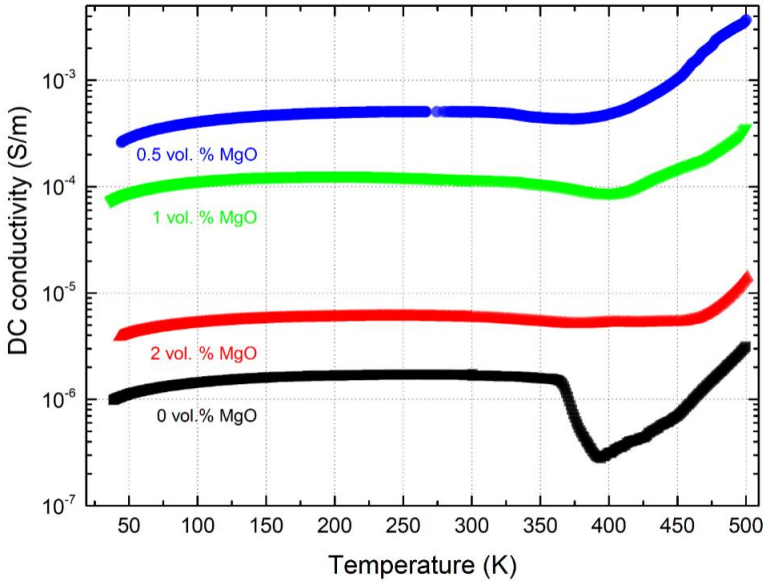

Figure 1. DC conductivity of the epoxy resin hybrid composites with 0.46 vol. % CNT and 0-2 vol. % MgO inclusions in a 33 – 500 K temperature range.

[1] Michael F. L. De Volder, Sameh H. Tawfick, Ray H. Baughman, John Hart, Carbon Nanotubes: Present and Future Commercial Applications, *Science vol.* 337, 535-537 (2013).
[2] Amir Masound Pourrahimi, Love K. H. Pallon, Dongming Liu, Tuan Anh Hoang, Stanislaw Gubanski, Mikael S. Hedenqvist, Richard T. Olsson, Ulf W. Gedde, Polyethylene Nanocomposites for the Next generation Ultralow-Transmision-Loss HVDC Cables Insulation Containing Moisture-Resistant MgO Nanoparticles, *ACS Appl. Mater. Interfaces 2016, 8,* 14824-14833 (2016).