Fluidized Carbon Nanotubes through Novel Modification Pathways

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Abstract: The dispersion of carbon nanotubes in liquids is critical in applications pertaining to polymer composites, thin films, nanoparticle hybrids and biomedicine. Generally, good dispersions can be obtained after surface modification of the nanotubes. This results in derivatives with long term colloidal stability, improved surface compatibility and exceeding solubility enabling for an easier manipulation of the dispersed solid through mixing, blending, impregnation, casting, spin-coating, evaporation and wet chemistry. Typical modifiers include organic reagents, polyaromatics, surfactants or polymers. Herein we present novel pathways towards the effective surface modification of multi-wall carbon nanotubes aiming to fluidized derivatives in the presence or absence of solvents. Solvent-dispersible adducts include perfluorinated carbon nanotubes and ionic cluster-carbon nanotube hybrids (ionic cluster: silica or fullerol polyanions). The first adduct is dispersible in perfluorinated solvents of low-boiling point, like hexafluoroisopropanol. Casting of the dispersion over a glass surface and evaporation of the solvent leads to high quality thin films with superhydrophobic properties. On the other hand, surface modification with silica or fullerol polyanions provides static repulsions that result in water-dispersible hybrids suitable for biomedical applications. Carbon nanotubes may exhibit fluid-like behavior in the absence of solvents after proper functionalization. In principle, the surface of the tubes is decorated with a soft organic corona that provides a liquid shell around the solid carbon core. Representative examples include adducts with a soft PEGylated amine or a liquid epoxy-silicone. In case of PEGylated amine, the derivative is isolated as a waxy solid that melts at 35 ^{o}C to afford a tar-like liquid. In case of silicone, the derivative is already a viscid fluid at room temperature. Such solvent-less nanofluids could be utilized in thermal dissipation and conductive inks.