**Supporting Information:**

# The retention of CdS/ZnS quantum dots (QDs) on the root epidermis of woody plant and its implications by benzo[a]pyrene: Evidences from the *in situ* synchronous nanosecond time-resolved fluorescence spectra method

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**Figure captions**

Figure S1 The nanosecond time resolved fluorescence spectra of different kinds of QDs at optimal emission wavelength (a) Oleylamine-CdS/ZnS QDs (b) PEG-COOH-CdS/ZnS QDs and (c) PEG-$NH_2$-CdS/ZnS QDs.

Figure S2 The NSFS of the Oleylamine-CdS/ZnS QDs retained on the epidermal tissues of *K. obovata* root with the presence of B[a]P after filter out < 10 ns fluorescence signal (a) NSFS, (b) S-NSFS.

Figure S3 The rates of QDs retained on the epidermal tissues of mangrove root (a) Oleylamine-CdS/ZnS QDs, (b) PEG-COOH-CdS/ZnS QDs and (c) PEG-$NH_2$-CdS/ZnS QDs.

Figure S4 The partition coefficients ($K_f$) of the QDs retained on the epidermal tissue of mangrove root at two different temperatures.

Figure S5 The FLIM images of Oleylamine-CdS/ZnS QDs retained on the epidermal tissue of mangrove root. (a) *K. obovata*, (b) *A. marina* and (c) *A. corniculata*.

**Table legends**

Table S1. Results of recovery experiment for the CdS/ZnS QDs retained on the epidermal tissues of mangrove root.

Table S2 Integration results from $^{13}$C-NMR of different kinds of mangrove roots.

Table S3 Surface functionalities of the epidermal tissue of mangrove root acquired by XPS.

