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Enhanced Thermal Conduction and Influence of Interfacial Resistance within Flexible High Aspect Ratio Copper Nanowire/Polymer Composites

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Abstract

Large quantities of high aspect ratio copper nanowires were synthesized from copper chloride using a simple solution-based method. The thermal conductivity of copper nanowire /polydimethylsiloxane and copper nanowire/polyurethane composites at different volume percentage loading from 0 to 4.1 % were studied. At the highest loading, the thermal conductivity of both composite types increased more than threefold compared to the thermal conductivity values of the neat polymers. A hydrogen annealing process was implemented prior to mixing for select samples in an attempt to reduce performance-limiting thermal interface resistance between contacting nanowires and at nanowire/polymer matrix interfaces. Two separate theoretical models were used to study the effects of hydrogen annealing on the thermal conductivity of the composites and interfacial thermal resistance. In terms of potential as a substrate for flexible electronics, thermal imaging of a concentrated heat source on both neat polymer and composite samples showed that the resulting hot spot was significantly less severe when using the composite samples.