Carbon nanotube-reinforced aluminum composites

: Dispersion, multi-step rupturing, radiation tolerance

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One-dimensional carbon nanotubes (CNTs), which are mechanically strong and flexible, possess better structural properties than their counterpart nanoparticles and other one-dimensional nanowires. We report a nano-dispersion strategy of CNTs in Al matrix that leads to enhance mechanical strength, irradiation resistance with a tenable ductility. This was realized by mechanically mixing Al particles with CNTs under oxygen-free conditions followed by spark-plasma sintering and extrusion. This allows for nano-dispersion of CNTs and strong covalent bonding of Al to the CNT surface. Oxygen-free environment was the key step to reach nanodispersion by preventing oxides on Al particles, which was verified by *in situ* TEM. We further observed the delayed dislocation propagation near CNTs via *in-situ* tensile deformation in TEM, the first experimental evidence of dispersion hardening, consequently improving yield strength. Non-uniform elongation region was further extended by multi-step rupturing process (MRP).

On the other hand, uniform dispersion of CNTs reduces radiation hardening and embrittlement as well in nuclear materials. Uniformly dispersed CNTs inside metal as 1D fillers (high aspect ratio) create prolific internal interfaces with the metal matrix that act as venues for the radiation defects to recombine (self-heal), reducing void/pore generation and radiation embrittlement at high displacements per atom (DPA).

Therefore, our observation of dispersion mechanism of CNT, MPR process and improved radiation resistance deepens scientific understanding and accelerates researches on various CNT-reinforced metal composites.