

Near Infrared Photoluminescence Properties of Diarylethene-functionalized Single-walled Carbon Nanotubes

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Local chemical functionalization of single-walled carbon nanotubes (SWCNTs) allows sp^3 carbon defect doping to the crystalline sp^2 carbon networks to enhance their near-infrared (NIR) photoluminescence (PL) properties.¹⁻³ The locally functionalized SWCNTs (lf-SWCNTs) show new red-shifted PL (E_{11}^*) with enhanced quantum yields compared to the original PL (E_{11}). The E_{11}^* PL wavelength of lf-SWCNTs have been found to be modulated by using functions of the functionalized molecules on their doped sites. For example, selective molecular binding based on molecular recognition⁴ and dynamic covalent bonding⁵ on the lf-SWCNTs have induced selective wavelength shifts of E_{11}^* PL.

In this study, we synthesize lf-SWCNTs functionalized with diarylethene derivatives (DAE)⁶ that show photochromism with high stability and sensitivity. For the synthesis of DAE-functionalized lf-SWCNTs (lf-SWCNTs-DAE), a diazonium salt having a DAE moiety was synthesized and reacted with the solubilized SWCNTs in D_2O . PL spectrum of the lf-SWCNTs-DAE shows peaks at 980 and 1142 nm (Figure 1). The former one is assigned to E_{11} PL and the latter one is assignable to E_{11}^* PL of the lf-SWCNTs-DAE. UV light irradiation to the lf-SWCNTs-DAE solution induced red-shifts of E_{11}^* PL peak. Moreover, visible light irradiation to the resultant solution induced the E_{11}^* PL peak shifts to the initial wavelength position. The reversible wavelength switching was repeatedly observed over 5 cycles. In UV/vis/NIR absorption measurements, photoisomerization of DAE on the lf-SWCNTs-DAE was confirmed by each light irradiation process. Thus, a photo-induced wavelength switching system for NIR PL has been created by the DAE functionalization.

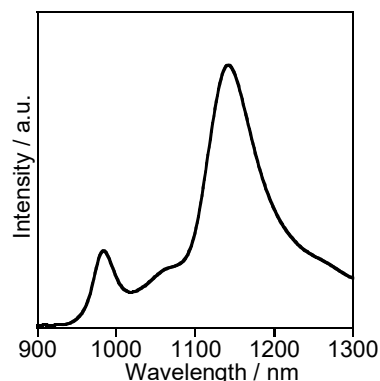


Figure 1. PL spectrum of lf-SWCNTs-DAE. $\lambda_{ex} = 570$ nm.

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