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Influence of oriented CNT forest on thermoelectric properties of polymer-based materials

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Abstract

Thermoelectric (TE) materials are highly important due to their ability to convert wasted heat energy into electricity. Among the different TE materials, organic-based or polymer-based TE systems are among the most promising due to their sustainability, non-toxicity and good electrical properties. In our research, we have investigated for the first time the application of vertically aligned carbon nanotubes forest (VA-CNTF) as a filler for TE composite; compared to unconnected carbon nanotubes (CNT), which are typically used in polymer/CNT composites, dry pulled VA-CNTF sheets have more ordered structure, which is supposed to improve the TE efficiency of the material. VA-CNTF and short unoriented multiwalled carbon nanotubes (MWCNT) were used as fillers of a polymeric matrix, to prepare TE composites. Various staking configurations were explored by using CNTF. All the samples were examined by scanning electron microscopy (SEM), micro-Raman spectroscopy, and four-point probe electrical measurements; MWCNT-based samples were used as benchmarking systems.

The results revealed a dramatic increase of the Seebeck coefficient up to 46 μV/K for the VA-CNTF-based sample, while the best MWCNTs-based sample (MWCNT concentration 50 wt.%) provided only 21.49, which is roughly the Seebeck coefficient of pure polymer. This research represents the first application of VA-CNTF as a promising material for TE systems and demonstrates that oriented nanoforests and related CNT sheets are a very perspective material for promising developments in the field.