Three problems in carbon nanotube and graphene fluid dynamics

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A nanofluid can be defined as a suspension of nanoparticles in a fluid, without particle-shape restrictions. The study of nanofluids attracts a great interest due to their special transport properties, which are ultimately given by the reduced dimensionality of the suspended nanoparticles. In a liquid dispersion, carbon nanotubes (CNTs) and graphene typically demonstrate their optical and electronic properties as 1D and 2D sp2 carbon nanoparticles, which can help to interpret the result of dynamic processes.
In the present communication, we show experimental data on three different dynamic processes that are utilized in the preparation of CNT and graphene materials for their application in electronical and optical devices, but they are not totally understood from a conceptual point of view. The three experimental cases are presented with the aim of searching for a mathematical background that works as interpretative and predictive:
1) Scaling gel chromatography column separations. Single-walled carbon nanotubes (SWCNTs) are synthesized as complex mixtures of many nanotube conformations. Gel chromatography quite easily allows the separation between metallic and semiconducting SWCNT fractions in surfactant suspensions [1, 2]. However, the optimal working conditions have to be found empirically. Here we present our results using two different column sizes for an identical SWCNT chromatographic system.
2) Viscosity in CNT and graphene fluids. We performed viscosity measurements of CNT suspensions in surfactant systems [3]. Different CNTs were tested, including multi-walled, single-walled and functionalized CNTs. Surprising results were found, such as the high viscosity of a particular CNT type, namely the CoMoCAT sample. In addition, we measured viscosity for graphene oxide (GO) in water. The evolution of viscosity and viscous flow activation energy is shown for GOs with different oxidation degrees.
3) Preferential stability under sedimentation forces. We have previously described the separation of SWCNTs from graphite and metal impurities by centrifugation in a surfactant [4]. Also, it was shown that the process selectivity depends on the surface chemistry [5], although this can be overcome applying strong enough centripetal forces [6]. However, the sedimentation theory has not been generalized for CNTs, CNT mixtures and graphene in liquid media.

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