Hibridiniai kompozitai su vario nanodalelėmis padengtais anglimi ir daugiasieniais anglies nanovamzdeliais elektromagnetiniams taikymams

Carbon-coated copper nanoparticles and MWCNT based hybrid composites for electromagnetic applications

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The swift advancement of electronic devices and communication systems has given rise to the substantial proliferation of electromagnetic pollution. Electromagnetic interference (EMI) shielding materials hold the capacity to effectively mitigate the deleterious consequences arising from EMI, thus serving as a potent countermeasure[1].

Traditionally, metal or metal alloy coatings that primarily reflect electromagnetic radiation were used for EMI shielding purposes.

In this work, we investigated a series of samples containing carbon-coated copper nanoparticles(Cu@C, 99.8%, 25nm, USNano) at different volume fractions A (A equals 5%, 10%, 15%, 20%) and/or MWCNT(>95%, OD: 10-20 nm, USNano) at volume fractions B (B equals 0.05%, 0.10%, 0.25%, 0.50%, 0.75%, 1.00%), introduced into the epoxy matrix.

The electromagnetic properties of prepared composites were investigated in the 20 Hz – 1 MHz frequency range by means of an HP 4284A LCR-meter. The properties of the investigated materials were calculated using standard techniques [2].

Samples containing only Cu@C in the epoxy matrix depict increase in the real and imaginary parts of dielectric permittivity with increasing volume fraction A. Conductivity value increases from 1.2×10^{-3} S/m up to 1.8 S/m at 1.2 kHz.

In turn, samples containing MWCNT in the epoxy matrix exhibit similar behavior, and the conductivity value increases from 1.2×10^{-8} S/m to 2.0×10^{-5} S/m at 1.2 kHz with increasing volume fraction B.

Hybrid composites containing both MWCNT and Cu@C particles were prepared with volume fractions A = 5% and B = 0.05%, 0.10%, 0.25%, 0.50%, 0.75%, 1.00%. Surprisingly, in that case we observed the peak conductivity value of 1.3×10^{-2} S/m in the case of sample with A = 5% and B = 0.10%. Further increase of A value resulted in a decrease of conductivity value.

Conductivity values (1.2 kHz) of the MWCNT/Epoxy and MWCNT/Cu@C/Epoxy samples are presented in Figure 1.

MWCNT/Cu@C/Epoxy (A = 5%) samples' thermal conductivity measurements results at room temperature are presented in the Table 1.

λ values are an order of magnitude higher than that of the air and are similar to that of pure Poly(dimethylsiloxane) (PDMS).

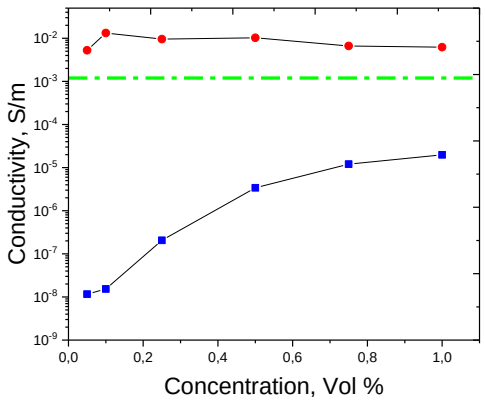

Figure 1. MWCNT/Cu@C/Epoxy (red) and MWCNT/Epoxy (blue) conductivity values versus the concentration of MWCNT. Green line represents conductivity value of Cu@C/Epoxy (A = 5%) sample at 1.2 kHz.

Table 1. Thermal conductivities of the MWCNT/Cu@C(5%)/Epoxy samples.

MWCNT Concentration, vol %	$\lambda, \mathrm{Wm^{-1}K^{-1}}$
0.05	0.244
0.10	0.245
0.25	0.230
0.50	0.254
0.75	0.239
1.00	0.259

Despite low thermal conductivity values such samples can be used for various electromagnetic coatings preparation.

Keywords: hybrid composites, electromagnetic interference, conductivity, dielectric permittivity.

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