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Polymer wrapping technique for selective extraction of specific large-diameter semiconducting single-wall carbon nanotubes

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Abstract

Single-wall carbon nanotubes (SWCNTs) show metallic or semiconducting features because the electric structures significantly change with their tube structures (i.e. tube diameter and wrapping angle). Actually, semiconducting SWCNTs exhibit intense near-infrared fluorescence, but metallic SWCNTs do not. In addition, SWCNTs have inner space in which other materials can be confined. For example, we can encapsulate fluorescent molecules into SWCNTs via the vapor phase of the molecules. The arrangement of the confined molecules changes with tube diameter. For uniform electronic properties of SWCNTs and the homogeneous arrangement of confined molecules, SWCNTs with specific tube structures are desirable. However, as-produced SWCNT materials are the mixture of SWCNTs with various tube structures. For small-diameter SWCNTs (<1.2 nm), there are several methods to obtain specific SWCNTs from the as-produced SWCNT materials. On the other hand, selective extraction of specific large-diameter SWCNTs is rather difficult owing to the stronger bundling effect of large-diameter SWCNTs.

Recently, using the polymer wrapping technique which leads to individually dispersed SWCNTs, we have revealed that poly(9,9-dioctylfluorene-alt-benzothiadiazole) (F8BT) and poly(9,9-dioctylfluorene-alt-pyridine) (PFOPy) can preferentially disperse specific large-diameter semiconducting SWCNTs in toluene via ultracentrifugation. On the basis of the tube-structure dependence of photoluminescence, the tube structures in their polymer-extracted semiconducting SWCNTs were identified by photoluminescence excitation (PLE) spectroscopy. The F8BT-extracted SWCNTs exhibit intense fluorescence of (15,4) SWCNTs, which are 1.38 nm in tube diameter, while the PFOPy-extracted large-diameter SWCNTs show 1500 nm emissions with a narrow diameter distribution. The results indicate that the fluorene-based copolymers are useful as wrapping polymers to selectively extract specific large-diameter SWCNTs (>1.2 nm).

Biography

Masayoshi Tange has completed his Ph.D from University of Tsukuba, Japan, in 2007. He was a Japan Society for the Promotion of Science (JSPS) research fellow (DC2 & PD) from April 2006 to March 2008 and a JSPS research fellow (PD) from April 2009 to March 2010. Currently, he is a senior researcher at National Institute of Advanced Industrial Science and Technology (AIST). His current research interests are in the synthesis and optical properties of low-dimensional materials such as carbon nanotubes-based nanocomposite.