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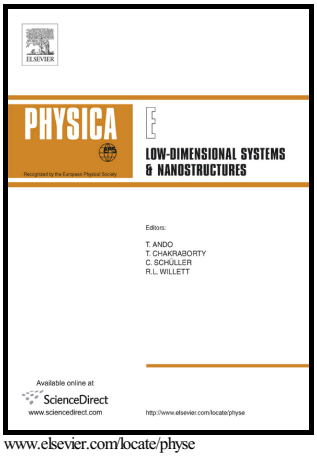

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Thermoresistive mechanisms of carbon nanotube/polymer composites

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Abstract. The mechanisms governing thermoresistivity of carbon nanotube (CNT)/polymer composites are theoretically and experimentally investigated. Two modeling approaches are proposed to this aim considering a broad range of CNT concentrations (0.5-50 wt.%). In the first model, thermal expansion of the polymer composite is predicted using a finite element model; the resulting CNT-to-CNT separation distance feeds a classical tunneling model to predict the dependence of the electrical resistance with temperature. The second approach uses the general effective medium considering the dilution of the CNT volume fraction due to the thermal expansion of the polymer. Both models predict that the electrical resistance increases with increased temperature (i.e. a positive temperature coefficient of resistance, TCR) for all investigated CNT concentrations, with higher TCRs for lower CNT concentrations. Comparison between modeling outcomes and experimental data suggests that polymer thermal expansion (and tunneling) play a dominant role for low CNT concentrations (≤ 10 wt.%) heated above room temperature. On the other hand, for composites at high CNT concentrations (50 wt.%) or for freezing temperatures (-110 °C), a negative TCR was experimentally obtained, suggesting that for those conditions the CNT intrinsic thermoresistivity and the electronic conduction between CNTs by thermal activation may play a paramount role.

Keywords: Thermoresistivity, carbon nanotubes, polymer nanocomposites, tunneling effect, thermal expansion.