Electronic Supplementary Material (ESI) for Photochemical & Photobiological Sciences.

Electronic Supplementary Material

A novel and sensitive chemosensor based on $KMnO_4$- rhodamine B -CdS quantum dots chemiluminescence system for meropenem detection

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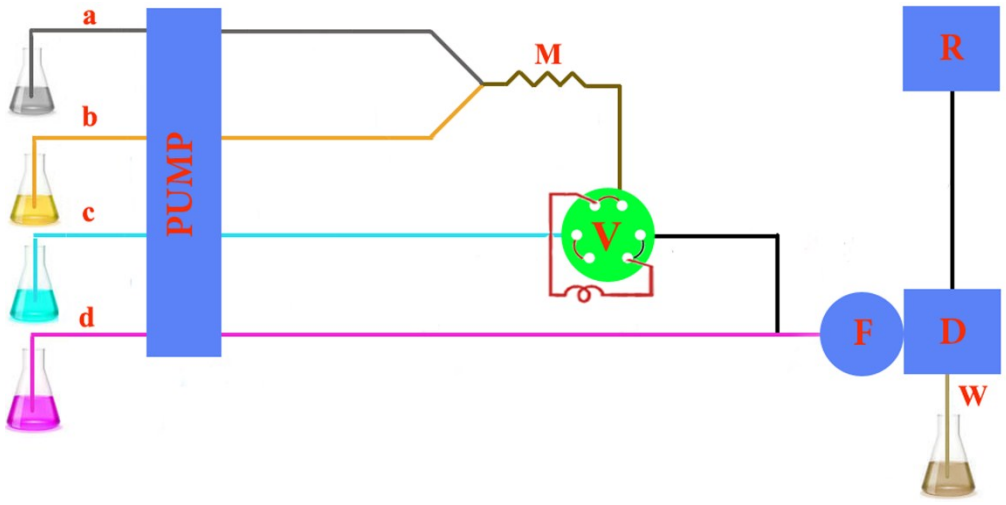


Figure S1. Schematic diagram of flow-injection CL system; (a): acid solution; (b): sample or standard solution of mixture of meropenem, Rh B, and CdS QDs; (c): H_2O as the carrier; (d): $KMnO_4$ solution; P: peristaltic pump; M: mixing tube; V: injection valve; F: flow cell; W: waste; D: detector (luminometer); R: recorder (personal computer).

Optical characteristics of synthesized CdS QDs

Optical characteristic assessment of CdS QDs which were formed in three various heating times (4, 5, and 6 h) was conducted by utilization of the room temperature UV-Vis absorption and PL spectra represented in Figures S2a and S2b, respectively.

As indicated in the figure, red shift to longer wavelength in absorption spectra which attributes to the first exciton peak (1_{sh}-1_{se}) arises from nanocrystal growth during hydrothermal process.[1, 2] The achieved results are in accordance with former investigations proving quantum confinement in the synthesized CdS QDs. Peng's equation[3] was applied to estimation of the as-prepared CdS QDs diameter as follow:

$$D = (-6.6521 \times 10^{-8})\lambda^3 + (1.9557 \times 10^{-4})\lambda^2 - (9.2352 \times 10^{-2})\lambda + 13.29 \quad (1)$$

In the aforementioned formula, D (nm) and λ (nm) express estimated size of CdS QDs and the wavelength of the first excitonic absorption peak of the QDs, respectively. Obtained results from diameter determination of CdS QDs via the noticed expression indicated that diameter of nanocrystals treated with 3, 4, 5, and 6 h hydrothermal procedure were 3.58, 4.07, 4.85 and 5.32 nm, respectively. In view of the fact that QDs band gap (E_g) is a significant point in the associated CL reaction, evaluation of the optical direct band gap energy of as-prepared CdS QDs was performed using the UV-Vis absorption spectra of CdS QDs samples and Tauc's equation:[4]

$$(Ah\nu)^2 = K(h\nu - E_g) \quad (2)$$

In the noted equation, A, hυ, K and E_g are representative of the absorption coefficient, the photon energy (eV), a constant and the optical direct band gap, respectively.

