Nanotek-2013

OMICS Group Conferences
Accelerating Scientific Discovery

3rd International Conference on
Nanotek & Expo

December 2-4, 2013 Las Vegas, USA

Dynamic tensile modulus and tunneling current under applied electric field for polymer-carbon filler composites

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Abstract

The characteristics of nanomaterials have been explored to attain enhanced mechanical properties and to achieve certain levels of electric conductivity through a percolation networks. The reported treatments contain precise experimental descriptions but the theoretical analyses are not still established. The reasons are 1) no method for testing mechanical properties and X-ray diffraction intensity under electric field, different from usual techniques by external forced heating and 2) misunderstanding for thermal fluctuation-induced tunneling conduction. Conductive (or semi-conductive) property of carbon filler-polymer composites certainly provides the temperature increase by Joule heat under applied electric field, but no method has been reported for testing mechanical and morphological properties under applied electric field precisely. This presentation deals with frequency dependence of the dynamic tensile modulus of carbon filler-polymer composites under applied electric field, different from classical measurements by external forced heating. To establish successful methods, home-made attachments were fixed on commercial instruments. The measurements are done for polyimide-vapor grown carbon fiber (VGCF) composites and ultra-high molecular weight linear polyethylene (UHMWPE)-nickel coated carbon fiber (NiCF) composites. The theoretical analyses were done in terms of thermal fluctuation-induced tunneling conduction. As the results, PI-VGCF composites were confirmed to be very stable to Joule heat arisen by electron collision against atoms on PI chains. In contrast, UHMWPE-NiCF provided X-ray intensity curve from only amorphous halo by perfect disappearance of crystal diffraction peaks at 129.0 ^{o}C (the equilibrium melting point, 145.5 ^{o}C) and storage modulus decreased drastically at low frequency indicating damage of positive temperature coefficient (PTC) materials against low-frequency earthquake.

Biography

Masaru Matsuo has completed his PhD at Kyoto University in Japan and he was a professor of Nara Women's University. After his retirement, he becomes a professor of Dalian University of Technology in China. He has published about 200 papers in refereed journal articles. He is IUPAC fellow and he received Paul Flory Polymer Research Prize on April 2010.