

Near Infrared Photoluminescence Modulation of Biotin-functionalized Single-walled Carbon Nanotubes Based on Avidin Binding

(¹Graduate School of Engineering, Kyushu University, ²CFC, Kyushu University, ³WPI-F²CNER, Kyushu University, ⁴CMS, Kyushu University) ○ Yoshiaki Niidome,¹ Rie Wakabayashi¹, Masahiro Goto^{1,2}, Tsuyohiko Fujigaya,^{1,3,4} Tomohiro Shiraki^{1,3}

Keywords: Carbon Nanotube; Near Infrared Photoluminescence; Chemical Functionalization; Molecular Recognition; Avidin-biotin Interaction

Photoluminescence (PL) in near infrared (NIR) regions from single-walled carbon nanotubes (SWCNTs) is useful for biomedical applications such as imaging and sensing due to the advantages of NIR light that show low-autofluorescence and high transparency to biological tissues.¹ The PL properties of SWCNTs can be enhanced by local chemical functionalization that allows sp³ carbon doping to their sp² carbon networks.² The resultant locally functionalized SWCNTs (lf-SWCNTs) emit red-shifted and bright E_{11}^* PL over 1000 nm regions. Recently we have reported that E_{11}^* PL of lf-SWCNTs showed larger spectral shifts than E_{11} PL of non-factionalized tubes by differences in polarities of surrounding environments.³ The enhanced wavelength shifts of E_{11}^* PL are expected to develop new sensing systems based on adsorption of analyte molecules on the lf-SWCNT surfaces.

Here, we investigate E_{11}^* PL wavelength shifts of lf-SWCNTs by the adsorption of proteins using a selective biomolecular binding system that is based on avidin-biotin interactions (dissociation constant is $\sim 10^{-15}$ M). The lf-SWCNTs tethering biotin groups (lf-SWCNTs-b) were synthesized through the chemical functionalization using an aryldiazonium salts, followed by its post-modification (Fig. 1). When neutravidin was mixed with a lf-SWCNTs-b solution, E_{11}^* PL peak was red-shifted, indicating the higher polarity environment formation by neutravidin adsorption on the lf-SWCNTs-b. When avidin or streptavidin was used for lf-SWCNTs-b binding experiments, wavelength shifting behaviors of E_{11}^* PL from lf-SWCNTs-b were clearly changed depending on the used avidin derivatives. The results would be due to different polar environment formation deriving from structural differences of each avidin derivative. Therefore, lf-SWCNTs are expected for development of advanced protein detection devices using NIR PL.

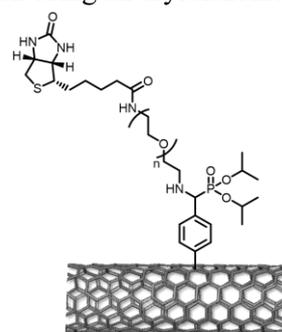


Fig. 1. Structural images of lf-SWCNTs-b

- 1) J. H. Choi *et al.*, *J. Mater. Chem. B* **2017**, *5*, 6511. 2) a) Y. Wang *et al.*, *Nat. Rev. Chem.* **2019**, *3*, 375. b) S. Tretiak *et al.*, *Acc. Chem. Res.* **2020**, *53*, 1791. c) T. Shiraki *et al.*, *Acc. Chem. Res.* **2020**, *53*, 1846. d) T. Shiraki, *Chem. Lett.* **2021**, *50*, 397. 3) a) T. Shiraki *et al.*, *Chem. Commun.* **2019**, *55*, 3662. b) T. Shiraki *et al.*, *J. Phys. Chem. C* **2021**, *125*, 12758.