Rheology of carbon nanotube dispersions in Pluronic solutions

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Surfactants are commonly used in dispersion of carbonaceous nanoparticles. Recently it was reported that the presence of dispersed nanoparticles may modify the phase behavior of self-assembled cetyl trimethyl ammonium bromide (CTAB) structures [1,2]. It was found that single-walled carbon nanotubes (SWNT) induce elongation and alignment of CTAB surfactant micelles in aqueous solutions in thin films under the action of shear, thus altering the phase behavior. This effect has not been observed for other nanoparticles. This finding reflected also in the rheological behavior of this system [3]. It was observed that the presence of small amounts of SWNT featured a dramatic increase of the steady shear viscosity at low shear rates, an effect not observed with other additives (multi-walled carbon nanotubes or carbon black particles). It was suggested that the origin of the change in phase behavior is the good size-match between SWNT and elongated CTAB micelles.

In order to further explore the effect of nanotubes on the morphology and phase behavior of the dispersing medium we examined the linear and nonlinear rheology [4] of carbon nanotubes dispersed in Pluronic® F127 (PEO-PPO-PEO triblock copolymer) solutions. While still the same rheological features are present with and without SWNT, we found that miniscule amounts of SWNT modify the phase behavior of the system in the region close to the isotropic to hexagonal phase transition. An effect on the phase transition region is similar but considerably less dramatic, when compared with SWNT dispersions made with CTAB.
Furthermore, we show that the measured rheological properties of the system are not the result of the formation of a carbon nanotube network but true manifestation of the morphology of the pluronic solution. Here as well, multi-walled carbon nanotubes have no effect on the rheology of the combined system.

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