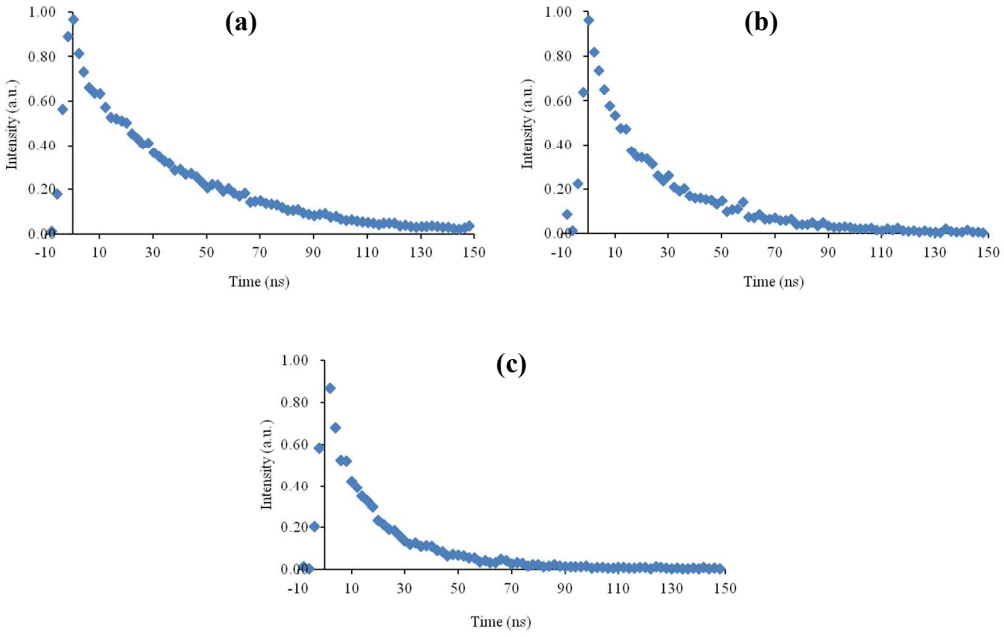
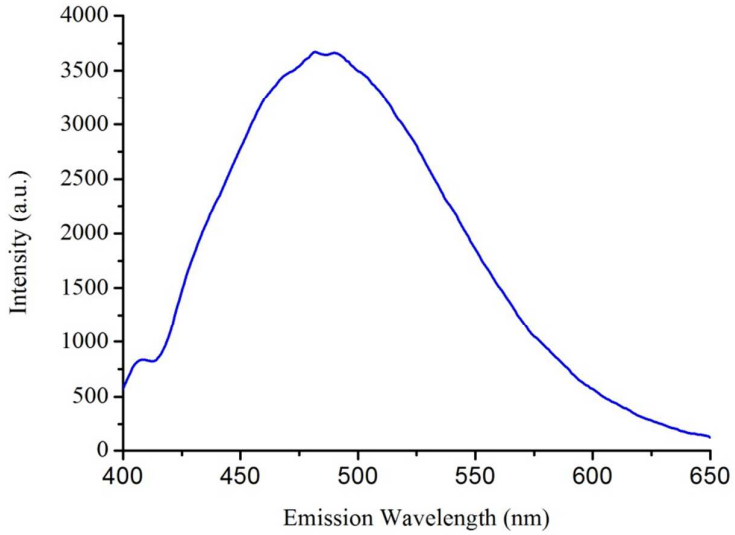
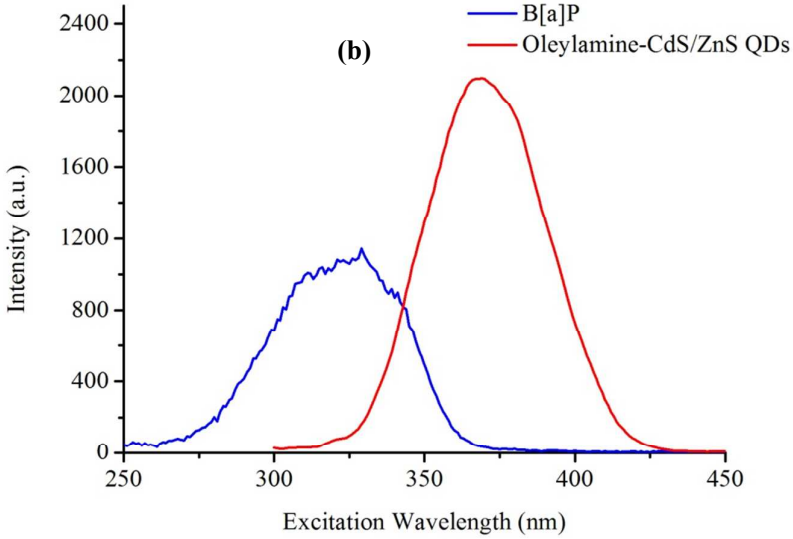



Figure S1 The nanosecond time resolved fluorescence spectra of different kinds of QDs on the epidermal tissues of mangrove roots at optimal emission wavelength (a) Oleylamine-CdS/ZnS QDs (b) PEG-COOH-CdS/ZnS QDs and (c) PEG-$NH_2$-CdS/ZnS QDs.

* The fluorescence lifetime of Oleylamine-CdS/ZnS QDs, PEG-COOH-CdS/ZnS QDs and PEG-$NH_2$-CdS/ZnS QDs on the epidermal tissue of mangrove root that calculated was 28.0 ns, 20.2 ns and 23.3 ns, respectively.

