Insight into the effect of zinc oxide nanoparticles coated multi-walled carbon nanotubes (ZnO/MWCNTs) on the thermal conductivity of epoxy nanocomposite as an electrical-insulating coating

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Abstract: The effect of zinc oxide (ZnO) nanoparticles on the thermal conductivity of zinc oxide/multi-walled carbon nanotubes (ZnO/MWCNTs) nanocomposite electrical-insulating coating was investigated. ZnO/MWCNTs was prepared by sol–gel method and incorporated into the epoxy matrix by ultrasonic-mechanical mixing to form the nanocomposite (ZnO/MWCNTs/epoxy). The SEM, XRD, and TGA analysis results showed that ZnO nanoparticles with 3–4 nm size formed layers on MWCNTs wires with a 10-nm diameter. The formed ZnO/CNT nanofillers had a diameter about 20–40 nm and had a highly homogeneous dispersion in the epoxy matrix. The thermal property of the nanocomposites was examined by the thermal imaging method. It was found that both MWCNTs and ZnO/MWCNTs nanofillers have significantly enhanced the thermal conduction of composites even at a low content load of 0.25 wt%. The thermal conductivity of ZnO/MWCNTs/epoxy and MWCNTs/epoxy composites was 0.62 and 1.09 $Wm^{-1} K^{-1}$ respectively. The formation of ZnO nanoparticles on MWCNTs was thus led to a decreasing of about 43% in thermal conductivity of the composite. However, the thermal conduction of the ZnO/MWCNTs/epoxy composite is significantly improved about 210% compared to that of neat epoxy. These results proposed a useful method to modify the surface of MWCNTs for the fabrication of epoxy nanocomposite where electrical-insulating and thermal conducting are both required. The composite was applied as an insulating edge coating for capacitive deionization electrodes.

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