The band gap energy of the CdS QDs with 3, 4, 5, and 6 h heating times relying on the extrapolation of linear portion graph of $(Ahν)^2$ versus hν were evaluated as 3.11, 2.96, 2.83, and 2.62 eV, respectively.

Complementary studies confirm quantum confinement in all synthesized CdS QDs samples based on gained E_g of synthesized CdS QDs which are higher than the described value for bulk CdS with absorption onset at 515 nm (E_g = 2.42 eV) [3]. Moreover reduce in E_g of QDs which results from growth in nanocrystals size can be assigned to the quantum confinement effect in all as-prepared samples.[5]

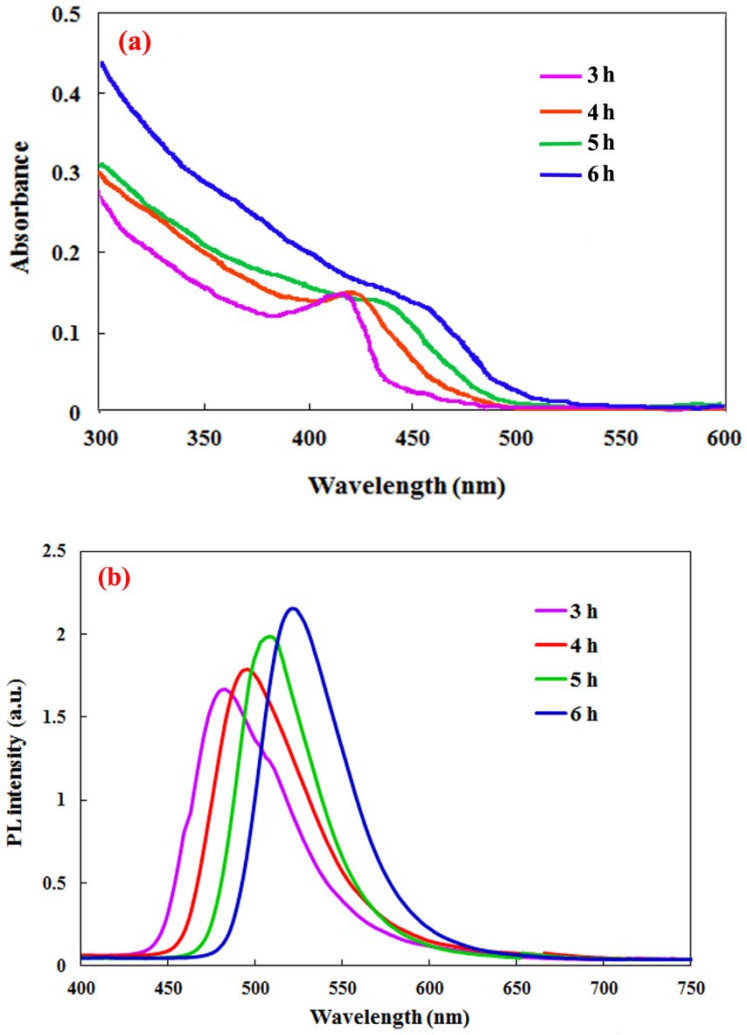


Figure S2. (a): UV-Vis absorption and (b): PL spectra of CdS QDs after different synthesis times (3, 4, 5, and 6 h) at 150 °C. CdS QDs concentration: 1.0 mmol L^{-1}; excitation wavelength: 375 nm.

