Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C

Supplementary Information for

Nanoscale Luminescence Characteristics of CdSe/ZnS Quantum Dots Hybridized with Organic and Metal Nanowires: Energy Transfer Effect

Yong-baek Lee[a], *Sungyeoun Park*[b], *Sunmi Lee*[a], *Jeongyong Kim*[c], *Kwang-Sup Lee*[b*], *and Jinsoo Joo*[a*]

[a]Department of Physics, Korea University, Seoul 136-713, Republic of Korea

[b]Department of Advanced Materials, Hannam University, Daejeon 305-811, Republic of Korea

[c]Department of Physics, University of Incheon, Incheon 406-772, Republic of Korea

Figure S1a shows Fourier transform-infrared (FT-IR) spectra of the CdSe/ZnS QDs functionalized with OA, Cu NWs, and QD/Cu NWs. The IR characteristic peaks of the QDs functionalized with OA were observed at 2852 and 2922 cm^{-1}, corresponding to the symmetric and anti-symmetric methylene stretching modes of the OA in the functional group, respectively. When the functionalized QDs were attached to the surface of Cu NW, the same IR peaks due to the OA groups could be observed from the QD/Cu hybrid NWs, as shown in Fig. S1a. Figure S1b shows FT-IR spectra of the CdSe/ZnS QDs functionalized with OH, P3HT NWs, and QD/P3HT NWs. The IR characteristic peaks of the functionalized QDs with OH were observed at 1050 ~ 1200 cm^{-1}, which originated from 11-mercapto-1-undecanol in the functional group. For the QD/P3HT hybrid NWs, the IR characteristic peaks were also detected at the same wave number (1050 ~ 1200 cm^{-1}), as shown in Fig. S1b. From the comparison with FT-IR spectra of the QDs and hybrid NWs, we confirmed the attachment of the functionalized QDs on the surface of the NWs.