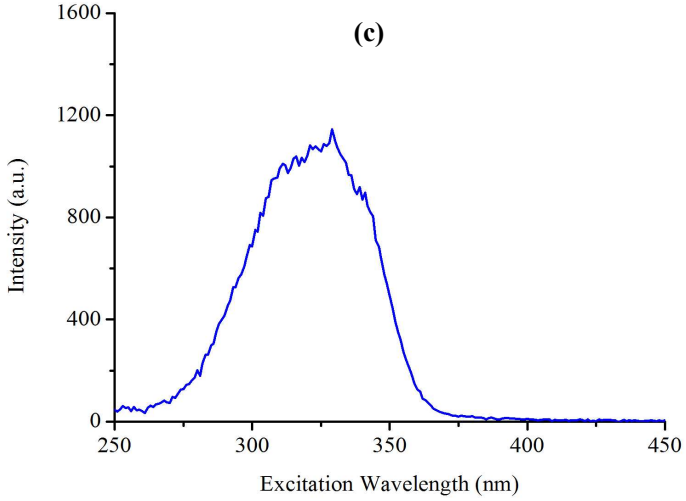
**(a)**


Intensity (a.u.)
Emission Wavelength (nm)


B[a]P
Oleylamine-CdS/ZnS QDs
Intensity (a.u.)
Excitation Wavelength (nm)

**(b)**

**(c)**


Intensity (a.u.)
Excitation Wavelength (nm)

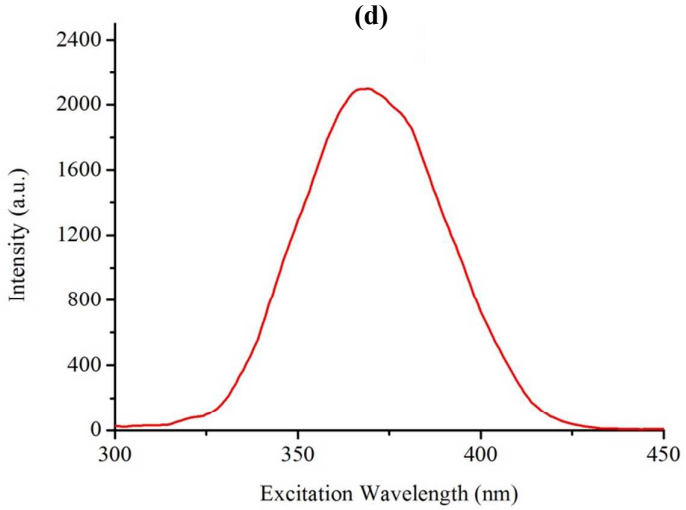



Figure S2 The fluorescence spectra of the Oleylamine-CdS/ZnS QDs retained on the epidermal tissues of *K. obovata* root with the presence of B[a]P after filter out < 10 ns fluorescence signal (a) NSFS[a], (b) S-NSFS[b], (c) S-NSFS of B[a]P, (d) S-NSFS of Oleylamine-CdS/ZnS QDs.

[a] This figure was the overlapped fluorescence spectra (NSFS) of QDs and B[a]P on the epidermal tissues. [b] This figure was the separated fluorescence spectra (S-NSFS) of QDs and B[a]P on the epidermal tissues.

