

## Electronic Supporting Information

### **Copper Ion-Induced Fluorescence Band Shift of CdTe Quantum Dots: A Highly Specific Strategy for Visual Detection of Cu<sup>2+</sup> with a Portable UV Lamp**

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## 1. Reagents and instruments

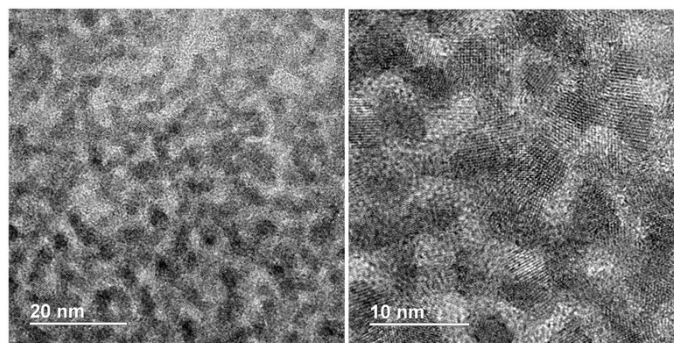
Tellurium powder, cadmium chloride ( $\text{CaCl}_2 \cdot 2.5\text{H}_2\text{O}$ ), sodium borohydride ( $\text{NaBH}_4$ ), copper sulfate ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ), sodium hydroxide and ascorbic acid were obtained from Sinopharm Chemical Reagent (Shanghai, China). Thioglycolic acid (TGA) was purchased from Sigma (USA). Real seawater samples were collected from Beidaihe (Qinghuangdao, China). All other reagents were used as received without further purification.

Amicon Ultra-2 Centrifugal Filter (10 KD) was purchased from Millipore. The thermostat metal bath used for controlling temperature was acquired from BIOER (Hangzhou, China). The fluorescence spectra of CdTe QDs were recorded on a Fluorolog 3-211 fluorescence spectrophotometer (Horiba Jobin-Yvon, France).

## 2. Synthesis and characterization of CdTe QDs

CdTe QDs stabilized by thioglycolic acid (TGA) were prepared according to the protocols described previously.<sup>S1, S2</sup> Briefly, 0.0300 g of tellurium powder and 0.1080 g of sodium borohydride were dissolved in 12 mL ultrapure water deaerated by nitrogen in advance and incubated in ice-bath for about 8 hours under nitrogen atmosphere with magnetic stirring. Then sulfuric acid (22.5 mL, 1 M) was added dropwise into the above mixture to form  $\text{H}_2\text{Te}$  gas.

Simultaneously, 0.2808 g of  $\text{CdCl}_2$  and 120  $\mu\text{L}$  of TGA were dissolved in 180 mL ultrapure water under stirring. Afterward, the pH of the solution was adjusted to 12 by addition of  $\sim 6$  mL NaOH solution (1 M) dropwise.  $\text{H}_2\text{Te}$  gas was passed through such solution together with nitrogen as a carrier gas. At this stage, CdTe precursors were formed. Subsequently, by refluxing the reaction mixture at 110  $^\circ\text{C}$  for  $\sim 0.5$  hour, the precursors were converted to CdTe QDs with the desirable green emission. To further enhance their fluorescence intensity, the as-prepared CdTe QDs stock solution was exposed to a fluorescent lamp for about 8 days. Finally, the CdTe QDs were purified with ultrafiltration tubes (10 KD, Millipore) to remove the excess reactants and then ready for use for the detection of  $\text{Cu}^{2+}$ . The size and morphology of the as-synthesized CdTe QDs was characterized on a Tecnai G2 F20 transmission electron microscope, and the typical TEM images of the CdTe QDs were shown in Fig. S1.



**Fig. S1.** Typical TEM images of the synthesized CdTe QDs.

### 3. Standard experimental procedures for the detection of Cu<sup>2+</sup>

Typically, 20  $\mu\text{L}$  of the as-synthesized CdTe QDs and 20  $\mu\text{L}$  of ascorbic acid (1 mM) were mixed with different concentrations of Cu<sup>2+</sup> ions, respectively. Afterward, the mixtures were diluted to 200  $\mu\text{L}$  with ultrapure water and then immediately incubated at 60 °C for 30 min. All fluorescence photos were taken with a Canon IXUS230HS digital camera under the irradiation of a 365 nm UV light, and the corresponding fluorescence spectra of the QDs were measured on a Fluorolog 3-211 fluorescence spectrophotometer with the excitation wavelength of 365 nm.

### 4. XPS results for the Cu<sup>2+</sup>-treated CdTe QDs

Fig. S2 shows the XPS spectra of Cu (2p) in the Cu<sup>2+</sup>-treated CdTe QDs. It is suggested that for Cu (2p), the binding energies of 933 and 952 eV can be ascribed to the Cu (2p<sub>3/2</sub>) and Cu (2p<sub>1/2</sub>). According to previous reports, the peaks in the spectra indicate the presence of solely Cu<sup>+</sup> rather than Cu<sup>2+</sup> ions.<sup>S3, S4</sup>

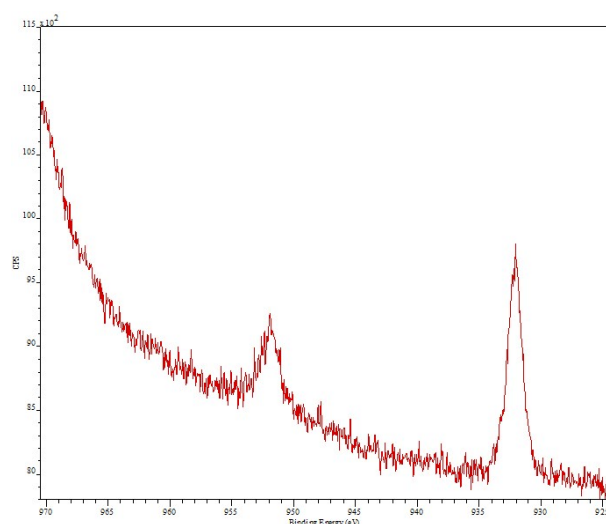


Fig. S2. XPS spectra of Cu (2p) in the Cu<sup>2+</sup>-treated CdTe QDs.

