Carrier Control of SWCNTs by Encapsulating Organic Molecules for Power Generation Devices

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For the high-efficiency electric power generation by electrolyte flow on a single-wall carbon nanotube (SWCNT) thin film, carrier density control of the SWCNTs is crucial. Chemical doping is a well-known method to control the carrier density of SWCNTs. Because the film surface is exposed to the environment in this application, the chemical doping should be from the inside surface of SWCNTs to protect dopant molecules [1] and stabilize the device performance.

In this study, two molecules were used: *N*,*N*'-bis(3-pentyl)perylene-3,4,9,10-bis(dicarboximide) (PBI) and 2,4-bis[4-(*N*,*N*-diphenylamino)-2,6-dihydroxyphenyl]squaraine (DPSQ), for n- and p-type dopant, respectively. Before encapsulation, SWCNTs (EC1.5, Meijo Nano Carbon) were heated in air to remove caps. The molecules were encapsulated by refluxing in 1,4-dioxane for 4 h. Then the SWCNTs were washed in the solvent for 6 times to remove the molecules outside SWCNTs. The SWCNTs after encapsulation with PBI and DPSQ molecules were named as PBI@eDIPS and DPSQ@eDIPS, respectively. As shown in Figs. 1A and 1B, the absorption peaks of PBI and DPSQ show red-shift, indicating the successful encapsulation. To control the carrier density, for the next step, we have to control the number of molecules to be encapsulated. Our doping system is designed for this purpose. The latest results will be shown in this presentation.

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Fig. 1. (A) Optical absorption spectra of empty eDIPS, PBI@eDIPS, and PBI molecules. (B) Optical absorption spectra of empty eDIPS, DPSQ@eDIPS, and DPSQ molecules.

Reference

[1] T. Takenobu et al. Nat. Mater. 2, 683 (2003).