

Fabrication of Vertical Standing Carbon Nano-Sheets for Heat Dissipation in a High Power Light Emitting Diode

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Abstract

We fabricated vertical standing carbon nanosheets (CNSs) on various substrates by a radio-frequency sputter system. This 3D nanomaterial demonstrated the benefits of a large surface area and laminated nanostructure for heat dissipation in high-power light emitting diodes (LEDs). Experimental measurements of thermal resistance from the CNS assembly confirmed the enhancement of heat transfer. The efficiency of heat transfer depends on the spacing density per unit area of the CNS array and the ambient pressure. Optimizing in the CNS density gives a large surface area with good porosity that enhances the air molecules exchanging heat in high efficiency. In addition, an extra coating on the CNS can further improve the efficiency of thermal conductivity and the best performance discovered in this work was a decrease in thermal resistance of over 18%. A model based on one-dimensional heat conduction was proposed which solving the system's heat conductivity and heat transfer coefficient. Such model explains the reasons for thermal resistance deduction of different CNS densities and coatings. We therefore tested the use of CNSs as heat sinks for high-power LEDs, which suffer from declining light power output and shifts in the output wavelength when temperatures rise. When assisted by cooling from the CNS, the enhancement of light output and a 3.7 nm wavelength shift were achieved.