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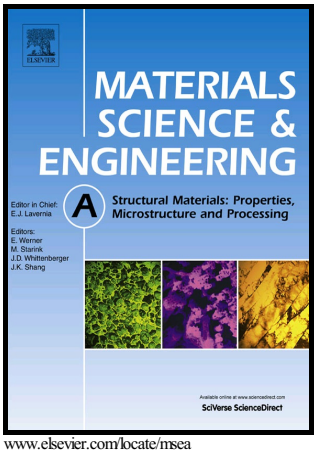

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Effect of thermal cycling on the mechanical properties of carbon nanotubes reinforced copper matrix nanolaminated composites

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Abstract:

The effect of thermal cycling on the mechanical properties of metal matrix composites (MMCs) reinforced with micro-fillers have been studied for a long time, but that for nano-size-reinforcements remains largely unexplored, such as carbon nanotubes (CNTs). We have fabricated CNTs/Cu laminated MMCs with well-balanced tensile strength and elongation via flake powder metallurgy. In this work, the effect of thermal cycling on their mechanical properties are investigated in a temperature range of –196/+200 ℃. The thermal cycling results in reductions in strength and elongation and modulus, but the strengthening role of CNTs remains in some extents as compared to the pure Cu counterpart. Tensile tests at room temperature show that high strain hardening ability can be regained even after a sharp stress drop in the thermally cycled composites. The observations on transmission electron microscope (TEM) and scanning electron microscope (SEM) show that the amount of crack increases gradually in the composites upon thermal cycling. Nevertheless, CNT bridges are often found bestriding the cracks and impeding their propagating. The TEM results indicate high density of dislocation in the Cu matrix after thermal cycling, but it decreases after enough thermal cycles, which might be attributed to the stress releasing caused by crack propagation. The failure mode is dominated by the inter-carbon-layer fracture of the multi-walled CNTs in the composites subjected to thermal cycling and tensile loading.

Keywords: Metal matrix composites; thermal cycling; carbon nanotubes; copper; laminated structure