Kompozitų su anglies nanovamzdeliais elektrinių savybių tyrimas

Broadband electrical properties of carbon nanotubes epoxy composites

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Carbon nanotubes (CNT) attract the attention of many researchers for investigations due to their excellent thermal, mechanical properties and very high electrical conductivity. Combining conductive CNTs and insulating polymer as the matrix the result is a new material with properties different from each component separately. Electrically percolative polymer composites are attractive due to their potential applications as antistatic, sensitive materials and electromagnetic coatings [1].

Despite of outstanding properties, CNTs are fairly expensive and while producing the composites it is important to use as small amount of CNTs as possible. That means that the percolation threshold should be as low as possible.

The percolation threshold according to excluded volume theory is inversely proportional to CNTs aspect ratio [2], however, the experimental percolation threshold value could be much higher or lower than theoretical. The electrical conductivity and the percolation threshold depends on filler parameters, dispersion and even from composite preparation technology. The impact of these factors on broadband electrical properties are not clearly understood and an investigation is still needed in this field. Due to that, epoxy resin composites filled with multiwalled carbon nanotubes (MWCNTs) were produced and electrical properties and percolation phenomenon were investigated in wide frequency range from 20 Hz to 2 THz.

The epoxy resin composites were produced with MWCNTs concentration from 0 wt.% to 2 wt.%, the average diameter of used nanotubes was about 30-40 nm, their length is up to 100 μm.

Pure epoxy resin is an insulator, with low dielectric permittivity value and has no DC conductvity at room temperature. The addition of small amount of MWCNT (0.25 wt%) into epoxy resin results several orders higher dielectric permittivity (below 10 kHz) and DC conductivity of 0.1 mS/m. The values of the dielectric permittivity and the electrical conductivity rapidly increase with MWCNT concentration, particularly at lower frequencies.

Above and near percolation threshold conductivity follows the power law:

$$\sigma(p) \propto (p - p_c)^t \qquad (1)$$

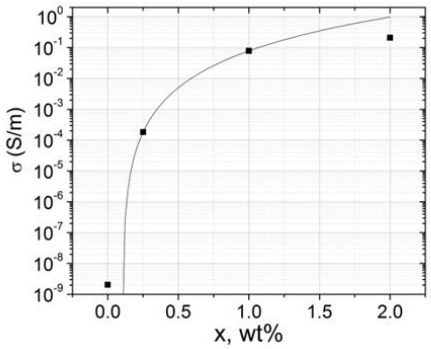

Fig. 1. Concentration dependences of electrical conductivity of MWCNT composites. Solid line is the fit of the power law

The dielectric permittivity and electrical conductivity of epoxy resin with 0 wt.% of MWCNT are very low and addition of small amount of conductive MWCNTs increases the electrical conductivity by several orders. The percolation threshold was estimated as 0.1 wt.%.

Reikšminiai žodžiai: elektrinis laidumas, kompozitai.

Literatūra

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