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Dispersed nano-graphene platelets within water-soluble bio-compatible polymers: Characterization of multi-scale electric charge flow in combined pressure and temperature conditions

The electronic properties of polymer composites with dispersed nano-graphene platelets (NGPs) depend on the transition rate of charge carrier transport by fluctuation induced tunneling through the insulating polymer. The transition rate is determined by the concentration of conducting islands, pressure and temperature. Different electric charge flow mechanisms are characterized by different transition rates which can be resolved by employing broadband dielectric spectroscopy (BDS). Polyvinylalcohol (PVA) and polyvinylalcohol/polyvinylpyrrolidone (PVA/PVP) 50 w/w, which are flexible, water-soluble, bio-compatible polymers with sufficient optical transparency, were loaded with NGP fractions in the vicinity of electrical percolation threshold. BDS at temperatures below 313 K and pressures up to 30 MPa results in balancing conductivity vs. capacitance effects. A number of interesting phenomena are reported and interpreted, in terms of the critical behavior of the composites around the insulator to conductor transition, as well as to the glass transition of PVA. Pressure-temperature BDS enables a detailed insight into microscopic charge transport processes, providing the knowledge for functionalization and optimization of the physical properties of the nano-composites. The switching behavior of the nano-composites suggests that they may probably be used as pressure sensors.

Biography

Anthony N Papathanassiou is leading the Dielectric Spectroscopy Laboratory at the Department of Physics, National and Kapodistrian University of Athens (NKUA), Greece. He got his PhD in Solid State Physics from NKUA. He worked as Research Associate in NKUA, Universität Bayreuth and Lyman Physics Laboratory, Harvard University as a Research Scholar or Research Fellow. His current research interest is on electric charge transport and relaxation in electron-conducting polymers and nano-composites, emphasizing on the role of pressure and temperature on electronic properties and phase transitions of condensed matter.

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