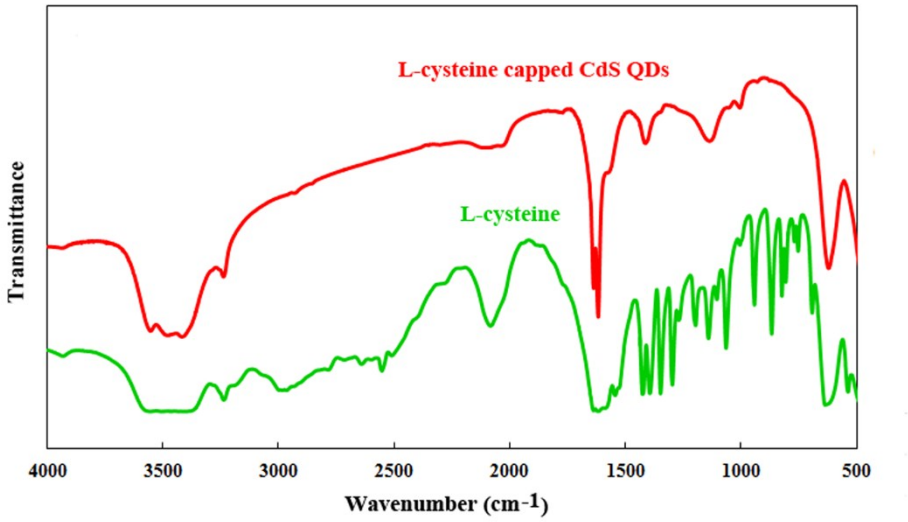
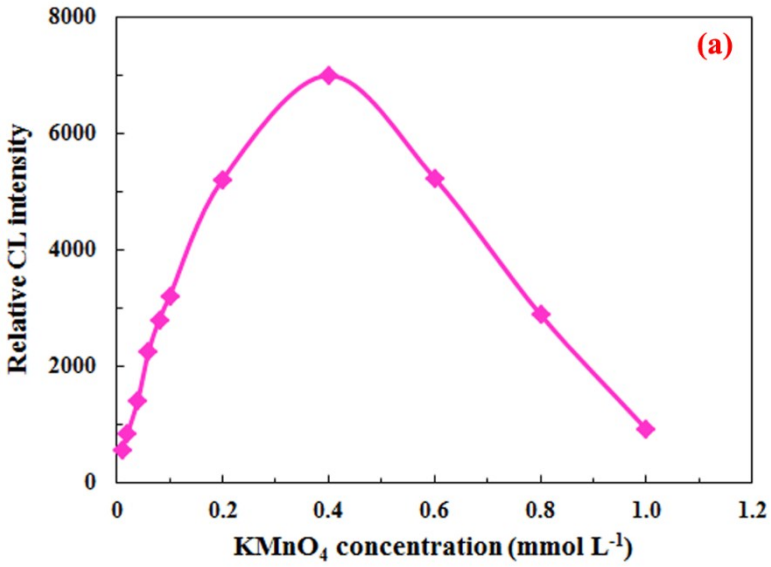
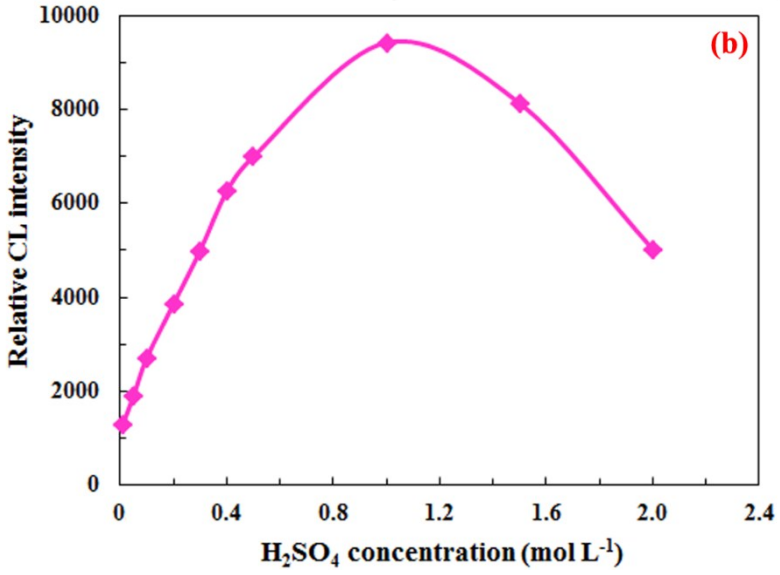


