MULTIFUNCTIONAL RESPONSE OF: FERRITE/EPOXY, MWCNT/EPOXY AND MWCNT/FERRITE/EPOXY NANODIELECTRICS

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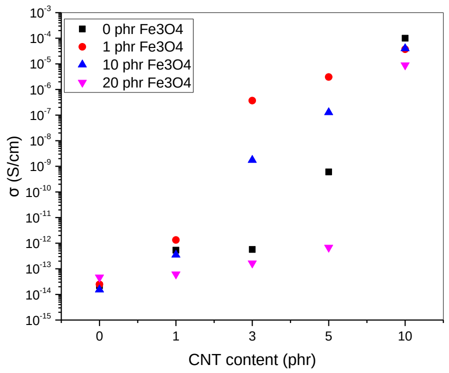
ABSTRACT

Multiwall Carbon nanotubes (MCNTs) constitute a popular reinforcing phase for the development of advanced nanocomposites, mainly because of their mechanical, thermal and electrical properties. Moreover, magnetic nanoparticles embedded in a polymer matrix influence both the dielectric and magnetic behaviour of the composite system[1-5].

In the present study, a series of composite nanodielectrics consisting of an epoxy matrix and iron oxide nanoparticles and/or MWCNTs have been developed and studied varying the filler type and content. The goal of the present study is to exploit in a single nanocomposite advanced mechanical, thermal, electrical and magnetic performance. The structure-properties relationships, were investigated by means of Scanning Electron Microscopy (SEM), Differential Scanning Calorimetry (DSC), Dynamic Mechanical Analysis respectively (DMA), and Broadband Dielectric Spectroscopy (BDS), while magnetic characterization was conducted by means of a Superconducting Quantum Interference Device (SQUID).

Depending on the filler type and concentration, nanodielectrics exhibit either insulator to conductor transition or dielectric relaxation phenomena. Dielectric response includes three distinct relaxation modes attributed to interfacial polarization, glass to rubber transition (α-relaxation) and motion of polar side groups (β–relaxation). The addition of small amount of Fe_3O_4 nanoparticles seems to facilitate the transition to the conductive phase, while nanocomposites with excessive ferrite content augments the insulating behaviour. As expected the presence of magnetic nanoparticles strengthens the magnetic properties of the nanocomposites. Finally, energy storage and harvesting is examined and optimum type and content for multifunctional behaviour is discussed.



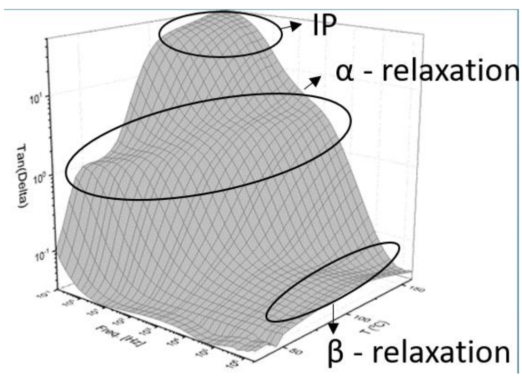


Figure 1. AC conductivity as a function of the MWCNT content at 30 °C and 0.1 Hz, for all examined systems (left), and loss tangent as a function of temperature and frequency for the nanocomposite with 1 phr MWCNT and 10 phr in Fe_3O_4 content (right).

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