Double-walled carbon nanotubes: The change in electronic structure and properties via functionalization

Double-walled carbon nanotubes (DWCNTs) are intermediate between single-walled and multi-walled carbon nanotubes. The DWCNTs can be considered as the simplest form of multi-walled nanotubes, while the presence of only two concentric shells allows using the radial breathing modes in Raman scattering for revealing functionalization of the shells. The relatively small outer diameters of DWCNTs make them comparative in reactivity with single-walled structures, at the same time the inner tube can remain intact that will save the electrical conductivity of the system.

Chemical modification is a way to change the properties of CNTs, notably to improve nanotube solubility and specific chemical activity, facilitate charge doping, etc. Here, the change in electronic structure of DWCNTs as the result of oxygenation, bromination, and fluorination is analyzed using Raman, X-ray photoelectron, and near-edge X-ray absorption fine structure spectroscopies. We compare three different fluorination techniques in their ability to loading and patterning the DWCNT surface, investigate supercapacitor performance of oxygenated DWCNTs, and reveal the effect of length on the linker on the quenching of photoluminescence of a fluorescein marker attached to the DWCNT surface.