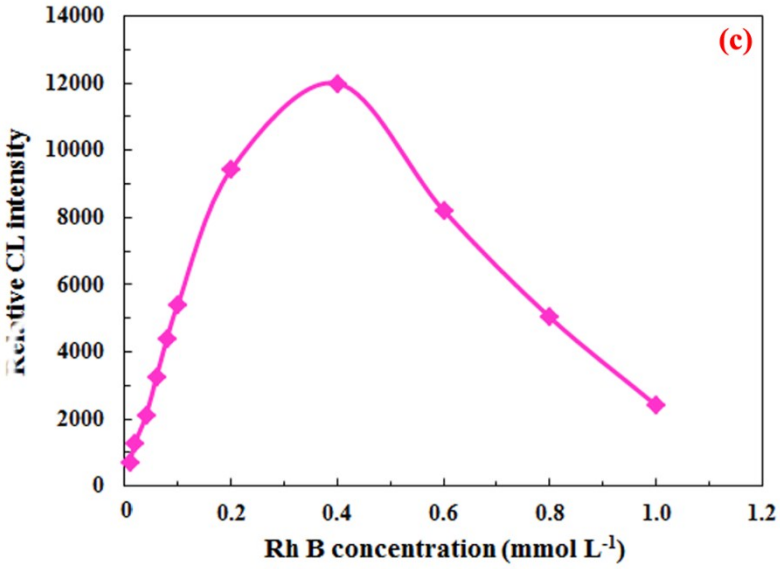
Figure S3. FT-IR spectra of L-cysteine and L-cysteine capped CdS QDs


(a)
Relative CL intensity
8000
6000
4000
2000
0
0
0.2
0.4
0.6
0.8
1.0
1.2
KMnO4 concentration (mmol L-1)

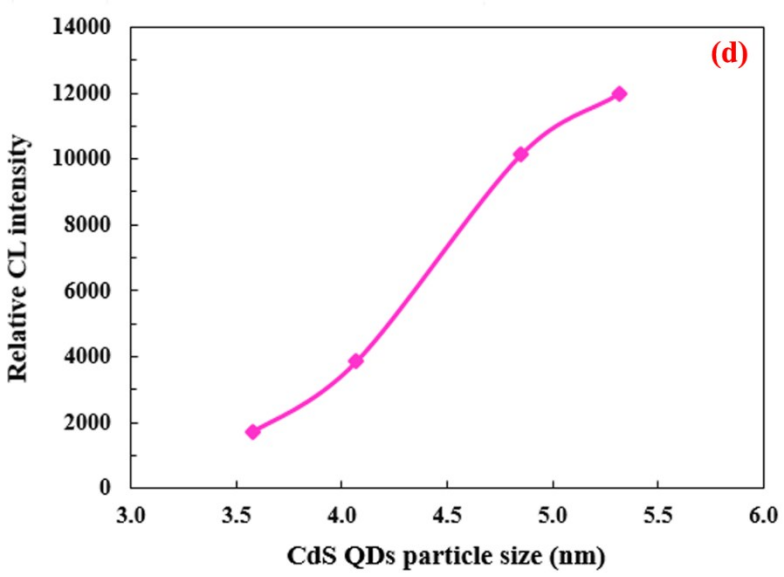
(a)


(b)
Relative CL intensity
10000
8000
6000
4000
2000
0
0
0.4
0.8
1.2
1.6
2.0
2.4
H2SO4 concentration (mol L-1)

