

Terahertz and Optical Plasmonics

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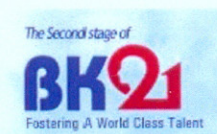
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Enhanced Light Emission of Organic Semiconductors Using Surface Plasmon Resonance

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Abstract: Significant enhancement of photoluminescence (PL) for a single strand of light emitting polymers; polythiophene (PTh) or poly (3-methylthiophene) (P3MT) nanotubes, coated with nanoscale copper (Cu), nickel (Ni), or cobalt (Co) metal, was observed and analyzed in terms of charge and/or energy transfer effect in surface plasmon resonance.

The coaxial hybrid double layered nanotubes (HDLNTs) consisting of light emitting polymers; polythiophene (PTh) or poly (3-methylthiophene) (P3MT) nanotubes, enveloped by nanoscale copper (Cu), nickel (Ni), or cobalt (Co) metal, were electrochemically synthesized using an Al₂O₃ nanoporous template. The metals with nanoscale thickness (about 10 nm) were sequentially electrochemically deposited onto the polymer nanotubes. The hybrid nanotubes were visualized and confirmed through scanning electron microscope (SEM), transmission electron microscope (TEM), high-resolution (HR)-TEM, and elemental analysis, as shown in Fig. 1.

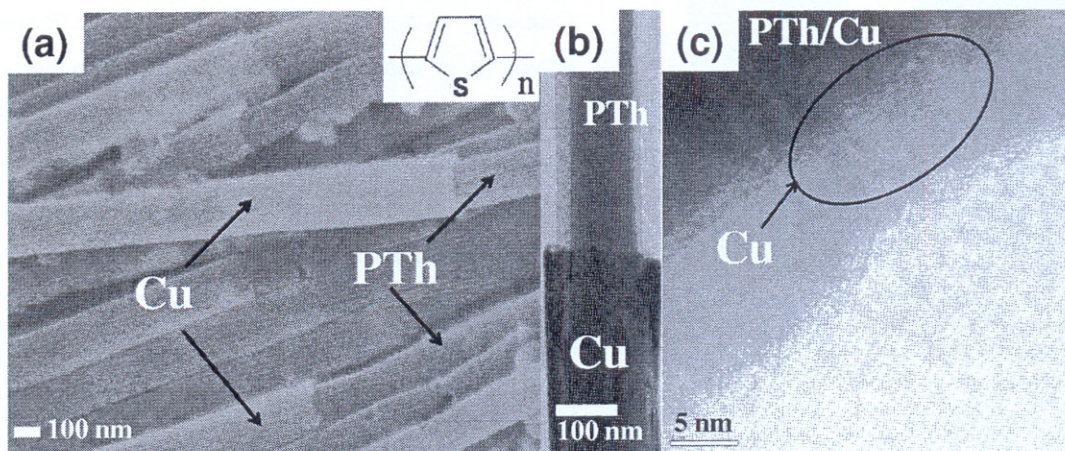


Fig. 1 (a) SEM, (b) TEM, and (c) HR-TEM images of the PTh/metals HDLNTs (from Ref. [1]).

The enhanced PL efficiency in nanoscale was determined through laser confocal microscope (LCM) PL measurements with a high spatial resolution. The LCM PL intensity of the single strand of the PTh/metal HDLNTs increased up to about 70 times depending on the kinds of nanoscale metals, as shown in Fig. 2 [1]. We also found that the nanoscale LCM PL intensities of doped P3MT nanotube based-HDLNTs remarkably increased as the doping levels of the P3MT nanotubes increased. We analyze that the significant enhancement of LCM PL of the PTh and P3MT based-HDLNTs might originate both from energy transfer and charge transfer in a surface plasmon resonance (SPR) coupling [2]. From ultraviolet and visible absorption spectra and calculations of local electric field enhancement for the hybrid nanostructures, the SP effects contributed to the enhancement of PL. The SP enhanced – PL of organic polymer and inorganic metal hybrid nanotubes could be significantly applied to organic based displays and nanoscale optoelectronics.

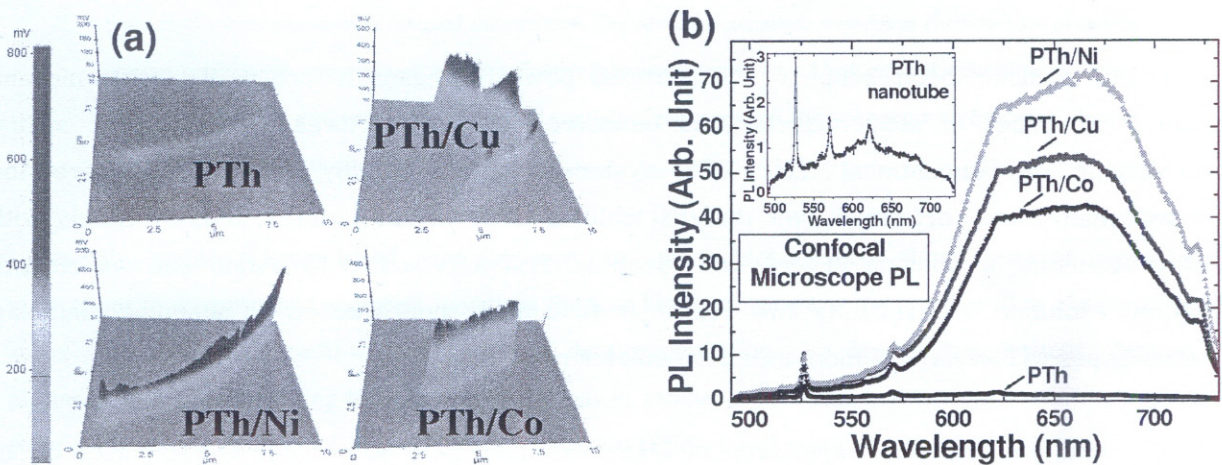


Fig. 2 LCM PL (a) images and (b) spectra of the PTh/metals HDLNTs (from Ref. [1]).

[1] J. Joo, D. H. Park, M. Y. Jeong, Y. B. Lee, H. S. Kim, W. J. Choi, Q. H. Park, H. J. Kim, D. C. Kim, and J. Kim, *Adv. Mat.* **19**, 2824 (2007).

[2] W. L. Barnes, A. Dereux, and T. W. Ebbesen, *Nature* **424**, 824 (2003).