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Carbon Nanotube Suspensions: some underlying issues[1]

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Entropy of mixing of rigid particles in a suspending medium is determined on a per-particle basis and thus, for a given weight fraction will decrease with increasing particle size. In the case of carbon nanotubes, the entropy contribution to mixing will thus be small compared with the interparticle forces which comprise the enthalpic energy contribution to any thermodynamic equilibrium. These forces will generally be short range with the exception of electrostatic forces in the cases that the particles carry a charge. The ability to form carbon nanotube suspensions depends on both the chemical affinity between the medium and the tubes and, it appears, the size of the medium molecules. Surface treatments of the nanotubes have been developed both using covalently attached functional groups and surfactants, and each strategy has been successfully applied to both multi and single wall CNTs. Because carbon nanotubes are long, thin, rigid and comparatively straight, they have been shown to self assemble into liquid crystalline phases showing all the attributes of conventional systems. The relationship between such CNT systems and the conventional Flory phase diagram will be described, as will the exploitation of these phase equilibria to fractionate nanotubes on the basis of mesogenicity. The use of liquid crystalline phases as a basis for the processing of carbon nanotubes into aligned assemblies such as fibres will also be outlined.

[1]In collaboration with Ian Kinlock and Shanju Zhang, Department of Materials Science, University of Cambridge