Electromagnetic shielding efficiency in Ka-band: carbon foam versus epoxy resin nanocomposites

P. Kuzhir, A. Paddubskaya, A. Pliushch, S. Maksimenko, A. Celzard, V. Fierro, G. Amaral-Labat, A. Pizzi, J. Macutkevic, G. Valusis, M. Ivanov, J. Banys, L. Coderoni, F. Micciulla, I. Sacco, S. Bellucci

Research Institute for Nuclear problems of Belarusian State University (INP BSU) IJL – UMR CNRS 7198 and LERMAB – ENSTIB, Center for Physical Sciences and Technology (CPST), Vilnius University (VU) INFN-Laboratori Nazionali di Frascati

We report on the comparative study of the effectiveness of electromagnetic (EM) shielding in Ka-band provided by epoxy resin filled with nanostructured carbon additives in relatively small concentrations (0.25-2 wt.%) and micro-structural porous carbon solids (carbon foams) of different bulk densities, from 0.042 to 0.150 g/cm3. Microwave probing of carbon foams shows that transmission of 2 millimeter thick layer strongly decreases with the decrease of pore size up to the level of 0.6% due to significant rise of the reflectance ability. The series of pre-percolative and close-to-percolation threshold nanocarbon based samples were prepared using Epoxy resin, an own curing agent A1 (modified TEPA) and different types of functional filler: artificial and natural graphite, thermally exfoliated graphite, thick graphene, carbon blacks having different surface areas, activated carbon of different granulometries, and carbon nanotubes (both single- and multi-walled). We found that 2 mm thick epoxy resin nanocomposites in some cases (1.5-2 wt.% content of thermally exfoliated graphite, thick graphene and carbon nanotubes) demonstrate pretty high EM attenuation of 26-37 GHz signal on the level of -18 □ -22 dB. To conclude, both carbon foam and epoxy resin loaded with nano-sized carbon inclusions could lead to fabrication of effective EM coating, thin and light, to be used for EM protection.

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Broadband dielectric spectroscopy of carbon nanotubes composites

J. Macutkevic[1*], A. Paddubskaya[2], J. Banys[3], P. Kuzhir[2], S. Maksimenko[2], V. Kuznetsov[4], I. Mazov[4], I. Simonova[4]

[1] Center for Physical Sciences and Technology, Lithuania
[2] Institute of Nuclear Problems, BSU, Belarus
[3] Vilnius University, Lithuania
[4] Boreskov Institute of Catalysis SB RAS, Russia

The dielectric properties of composites with carbon nanotubes (CNT) are widely studied, due to their attractive applications and interesting fundamental physics. High dielectric permittivity and electric conductivity are reported for polymer composites with carbon nanotubes embedded in concentrations close and above the percolation threshold. However, there is a lack of a deep understanding of relations between microscopic CNT parameters (such as, dielectric poliarizability, matrix microstructure chain length and degree of polymeratation, etc) and dielectric properties of fabricated composites as a whole. In this contribution the effects of processing conditions and CNT oxidation treatment on dielectric properties of multiwall carbon nanotube/PMMA composites has been discussed. We present the dielectric properties of polymethyl methacrylate (PMMA) composite filled with multi-walled carbon nanotubes (MWCNT) with different average diameter in wide frequency (20 Hz – 1 MHz) and temperature range (300 – 400 K). CNT with narrow outher diameter distribution and known number of inner shells were produced via reaction of ethylene decomposition at 650-700 ^{0}C in standard CVD setup using Fe-Co catalysts. Two types of CNT were investigated, named FCA and FCM series, with average outer diameter ~ 9 nm and 12-14 nm respectively. The wall number has been estimated for thin nanotubes as 3-7, for the thick ones as 8-15 walls. The composites were produced via coagulation precipitation technique and in-situ polymerization of MMA. The temperature dependence of complex dielectric permittivity at different frequencies is mainly caused by β relaxation for all investigated samples. The mean relaxation time decreases on cooling according to Arrhenius law.

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