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Functionalization of Single-Walled Carbon Nanotubes with Inorganic Compound: Prussian blue

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Since the discovery of carbon nanotubes in 1991 by Lijima, the unique properties such as high mechanical strength and chemical stabilities, as well as the relationship between the geometric and the electronic properties have been stimulated to study intensively. Many reaches had focused on the chemical functionalization of carbon nanotubes, which constructed plenty of new structures and brought ample new properties into them. These attempts broadened the usages of the carbon nanotubes, such as scanning probe tips, sensors, and catalyst or biomolecular carriers.

But to the best of our knowledge, the modification was often confined of organic molecules, by either covalence or noncovalence, such as π-π stacking. The inorganic molecules could also interact with carbon nanotubes through covalence or noncovalence. Here we introduced one promising inorganic compound, Prussian blue (PB) into the functionalization of single-walled carbon nanotubes (SWNTs). PB is a kind of polynuclear and mixed-valent iron cyanide complex with repeating unit of $Fe^{3+}[Fe^{2+}(CN)_6]^{2-}$. And the cubic PB structure was not limited to the iron ion and compositions could be varied to include combinations of several transition metal ions in different oxidation states. Due to its' unique properties, they had been employed intensively in many fields, such as electrochemical, electrochromic, photophysical, magnetic and potential analytic applications. The synthetic versatility and the ability of the bridging cyanide ligand to efficiently mediate its properties was the motivation of the functionalization of SWNTs with PB.

Before functionalization, SWNTs were cut by oxidation by sonicating SWNTs in a 3:1 v/v solution of mixed concentrated sulfuric acid (98%) and concentrated nitric acid (70%). After cutting process, the open ends of the SWNTs were modified with COOH groups. The PB modified SWNTs and the interaction between them were investigated by FT-IR, UV-vis, Raman, XPS, and TEM. The preliminary results indicated that PB was successfully modified on the out surface of SWNTs. From TEM image, the small PB nano-particles were absorbed around the SWNTs uniformly. The interaction between PB and SWNTs could be explained by two parts: ionic chemical bond between COOH moiety of SWNTs and Fe ion of PB; and non-covalent bond, π-π stacking between SWNTs and CN moiety of PB. We are currently investigating the electrochemical and other properties of PB modified SWNTs.

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