Editorial corner – a personal view

Carbon nanotubes – attractive nanofillers for forming bio-, functional and structural polymer composites

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Carbon nanotubes (CNTs) have attracted increasing interest from researchers due their exceptional mechanical, electrical and thermal properties. Polymer resins (thermoplastics, thermosets, elastomers) filled with low CNT contents exhibit superior mechanical strength and stiffness as well as excellent toughness (in some cases). Accordingly, the structures, mechanical and thermal properties of polymer/CNT composites have been extensively studied. Homogeneous dispersion of CNTs in the polymer matrix is a prerequisite for obtaining improved mechanical properties. Covalent and non-covalent functionalization of CNTs can enhance their dispersion in the polymer matrix.

Apart from their uses as structural materials, polymer/CNT composites also find potential applications in electromagnetic interference shielding, bipolar plates for fuel cells, chemical sensors, etc. The exceptional high electrical conductivity and large aspect ratio of carbon nanotubes render them attractive nanofillers for forming conducting nanocomposites with multifunctional properties. CNTs with large aspect ratios enable formation of conducting path network in the polymer matrix with very low percolation threshold. This is in sharp contrast to conventional microcomposites in which large filler contents are needed to achieve desired electrical properties. The conductivity and dielectric properties of polymer/CNT nanocomposites can be tailored over several orders of magnitude by proper aligning CNTs under electric or magnetic fields. It is noted that chemical functionalization of

CNTs frequently degrades the conductivity due to electron localization. In general, multi-wall carbon nanotubes synthesized by a chemical vapor process are more cost effective than single-wall nanotubes for technological applications.

CNTs have been reported to promote osteoblasts (bone forming cells) and neurons proliferation, and found to be effective nanocarriers for several biomolecules such as proteins, DNA and carbohydrates. Recently, polymer/CNT nanocomposites have been explored as scaffolds for cell growth and load-bearing implant materials for replacing defective human bones. However, some researchers reported that CNTs exhibit cytotoxicity to human dermal cells. Potential health hazard could also arise from the inhalation exposure. The discrepancy in such biocompatibility results can be attributed to the complicated physicochemical interactions between carbon nanotubes and biological cells, and to different cell viability methods and CNT sources. More efforts are needed to solve these issues prior to the incorporation of polymer/CNT nanocomposites into human body.

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