Metallic carbon nanotubes (CNTs) composites are the promising advanced materials that are being developed to take advantage of the exceptional properties of CNTs. Because of the intrinsically strong in-plane atomic SP2 bonding, CNTs offer high Young’s modulus (1.0–1.8 TPa), high tensile strength (30–200 GPa) and high elongation at break (10–30%). The thermal conductivity of individual single-walled carbon nanotube (SWCNT) and multi-walled carbon nanotube (MWCNT) are about 6000 W/m·K and 3000 W/m·K, respectively. Therefore, it is expected that by incorporation of CNTs in metal matrices, multi-functional composites can be used ideally as thermal interface materials, lightweight high-strength structural materials, electric components, optical devices, electromagnetic absorption materials, etc. However, so far results are far from satisfied for CNT composites, mainly due to the fact that there are two main key issues remained without good solutions for CNT composites: the poor uniformity in CNT dispersion and the weak interfacial bonding between CNTs and the matrices.

In this study, MWCNTs were functionalized and coated with metals like Cu and Ni by electroless deposition methods prior to their application. Metal coatings result in strong interfacial bonding at CNT-metal interfaces and uniform dispersion. During metal coating processes, CNTs are physically separated in electrolyte and after coating they get physically retain the separation by the coated metal layer that they are not allowed to aggregate to form bundles. Moreover, after metal coating, the resultant density of Ni-coated MWCNTs is close to that of molten metal matrix. This prevents separation of CNTs due to buoyancy effects and results in uniform dispersion. Metal coating on CNT surfaces also allows to form strong interfacial bonding with the metal matrices.

SnBi alloy has been identified as a novel lead-free thermal interface material (TIM) for electronics packaging. However, the thermal conductivity and the mechanical strength of pure SnBi alloy are not sufficient to withstand harsh environment imposed by powder electronics. Therefore, how to increase the thermal conductivity and the mechanical strength of SnBi solders becomes important. In this study, MWCNTs have been added into SnBi alloy to form SnBi/CNT composite solders by different material processing methods. First, in sandwich method Cu-coated CNTs were added to the 70Sn-30Bi alloy and mixed mechanically. UTS was increased by 47.6% for 3 wt.% Cu/CNTs addition. Second, Ni-coated CNTs were added by sonication assisted melting method in fabricating 70Sn-30Bi solder. For 3 wt.% Ni-coated MWCNTs, equivalent to 0.6 wt.% pure MWCNTs, UTS and YS were increased by 88.8% and 112.3% respectively. In addition, the thermal conductivity was also increased by more than 70%. Ni-coated CNTs were also added to pure Al by powder metallurgy method. For 7 wt.% Ni/CNTs having diameter 30–50 nm, UTS and YS were increased by 92.7% and 101.6% respectively. For CNTs having diameter 8–15 nm, UTS and YS were increased by 108.9% and 128.2% respectively for 3 wt. % addition. All these results are the first time obtained that are much greater than published data on CNT/metal composites. Results discussion and mechanism in reinforcement were also presented.

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The public is welcome to attend.