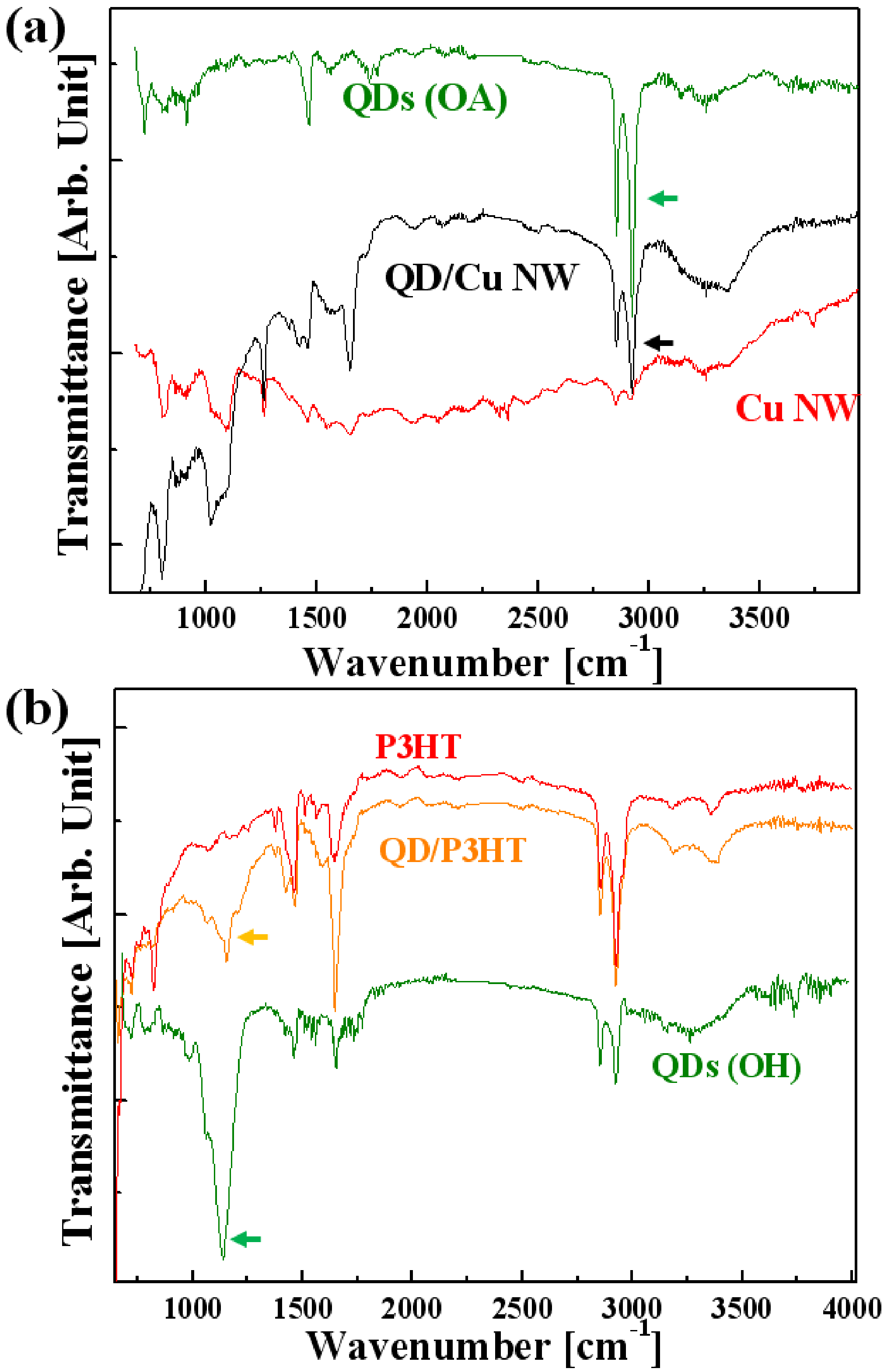

Figure S1. Comparison of FT-IR spectra of (a) the CdSe/ZnS QDs functionalized with OA, Cu NWs, and QD/Cu NWs and of (b) the CdSe/ZnS QDs functionalized with OH, P3HT NWs, and QD/P3HT NWs.

Figures S2a and S2b show high-resolution transmission electron microscope (HR-TEM) images and the analysis of electron dispersive spectroscopy (EDS) patterns for functionalized CdSe/ZnS QDs and Cu NWs, respectively. The constituent atoms of the QDs including Cd, Se, Zn, and S were detected, as shown in the EDS pattern of the CdSe/ZnS QDs (top-right of Figure S2a), and the thickness of ZnS shell was ~1.5 nm (bottom-right in Figure S2a). From the EDS analysis of the Cu NW, we estimated the thickness of the oxidation layer of the Cu NW to be about 10 nm (bottom-right in Figure S2b).

From the time-resolve PL decay curves in Fig. 4, the exciton lifetime (τ) can be estimated by multi-exponential fitting;

$$y = \sum_i A_i e^{-\left(\frac{t}{\tau_i}\right)} \qquad (1)$$

$$\tau_{avg} = \frac{\sum_i A_i \tau_i^2}{\sum_i A_i \tau_i} . \qquad (2)$$

Here, A_i represents the absolute amplitude and τ_I is the characteristic lifetimes of exciton component. From the extracted components of τ's, the intensity-weighted average exciton lifetime (τ_{avg}'s) of the P3HT NWs, CdSe/ZnS QDs, and the hybrid NWs were estimated as listed in Table S1.

