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Self-sensing of strain in a fiber glass/epoxy composite by built-in stripe of carbon nanotubes with Ag nanoparticles

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Statement of the Problem: Strain sensing composite materials have attracted considerable attention for their unique characteristics exceeding conventionally applied materials. Between different solutions and various types of transducers available for these applications, piezo-resistive strain sensors are among the most investigated ones usually based on conductive polymer composites prepared by embedding of electrically conductive fillers as carbon nanotubes into a polymeric matrix. This principle can be used for monitoring of deformation or stress stimulus in elongation or compression. The responses are sensitive and reversible with sufficient durability in the dynamic loadings measured by a macroscopic electrical resistance change. Methodology & Theoretical Orientation: In our contribution we introduce a strain sensing composite material composed of electrically conductive entangled network of Ag decorated multiwalled carbon nanotubes (MWCNTs) integrated into the glass fiber/epoxy composite. A vacuum infusion technique was used for the composite fabrication. The experimental results revealed that an integrated strain sensing exhibit long term electromechanical stability which was linked to the level of strain in the host glass fiber/epoxy structure. It has been proven that modification of pristine MWCNTs with Ag nanoparticles increase the sensitivity to applied strain. Simultaneously pre-strain stimulation was also applied to further enhance detection ability. The resistance sensitivity, quantified by a gauge factor, increased more than hundredfold for a pre-strained sensor with Ag decorated nanotubes in comparison with the value of about 5 for sensor with pristine nanotubes. This is a substantial increase which ranks this new material among strain gauges with the highest electromechanical sensitivity. The obtained data indicated also a reasonable stability of the measurement with no effect of load alterations on the sensor resistance changes. Additionally, the thermoelectric properties, Joule heating and antennal signal reception by MWCNT stripe will be mentioned.

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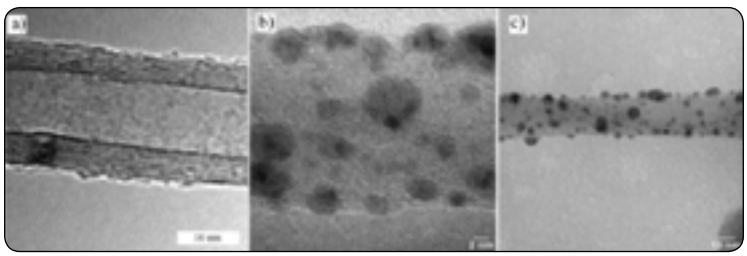

HRTEM micrograph of the structure of individual nanotube; b) and c) TEM micrographs of individual nanotubes with deposited Ag clusters

Recent Publications:

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5. Slobodian P, Riha P, Saha P (2012) A highly-deformable composite composed of an entangled network of electrically-conductive carbon-nanotubes embedded in elastic polyurethane. Carbon 50: 3446-3453.
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Biography

Petr Slobodian received the Ph.D. degree in polymer science from the Faculty of Technology, Tomas Bata University (TBU), Zlin, Czech Republic and the Ms. degree from the Brno University of Technology, Brno, Czech Republic. He is a Scientific Researcher at the Centre of Polymer Systems, TBU. He is the associate professor at the Faculty of Technology since 2008. He is author or co-author of 76 scientific articles all published in the impacted journals. His main interests are polymer composite materials, carbon nanotubes and their use in the organic vapor sensors, strain sensors and stretchable thermoelectric materials.

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