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Thermal transport mechanisms and thermal boundary resistances in multi-phase heterogeneous media containing carbon nanotubes

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Directional thermal conductivities of two and there-phase carbon nanotube (CNT) polymer nanocomposites are calculated using a random walk simulation with and without inter-CNT contact effects. The simulation results agreed well with reported experimental data for multi-phase CNT composites. The CNT-contact effect has not been explored for its role in thermal transport, and it is shown here to significantly affect the effective transport properties including anisotropy ratios. The primary focus of the talk is on the non-isotropic heat conduction in aligned-CNT polymeric composites, because this geometry is an ideal thermal layer as well as it constitutes a representative volume element of CNT-reinforced polymer matrices in hybrid advanced composites under development. The effects of CNT orientation, type (single vs. multi-wall), inter-CNT contact, volume fraction and thermal boundary resistance on the effective conductivities of CNT-composites are also discussed. It is found that when the CNT-CNT thermal contact is taken into account, the maximum effective thermal conductivity of the nanocomposites having the CNTs parallel to the heat flux decreases. CNT-CNT contact effects, rather than CNT-matrix interfacial effects dominate heat transport. These simulation results can be very useful for developing techniques to enhance the effective thermal conductivity of composites using conductive nanomaterials embedded in matrices, and assist experimentalists in interpreting heat conduction measurements.

Biography

Hai M Duong received his PhD in Chemical Engineering at Melbourne University in 2004. He was awarded four Postdoctoral fellowships at world-class laboratories: Oklahoma University (computational group, 2004-2006), Tokyo University (synthesis and characterization of single- and multi-walled CNTs, 2006-2008), the Dept. of Aeronautics & Astronautics, MIT (nano-engineered composites, necst.mit.edu, 2008-2010) and at University of Cambridge, UK (km-long carbon nanotube fibers, 01/2010-10/2010). Currently, as an Assistant Professor of at National University of Singapore, he has awarded approx. $2.5M as the PI for his research interests including a number of emerging fields such as carbon nanotubes (CNTs), graphene, cellulose fibers and their aerogels and their applications for aerospace structures, energy devices, environmental treatment, and thermal transport phenomena in small-scale of biological systems. He has given 20+ invited and keynote talks and published 115+ international journal papers and conference proceedings, supervised 4 Postdocs and 7 PhD students.

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