

## Elektrinės kompozitų su anglies nanovamzdeliais ir grafenu savybės

### Electrical properties of composites filled with carbon nanotubes and graphene nanoplatelets

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The need of more performant integrated circuits and high power density communication devices drives the development of materials enhancing the conductive performances by carbon nanoparticles. Among nanocomposites, the ternary hybrid carbon nanotubes/graphene nanoplatelets/polymer composites represent a debatable route to enhance the transport performances.

Polymer composites with various carbon inclusions like multiwalled carbon nanotubes (MWCNT), carbon black (CB), graphite or graphene are interesting for fundamental research and are attractive for various applications [1]. The electrical percolation threshold of these composites could be very low and it is important to obtain as low percolation threshold as possible in order to reach optimal mechanical properties of composites and to use minimal concentration of expensive fillers. Adding several different fillers in the matrix the percolation threshold can decrease in comparison with single filler composites due to synergy effect between the different components [2].

In this contribution the dielectric/electrical properties of epoxy resin composites filled with different nanofillers were investigated. The composites were filled with MWCNT (filler content 0.015 – 0.3 wt.%), graphene nanoplatelets (GNP) (filler content 0.015 – 3 wt.%) and hybrid MWCNT/GNP filler with total contents 0.03 and 0.3 wt.% and in different ratios.

The dielectric measurement were performed in frequency range from 20 Hz to 3 GHz at room temperature and at low frequencies (20 Hz – 1 MHz) in temperature range from 30 K to 300 K. In frequency range from 20 Hz to 1 MHz measurements were performed using LCR meter (HP4284) measuring the capacitance and the loss tangent. For low temperature measurements the helium closed cycle cryostat was used. In frequency range from 1 MHz to 3 GHz reflection and phase were measured using the coaxial line technique with the vector network analyzer (Agilent 8714 ET).

The quantitative synergy effect on the material electrical conductivity was obtained due to combination of both carbon fillers at filler content 0.3 wt.%. The electrical conductivity of hybrid filler composites, containing 0.25 wt.% of MWCNT and small amount of GNP 0.05 wt.% was 4 times higher than the conductivity of composites containing only MWCNT with total 0.3 wt.% content.

In this presentation the results of electrical investigations of epoxy resin matrix composites filled with MWCNT, GNP and hybrid MWCNT/GNP composites will be presented and discussed in wide frequency and temperature range.

*Reikšminiai žodžiai: dielektrinė spektroskopija, kompozitai, anglies nanovamzdeliai, grafenas.*

#### References

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