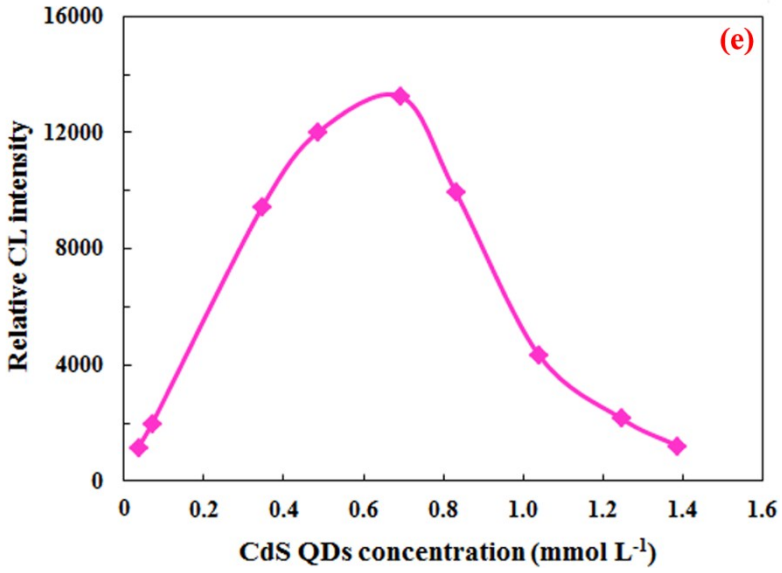
(b)


(c)
14000
12000
10000
8000
6000
4000
2000
0
Relative CL intensity
0
0.2
0.4
0.6
0.8
1.0
1.2
Rh B concentration (mmol L-1)

(c)


(d)
Relative CL intensity
14000
12000
10000
8000
6000
4000
2000
0
3.0
3.5
4.0
4.5
5.0
5.5
6.0
CdS QDs particle size (nm)

(d)



(e)

Figure S4. Optimization of the CL reaction conditions: (a) effect of $KMnO_4$ concentration. Conditions: the concentrations of Rh B, H_2SO_4, and CdS QDs were 0.2 mmol L^{-1}, 0.5 mol L^{-1}, and 0.48 mmol L^{-1}, respectively; (b) effect of H_2SO_4 concentration. Conditions: the concentrations of $KMnO_4$ was 0.4 mmol L^{-1}, other conditions were as in (a), (c) effect of Rh B concentration. Conditions: the concentrations of H_2SO_4 was 1.0 mol L^{-1}, other conditions were as in (b), (d) effect of particle size of CdS QDs. Conditions: the concentrations of Rh B was 0.4 mmol L^{-1}, other conditions were as in (c), (e) effect of CdS QDs concentration. Conditions: particle size of CdS QDs was 5.32 nm, other conditions were as in (d).

Table

Table S1. Tolerable concentration ratios with respect to 1.0 mg L^{-1} of meropenem.

Species	Tolerable concentration ratio [$C_{interferent\ (mg\ L^{-1})}/C_{meropenem\ (mg\ L^{-1})}$]
Na^+, Cl^-, K^+, SO_4^{2-}, CH_3COO^-	1000
Br^-, CO_3^{2-}, PO_4^{3-}, Mg^{2+}, Ca^{2+}, Tartaric acid, Lactose, Valine	600
Alanine, Sucrose, Glucose, Starch, NO_3^-	230
Methyl parabene, Propyl parabene	150
Ni^{2+}, Pb^{2+}, Al^{3+}, Zn^{2+}	54
Fe^{2+}, Co^{2+}	40
Cu^{2+}	10

References

1. Y. Li, P. Yang, P. Wang, X. Huang and L. Wang, *Nanotechnology*, 2007, **18**, 225602.
2. Z. Wang, J. Li, B. Liu, J. Hu, X. Yao and J. Li, *J. Phys. Chem. B*, 2005, **109**, 23304-23311.
3. W. W. Yu, L. Qu, W. Guo and X. Peng, *Chem. Mater.*, 2003, **15**, 2854-2860.
4. J. Tauc, *Mater. Res. Bull.*, 1968, **3**, 37-46.
5. Z. Wang, J. Li, B. Liu and J. Li, *Talanta*, 2009, **77**, 1050-1056.