361a Length Separation of Single-Walled Carbon Nanotubes by Extraction Processes

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Single-walled carbon nanotubes (SWNTs) have received great attention because of their unique electronic and mechanical properties combined with their chemical stability. Typically, SWNTs are microns in length; however, intermediate lengths between small spheroidal fullerenes and long SWNTs could have significant scientific and technological importance. One such application is molecular electronics, in which a nanotube of precise length and specific band gap will need to be placed in a well-defined location. Specific length nanotubes will also be useful in biological imaging and sensing applications where shorter nanotube lengths may be required to penetrate cells and to serve as biological markers. Finally, the ability to control the length of the nanotubes will allow control over their solubility, which will aid in the development of many applications such as the dispersion of SWNTs into composites. To effectively use carbon nanotubes for these applications, we need to develop economically feasible and scalable methods of cutting and sorting SWNTs by length. Here, we develop a two-phase liquid-liquid extraction process which is capable of extracting water-soluble SWNTs into an organic phase. The extraction utilizes electrostatic interactions between a common phase transfer agent and the sidewall functional groups on the nanotubes. Large length-dependent van der Waals forces for nanotubes allow the ability to control the length of nanotubes extracted into the organic phase as demonstrated by AFM.