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Carbon nanotubes and their composites with nanodiamond for thermal packaging: Syntheses, characterization and modeling

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In the family of carbon-based nanosystems, carbon nanotubes (both single- and multi-walled) are cylindrical carbon molecules with many extremely useful properties that make them ideal for use in multitude of technological applications. Owing to their extremely high thermal conductivity properties, nanotubes enable the most potentially efficient heat-transfer applications. The microchip industry would see great benefits for thermal management applications. Nanodiamonds (nano-scale diamond structures), on the other hand are also of great interest have equally reasonable thermal conductivity and a radiation hard material. Combination of nanotubes and nanodiamonds forming truly trigonal-tetragonal composites could provide quite effective heat-transfer plus the added bonus of being radiation resistant for harsh environments such as space. The present research work is designed to measure the thermal conductivities of nanotubes and their composites with nanodiamond following Nielsen method applicable for two-phase systems and well-known Widemann-Franz law determining electronic contribution towards thermal conductivity (kappa_e). This model will allow us to predict the thermal conductivity of nanocomposites that may lie somewhere between the conductivity of the two constituents, following the most versatile Halpin-Tsai equation of phase mixing. Variation of thermal conductivity of these nanocomposites with gamma irradiation is determined following the similar approach as described above. They were analyzed prior to and post-irradiation in terms of morphology, microscopic structure and physical properties using electron microscopy, visible Raman spectroscopy and electrical [I(V)] measurements to establish property-structure-processing relationship.