Analytical Ultracentrifugation Characterization of Surfactant Variant Structures on Single-Wall Carbon Nanotubes

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The nanometer scale layer of adsorbed surfactant or dispersant at the solvent interface of dispersed nanotubes is often the critical structure that modifies the intrinsic properties of the nanotube and provides handles for property-driven separations. However, characterization of the properties of this adsorbed layer such as the quantity of material in the layer, the structure of the material, and its hydration are challenging to measure and have generally been only inferred from the effects to optical properties of the nanotube or overall dispersion performance. Recently analytical ultracentrifugation has been demonstrated as a valuable methodology to extract explicit characteristics of these bound layers. In this presentation, the use of doubly or triply sorted nanotubes by length, density, water-filling, and/or chiral angle will be shown to dramatically increase the precision of AUC as a characterization method, and the results of modifying the surfactant chemical structure on the adsorbed layer structure will be described.

The primary focus of this report is on the variation of the adsorbed layer structure for multiple variants of the commonly used bile salt surfactants, including sodium deoxycholate, sodium cholate, and sodium taurodeoxycholate. Through separate measurements of sedimentation boundaries during centrifugation both the surfactant shell hydration layer densities for each surfactant can be extracted. Results from these measurements indicate that each bile salt forms a different structure on the surface of an identical (6,5) SWCNT population, and that conclusions drawn optical metrics used to evaluate these layers are generally consistent, though more affected by sample quality issues. The characterization of the bound layers and the use of AUC in assisting development of structure-function relationships for dispersed nanotubes will be discussed.