Dielectric properties of graphene nanoplatelets/epoxy composites

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Polymer composite mixing bulk specific properties of the matrix flexibility, resistance to corrosion, good processability, strong adhesion to different substrates, curing ability etc- and conducting properties from the fillers (ferrites, noble metals, carbon and graphite nano- and microstructures) have received a lot of attention during the last two decades. These advanced materials find more and more applications in aerospace, automotive, energy, electronics, defense and health care sectors. Among others, one of the most promising fillers used to produce conductive polymer composites is carbon in various forms: carbon black, graphene, microsized quartz coated by graphene vapor-grown carbon fibers, multi-walled and single-walled carbon nanotubes, onion-like carbon [1]. A reason for that is the light weight, the chemical resistance and the high dc and ac conductivity of those structures. To explore the electromagnetic (EM) applications of composites, it is important to measure and analyze their electrical conductivity and effective permittivity.

In this presentation will be presented results of broadband dielectric spectroscopy of epoxy resin composites containing graphene nanoplatelets (GNP) in a wide temperature range (25-500 K). The as-produced composites were heated at temperatures above the epoxy glass transition and subsequently cooled down to room temperature. This annealing was proved to be a simple but powerful process to improve significantly the electromagnetic properties of the GNP-based composites. The dc conductivity of epoxy filled with 4 wt% GNP is 68 times higher after annealing. Another benefit of the annealing is to lower substantially the percolation threshold, from 2.3 wt% for as-produced samples to 1.4 wt%. In composites above the percolation threshold, the electrical conductivity is the result of tunneling between GNP clusters. For a given GNP concentration, the tunnel barrier decreases after annealing.

References

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