

Biomolecule Assisted Separation and Macroscopic Assembly of Carbon Nanotubes

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Carbon nanotubes (CNTs) have remarkable electrical, thermal, mechanical, and optical properties; thus, they are uniquely suited as building blocks for electronics and biomedical applications. Incorporating this material into real-world technology however remains challenging due to fundamental processing difficulties including dispersion, purification and controlled assembly. In this seminar, I will discuss how to utilize the recognition abilities of single-stranded DNA (ssDNA) to separate single-wall carbon nanotubes (SWCNTs) by diameter and electronic structures, and how to make use of biomolecules to assist the macroscale assembly of SWCNTs into optical films and antibacterial fibers.

Polymer aqueous two-phase (ATP) extraction has been demonstrated recently as an effective technique to sort polydisperse nanotube material. The spontaneous partition of ssDNA-wrapped SWCNTs in a given polymer two-phase system is strongly sequence-dependent and can be further modulated by salt and polymer additives. The DNA-controlled partition of SWCNTs in ATP systems highlights the sensitive dependence of the hydration energy on the spatial distribution of hydrophilic functionalities determined by both the DNA sequence and the SWCNT chirality. In addition to its technological implications, SWCNT partitioning in ATP systems provides a useful experimental model to study macromolecular behavior in aqueous phases. In separate work, the first lyotropic cholesteric SWCNT liquid crystal phase was obtained by dispersing SWCNTs in an aqueous solution of double-stranded DNA (dsDNA). Depending on the dispersion methodology, the polydomain nematic phase previously reported for other lyotropic CNT dispersion could also be obtained. This readily controlled phase behavior opens new routes for producing SWCNT films with controlled morphology.