

Single Wall Carbon Nanotubes Wrapped by Helically Chiral Semiconducting Polymers: New Opportunities for the Design of Electro-Optically Functional Nanoscopic Materials

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Amphiphilic, linear, semi-conducting aryleneethynylene polymers efficiently disperse single-walled carbon nanotubes (SWNTs) under ultra-sonication conditions into organic and aqueous solvents. Vis-NIR absorption spectroscopy, atomic force microscopy (AFM), and transmission electron microscopy (TEM) demonstrate that these solubilized SWNTs are individualized. AFM and TEM data reveal that the interaction of these polymers with SWNTs gives rise to self-assembled superstructures in which an aryleneethynylene polymer monolayer helically wraps the nanotube surface. These well-defined, organic-solvent-soluble nanotube/semi-conducting polymer hybrid structures open up new opportunities to interrogate SWNT electronically excited states, and design new classes of electro-optically active nanoscale constructs. For example, fs-ms time domain pump-probe transient absorption spectroscopic experiments, carried out over the vis-to-NIR spectral domain, enable for the first time the characterization of the SWNT electronically excited triplet state, while related work provides new insights into fluence dependent exciton dynamics and biexciton formation in electronically excited SWNTs. Aryleneethynylene polymers, designed to wrap SWNTs with a fixed helical chirality provide new hyperpolarizable nanoscale objects. Utilized in combination with ionic self-assembly approaches, these compositions enable for the first time the organization of chiral SWNT-based nano-objects into complex hierarchical structures in which that nanotubes maintain their respective individualized character.