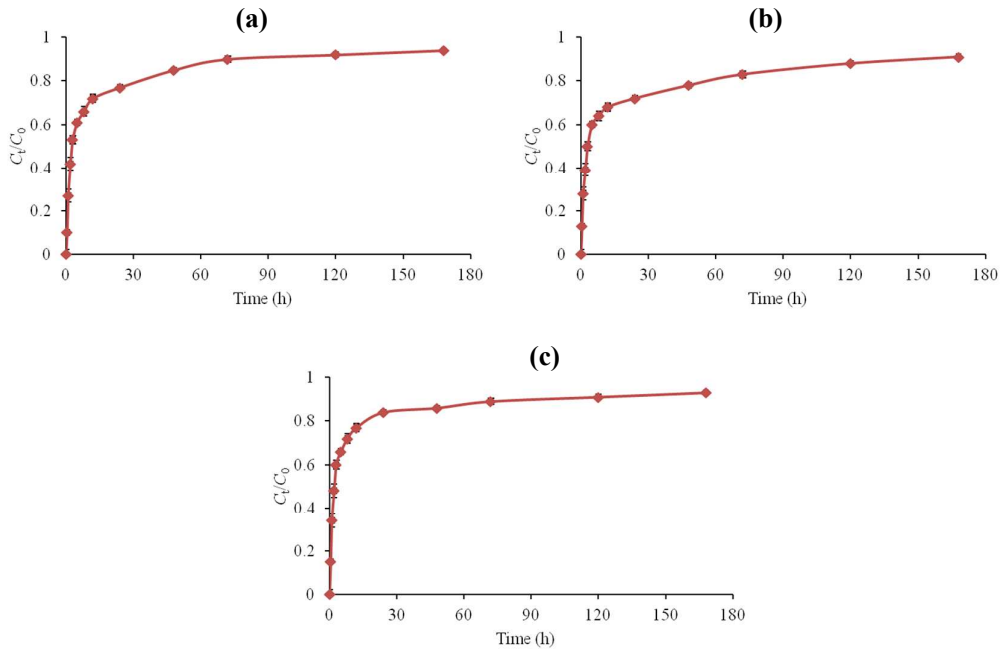



Figure S3 The rates of Oleylamine-CdS/ZnS QDs retained on the epidermal tissues of mangrove root (a) *K. obovata*, (b) *A. marina* and (c) *A. corniculata*. The error bars represent the standard deviations of nine measurements.

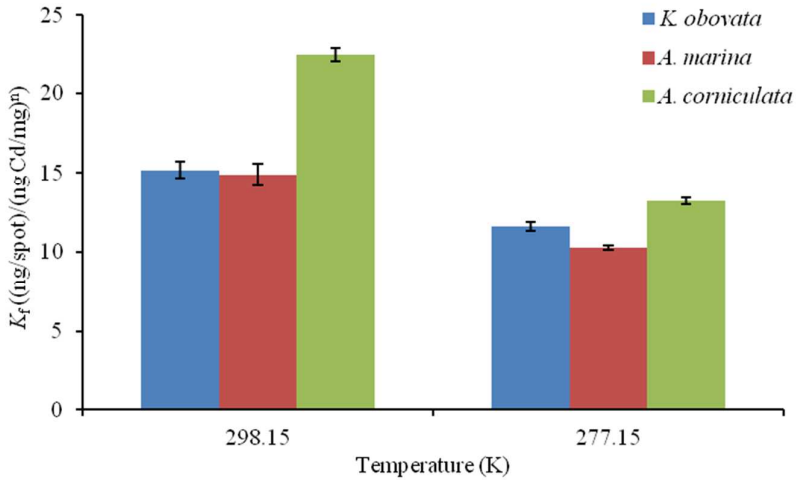



Figure S4 The partition coefficients ($K_f$) of the QDs retained on the epidermal tissue of mangrove root at two different temperatures.