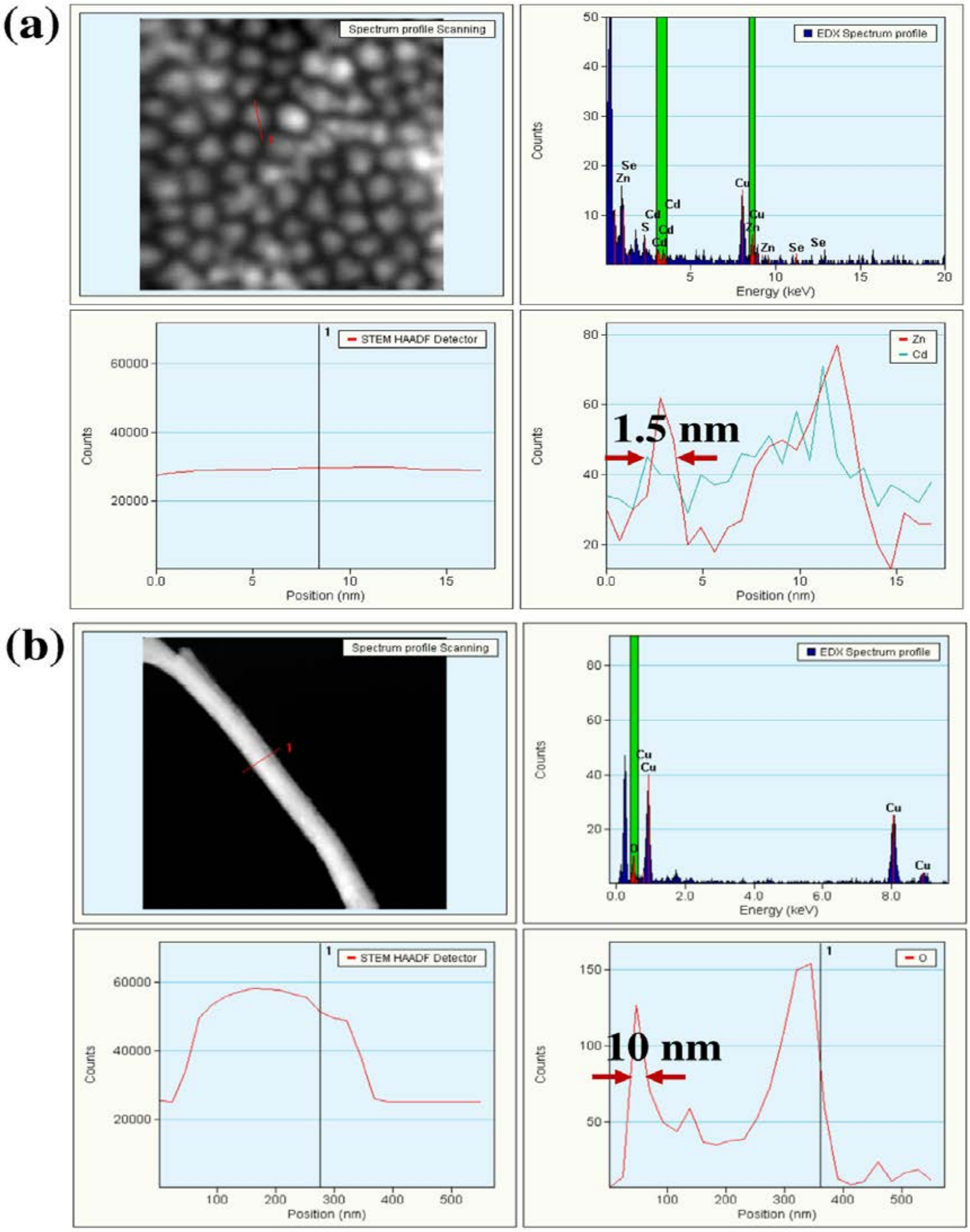

Figure S2. HR-TEM images and EDS results of (a) the functionalized CdSe/ZnS QDs and (b) Cu NWs.

Table S1. Absolute amplitudes and exciton lifetimes of P3HT NW, CdSe/ZnS QDs, QD/P3HT NW, and QD/Cu NW.

Amplitude and τ

	P3HT NW	QDs (OH)	QD/P3HT NW	QDs (OA) full detection	QD/Cu NW
Amp. 1 (A_1)	1774.48	3172	698.98	3007.88	111.7
τ_1 (ns)	0.15	1.88	2.05	3.55	7.84
Amp. 2 (A_2)	1761.75	3315.79	7067.41	660.67	1537.34
τ_2 (ns)	0.48	16.83	0.41	93.28	0.48
Amp. 3 (A_3)		1200.37	2412.9	4818.48	485.56
τ_3 (ns)		50.70	0.03	19.77	2.55
Amp. 4 (A_4)			249.17		
τ_4 (ns)			10.78		
τ_{avg} (ns)	0.40	32.91	4.67	45.77	3.64