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POSTER #26

THE RELATION BETWEEN CNTs DIAMETER AND THEIR PHASE BEHAVIOR IN SUPER-ACID SOLUTIONS

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On the molecular level, carbon nanotubes (CNTs) exhibit excellent mechanical strength, thermal and electrical conductivity properties, combined with low density. This unique-feature combination makes CNTs ideal candidates for processing multifunctional macroscopic fibers. However, translating the unique characteristics of a single molecule into macroscopic material is challenging.[1]

The most significant limitation that prevents wide-scale use of CNTs in applications is the difficulty of dispersing CNTs to form thermodynamically stable solution, free of aggregates or bundles. Recently, it was discovered that CNTs spontaneously dissolve in chlorosulfonic acid (CSA), forming a molecular solution, namely, the nanotubes are dispersed as individual molecules, and at higher concentrations form a lyotropic liquid crystalline nematic phase.[2–4] Alignment of CNTs in a solution is essential to achieve the best properties in a CNT-based macroscopic material.[5]

CNT parameters, such as, length, diameter, and degree of purity, dictate CNT' solubility in acid, and phase-transition concentration from isotropic to biphasic, where isotropic and nematic phases coexist, CNTs arrangement in the biphasic, and the fully nematic phase. Therefore, understanding the influence of CNT parameters on the CNT/CSA system phase behavior, and specifically, the formation of liquid crystalline phase, is necessary for designing a successful CNT fluid-phase process, while preserving CNTs' unique molecular properties.

In this study we analyzed with cryogenic electron microscopy and Raman spectroscopy the effect of CNTs diameter on CNTs phase behavior in the solution. Cryo-TEM results demonstrate that solutions with larger diameter CNTs, phase separate at lower concentrations. These results are also supported by Raman spectroscopy, which indicate the efficiency of CNTs protonation[6] as a function of diameter; CNTs with smaller diameter protonate more easily, and therefore phase separate at higher concentrations.

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