Ordered composites of carbon nanotubes with ultra-low surfactant concentration lyotropic liquid crystals

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Lyotropic Liquid Crystals (LCs) are attractive materials as host systems for nanoparticles, in particular for carbon nanotubes (CNTs), due to the LC templating action. In fact, CNTs can be dispersed efficiently in lyotropics and, at the same time, aligned via transfer of order from the host. Although surfactants are useful for preventing CNT aggregation, they can alter the nanotube pristine properties, becoming detrimental for applications, thus it is important to find ways to reduce the amount of surfactant employed in all stages of CNT processes.

In the present work we aim at realizing a lyotropic LC host for CNTs at very low surfactant concentration, dramatically lower than previously reported [1]. We use a combination of cationic and anionic surfactants SDS (sodium dodecyl sulfate) and 12TAB (dodecyltrimethylammonium bromide) for forming the lyotropic LC phase. In addition, CNTs are dispersed using octadecyltrimethylammonium bromide (OTAB), using the sub Krafft method [2] for minimizing the excess of surfactant in the suspension.

Our approach was successful in obtaining a total concentration of surfactant for the LC host as low as 8 wt%, Small variations in the molar ratio of the two surfactants, still at a fixed total surfactant amount, yield a very different phase behavior. CNTs could be successfully dispersed in the host, thereby forming an overall low-surfactant composite. Interestingly, the presence of nanotubes strongly influences the behavior of the host, bringing a stabilization of the LC phase. Finally, we experimentally verified the alignment of CNTs in fibers drawn from the lyotropic LC-CNT composite, by polarized Raman spectroscopy.

Figure. Image of CNT-lyotropic LC composite in a capillary (A) and polarized Raman spectroscopy of filaments of the composites (B). The left part of (B) shows a scheme of the experimental configurations while the right shows a map over the sample of the G band from CNTs for perpendicular polarizations.

References:

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