

Numerical simulation on piezoresistivity of nanofiller and polymer based nanocomposites

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Abstract

In this work, we propose a 3 dimensional (3D) resistor-network numerical model to predict the piezoresistivity behaviors of a nanocomposite material made from an insulating polymer filled by various conductive nanofillers, e.g., carbon nanotubes (CNTs) considered here. This material is very hopeful for its applications in highly sensitive resistance-type strain sensors by measuring its piezoresistivity, i.e., the resistance change ratio versus the applied strain. In this 3D numerical model, three main working mechanisms, which are well-known to induce the piezoresistivity of the nanocomposite strain sensors to date, are considered. They are, a) the change of the internal conductive network formed by the CNTs; b) the tunneling effects among neighboring CNTs and c) the piezoresistivity of the CNTs themselves, respectively. Comparisons between the present numerical results with our previous experimental results are also performed to validate the present numerical model. The influence of the piezoresistivity of the CNTs on the piezoresistivity of the nanocomposite strain sensors is explored in detail by comparing it with the effects of the other two mechanisms. It is found that the main working mechanisms for the nanocomposite sensors should be the change of the internal conductive network and the tunneling effects. The contribution from the piezoresistivity of the CNTs to the total piezoresistivity of the nanocomposite sensors is very small.

Keywords: Carbon nanotube, Conductive network, Nanocomposite, Piezoresistivity, Tunneling effect.