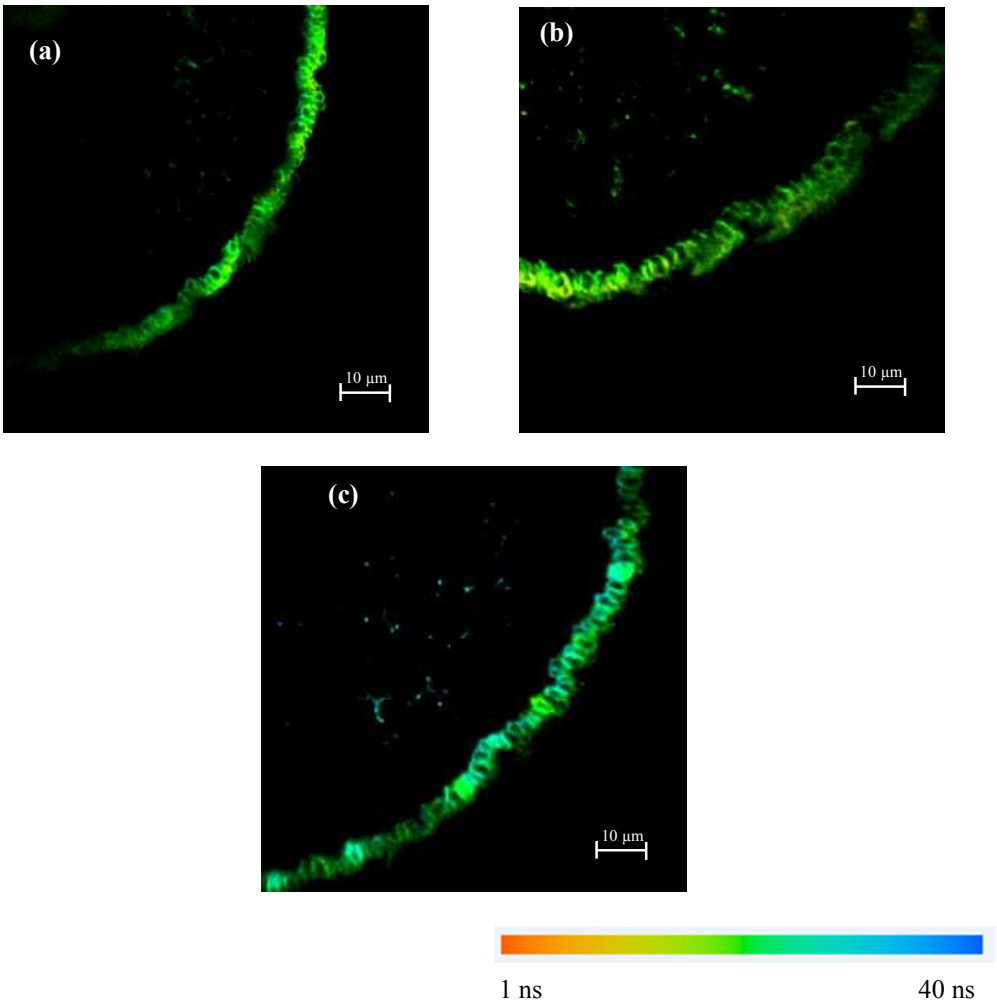



Figure S5 The FLIM images of Oleylamine-CdS/ZnS QDs retained on the epidermal tissue of mangrove root. (a) *K. obovata*, (b) *A. marina* and (c) *A. corniculata*. The RSD value of mean fluorescence intensity of each images from a to c were 2.55 %, 1.84 % and 2.02 % (n=9).

Table S1. Results of recovery experiment for the CdS/ZnS QDs retained on the epidermal tissues of mangrove root.