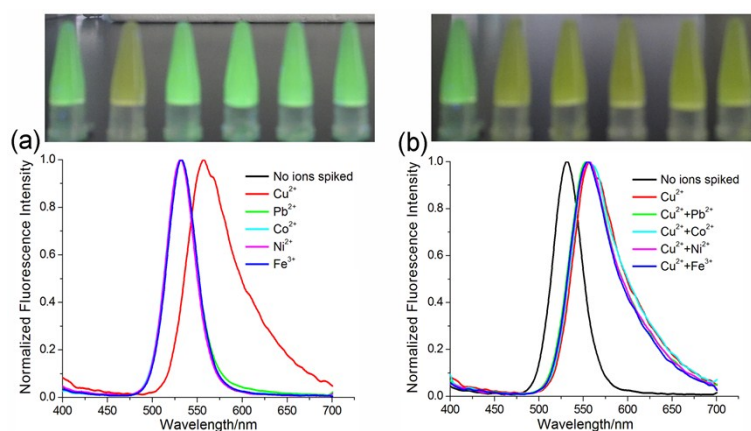
### 5. Comparison of different QDs-based assays for the detection of Cu<sup>2+</sup>

Table S1. Comparison of different QDs-based assays for the detection of Cu<sup>2+</sup>.

Detection Strategy	Sensing materials	Detection limit	Dynamic range	Ref.
Fluorescence quenching	Branched poly(ethylenimine)-functionalized carbon QDs	6 nM	0.01~1.1 $\mu\text{M}$	S5
Fluorescence quenching	Fe <sub>3</sub> O <sub>4</sub> @C@CdTe core/shell microspheres	Not Available	1~10 $\mu\text{M}$	S6
Fluorescence quenching	CTAB-modified CdSe/ZnS QDs in the presence of thiosulfate	0.15 nM	0.03~0.6 $\mu\text{M}$	S4
Fluorescence quenching	L-cysteine-capped ZnS QDs	7.1 $\mu\text{M}$	20~260 $\mu\text{M}$	S7
Fluorescence	Thioglycerol-capped CdS QDs	0.1 $\mu\text{M}$	1~1200 $\mu\text{M}$	S8

quenching				
Fluorescence quenching	Type-II core/shell CdTe/CdSe QDs	20 nM	0.05~50 $\mu$ M	S9
Fluorescence quenching	CdTe QDs coated by octamercaptopropyl polyhedral oligomeric silsesquioxane	2.3 nM	0.01~1 $\mu$ M	S10
Fluorescence quenching	CdSe/CdS core/shell QDs modified with a polymer of MAO-mPEG	16 nM	0.01~0.5 $\mu$ M	S11
Fluorescence quenching	Size dependent quenching of CdTe QDs	0.02 $\mu$ M	0.05~4 $\mu$ M	S12
Fluorescence quenching	Mercaptopropionic acid (MPA)-capped CuInS <sub>2</sub> ternary QDs	0.037 $\mu$ M	0.1~10 $\mu$ M	S13
Fluorescence quenching	Silica-coated ZnS:Mn QDs	7.3 nM	0.2~4 $\mu$ M	S14
Fluorescence quenching	Gemini surfactant C <sub>12-4-12</sub> -coated CdSe/ZnS QDs	1.1 $\mu$ M	20~500 $\mu$ M	S15
Fluorescence quenching	16-mercaptohexadecanoic acid (16-MHA)-capped CdSe QDs	5 nM	0~100 $\mu$ M	S16
Fluorescence quenching	Peptide-coated CdS QDs	0.5 $\mu$ M	0~2 $\mu$ M	S17
Fluorescence quenching	Amino TPEA-modified carbon QDs	10 nM	1~100 $\mu$ M	S18
Fluorescence band shift	Thioglycolic acid (TGA)-capped CdTe QDs	0.1 $\mu$ M	0.1~20 $\mu$ M	This work

## 6. The effect of coexisting quenching ions on the detection of Cu<sup>2+</sup>



**Fig. S3.** Investigation of the effect of coexisting quenching ions on the detection of Cu<sup>2+</sup>. (a) the results of the proposed sensing system treated with water samples spiked with individual metal ions (2  $\mu$ M each), respectively; (b) the results of the proposed sensing system treated with water samples spiked with Cu<sup>2+</sup> or the mixture of Cu<sup>2+</sup> and a certain quenching ion (2  $\mu$ M each), respectively. The samples in the photos (from left to the right): no spiked metal ions, Cu<sup>2+</sup>, Pb<sup>2+</sup>, Co<sup>2+</sup>, Ni<sup>2+</sup> and Fe<sup>3+</sup> for images in Fig. S3a and no spiked metal ions, Cu<sup>2+</sup>, Cu<sup>2+</sup>/Pb<sup>2+</sup>, Cu<sup>2+</sup>/Co<sup>2+</sup>, Cu<sup>2+</sup>/Ni<sup>2+</sup> and Cu<sup>2+</sup>/Fe<sup>3+</sup> for images in Fig. S3b.

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