Microstructure and Properties of CNTs/Metal/Al_2O_3 Nanocomposites Prepared by Thermal CVD and Spark Plasma Sintering

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Many researches have been performed to fabricate carbon nanotube (CNT)-reinforced polymer, metal or ceramic composites with enhanced properties such as electrical conductivity, high strength and toughness. However, the extraordinary properties of CNT have not been successfully used in composites. This is basically attributed to the difficulty in homogeneous mixing between CNT and matrix powders due to the agglomeration of CNT as well as their full densification with sound microstructure. Therefore, for industrial application of CNT-dispersed composites the development of new processing is strongly required.

In this study, we demonstrate the fabrication of CNTs-dispersed Al_2O_3 nanocomposites with required properties by applying a novel route for the *in situ* formation and homogeneous dispersion of CNTs on nano-sized Fe dispersed Al_2O_3 powders. In addition, mechanical and electrical properties for sintered composites are estimated. Finally, we suggest the optimum route to fabricate the functional nanocomposites with CNT dispersion and its engineering application.

Homogeneous Al_2O_3 composite powders with catalyst metals of 20 nm in size were successfully synthesized by chemical method using metal nitrates. Fig. (a) shows the calcined Fe-oxides/Al_2O_3 composite powder. The nanocomposite powders of CNT/metal/Al_2O_3 was successfully prepared by thermal CVD, in which the CNTs showed the diameter of 25-43 nm and homogeneously distributed in the Al_2O_3 powders (Fig. b). Sintering was performed at 1400°C for 10 min using spark plasma sintering, and the sintered composite showed homogeneous microstructure with relative density of 96.3%. The hardness of composite was measured as 1690 HV. Fracture surface of composite was characterized by intracrystalline fracture and pull-out phenomena of CNT, as shown in Fig. (c). Electrical conductivity was measured as 1.48 x 10^{-9} mS/m in sintered composite, which is significantly large value compared with that of Al_2O_3 monolith.

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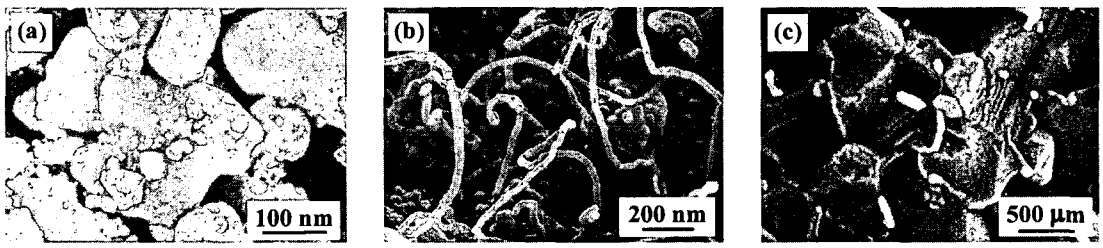

Figure. SEM images of (a) calcined Fe-oxide/Al_2O_3 powder, (b) CNTs/Fe/Al_2O_3 powder prepared by thermal CVD and (c) CNTs/Fe/Al_2O_3 composite densified by SPS.