| Mangrove | QDs | Original (ng/spot) | Added (ng/spot) | Total (ng/spot) | Measured (ng/spot) | Recovery (%) |
|---|---|---|---|---|---|---|
| *K. obovata* | Oleylamine-CdS/ZnS | 100.0 | 50.0 | 150.0 | 141.7 | 94.5 |
| | | 200.0 | 100.0 | 300.0 | 288.6 | 96.2 |
| | | 300.0 | 150.0 | 450.0 | 460.9 | 102.4 |
| | PEG-COOH-CdS/ZnS | 100.0 | 50.0 | 150.0 | 140.9 | 94.0 |
| | | 200.0 | 100.0 | 300.0 | 275.8 | 91.9 |
| | | 300.0 | 150.0 | 450.0 | 443.1 | 98.5 |
| | PEG-$NH_2$-CdS/ZnS | 100.0 | 50.0 | 150.0 | 155.6 | 103.7 |
| | | 200.0 | 100.0 | 300.0 | 292.4 | 97.4 |
| | | 300.0 | 150.0 | 450.0 | 462.5 | 102.8 |
| *A. marina* | Oleylamine-CdS/ZnS | 100.0 | 50.0 | 150.0 | 142.2 | 94.8 |
| | | 200.0 | 100.0 | 300.0 | 305.3 | 101.8 |
| | | 300.0 | 150.0 | 450.0 | 445.6 | 99.0 |
| | PEG-COOH-CdS/ZnS | 100.0 | 50.0 | 150.0 | 157.3 | 104.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 200.0 | 100.0 | 300.0 | 282.5 | 94.2 |
| | | 300.0 | 150.0 | 450.0 | 463.7 | 103.0 |
| | | 100.0 | 50.0 | 150.0 | 138.6 | 92.4 |
| | PEG-$NH_2$-CdS/ZnS | 200.0 | 100.0 | 300.0 | 293.5 | 97.8 |
| | | 300.0 | 150.0 | 450.0 | 470.2 | 104.5 |
| | | 100.0 | 50.0 | 150.0 | 147.3 | 98.2 |
| | Oleylamine-CdS/ZnS | 200.0 | 100.0 | 300.0 | 311.1 | 103.7 |
| | | 300.0 | 150.0 | 450.0 | 431.4 | 95.9 |
| | | 100.0 | 50.0 | 150.0 | 159.8 | 106.5 |
| *A. corniculata* | PEG-COOH-CdS/ZnS | 200.0 | 100.0 | 300.0 | 289.6 | 96.5 |
| | | 300.0 | 150.0 | 450.0 | 472.6 | 105.0 |
| | | 100.0 | 50.0 | 150.0 | 153.4 | 102.2 |
| | PEG-$NH_2$-CdS/ZnS | 200.0 | 100.0 | 300.0 | 288.9 | 96.3 |
| | | 300.0 | 150.0 | 450.0 | 442.2 | 98.3 |

Table S2 Integration results from $^{13}$C-NMR of different kinds of mangrove roots (n=9).

| Mangrove | Relative distribution of organic carbon chemical shift (ppm) (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alkyl C (0-50) | O-alkyl C (50-109) | Aromatic C (109-145) | Phenolic C (145-163) | Carboxyl C (163-190) | Carbonyl C (190-220) | Aliphatic C[a] |
| *K. obovata* | 23.6±2.1[b] | 33.7±2.6 | 22.2±1.5 | 8.9±0.8 | 3.5±0.4 | 8.1±1.1 | 52.3±3.3 |
| *A. marina* | 29.4±1.7 | 24.4±2.7 | 28.8±1.3 | 6.0±0.7 | 4.2±0.6 | 7.2±0.8 | 53.8±2.9 |
| *A. corniculata* | 20.3±3.0 | 35.9±1.8 | 18.7±1.4 | 8.8±0.9 | 6.5±0.3 | 9.8±1.0 | 56.2±2.6 |

[a] aliphatic C content (0-109 ppm)= Alkyl C content+ O-alkyl C content, [b] the mean value and standard deviations of bulk mangrove root functionalities group (n=9).

Table S3 Surface functionalities of the epidermal tissue of mangrove root acquired by XPS.

| Plant | C (%) | | | | | O (%) | N (%) | (O+N)/C |
|---|---|---|---|---|---|---|---|---|
| | Total [a] | C-C | C-O | C=O | COOH | | | |
| *K. obovata* | 64.2±4.3 | 41.1±1.5 | 11.2±1.7 | 6.8±1.1 | 5.1±2.0 | 20.6±3.7 | 15.2±3.3 | 0.56±0.08 |
| *A. marina* | 68.3±5.6 | 45.1±2.1 | 10.7±1.3 | 8.2±0.6 | 4.3±0.9 | 21.4±2.6 | 10.3±1.4 | 0.46±0.16 |
| *A. corniculata* | 71.1±6.4 | 44.8±3.6 | 16.6±2.9 | 5.7±1.3 | 4.0±1.2 | 19.9±4.2 | 9.0±3.1 | 0.41±0.19 |

[a] the mean value and standard deviations of mangrove root surface functionalities group (n=9).