Selective Isolation of (6,5) Carbon Nanotubes by Density Gradient Ultracentrifugation

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Density gradient ultracentrifugation (DGU) [1] is a widely used method in biology to separate DNA strands of different molecular mass. Recently it was introduced into the selection of single-walled carbon nanotubes (SWNTs) because carbon nanotubes with different diameters, thus different buoyant density, can be redistributed in the density gradient. Small diameter nanotubes will always appear at the top of the density gradient and generally they show a bright colored band in solution because of their absorption peaks in visible light range. Here we present a protocol to selectively isolate SWNTs with a chirality of (6,5) using this DGU method, since it is one of the smallest diameter species in the available commercial SWNT samples. Starting with different pristine SWNTs, prepared by the CoMoCAT (Co-Mo catalytic process, from SouthWest NanoTechnologies, Inc.), HiPCO (high pressure CO disproportionation, from Carbon Nanotechnologies, Inc.) and ACCVD (alcohol catalytic chemical vapor deposition, from Toray Industries, Inc.) methods, we used *sodium deoxycholate* (DOC), *sodium dodecyl sulfate* (SDS) and *sodium cholate* (SC) as co-surfactant encapsulating agents[2] to selectively isolate (6,5) SWNTs. The optical absorbance spectra, photoluminescence excitation (PLE) map and the transmission electron microscopy images show that the resulting samples contain a high relative purity of (6,5) SWNTs, and that other chiralities were present at relatively low concentrations. Although different starting materials were used, the isolated (6,5) species showed the same optical properties. Nevertheless, a small amount of (8,3) SWNTs were also present. The isolation of (6,5) SWNTs was obtained without iterations, illustrating the potential for complete isolation of different SWNT samples by DGU. We believe that by further refinement and improvement of this process, more chiralities can be isolated through iterations and adjusting the experimental parameters.

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[2] K. Yanagi, Y. Miyata and H. Kataura, *Appl. Phys. Express* **1**, 034003 (2008)