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

Supporting Information

Rapid detection of an anthrax biomarker based on the recovered fluorescence of carbon dots-Cu(II) system

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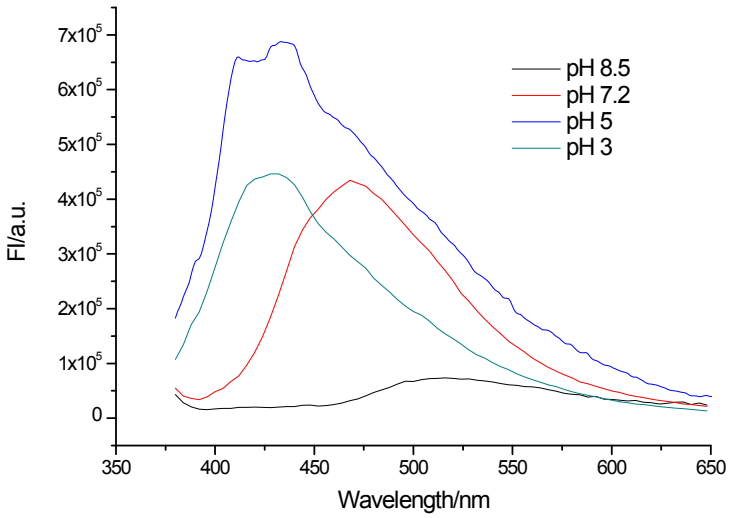

Fig. S1 Emission spectra under 365nm excitation of CDs prepared at different pH.

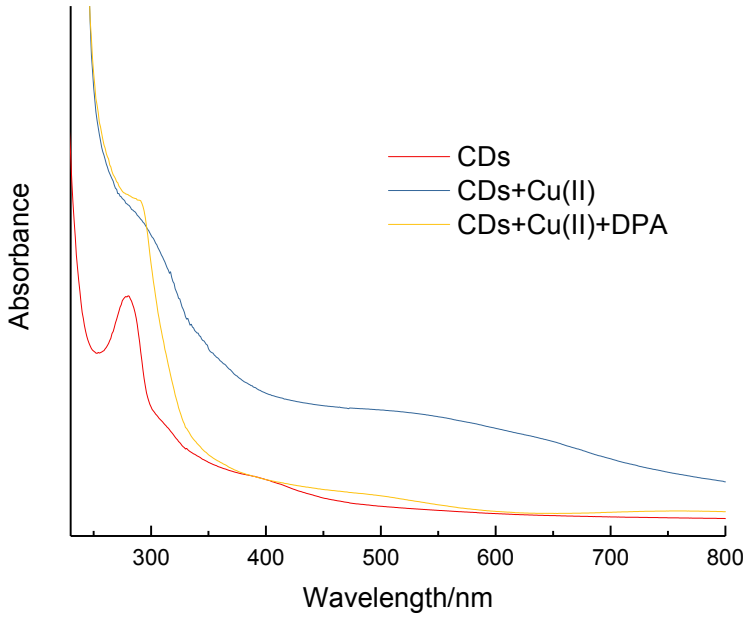

Fig. S2 UV/Vis absorption (Abs) spectra in the absence and presence of Cu(II).

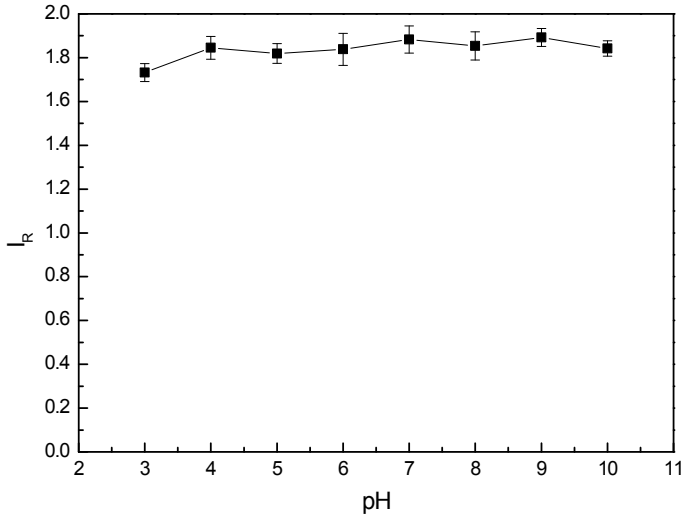

Fig. S3 pH effect on the fluorescence of CDs. I_R is the fluorescent ratio of I_{420}/I_{352}.

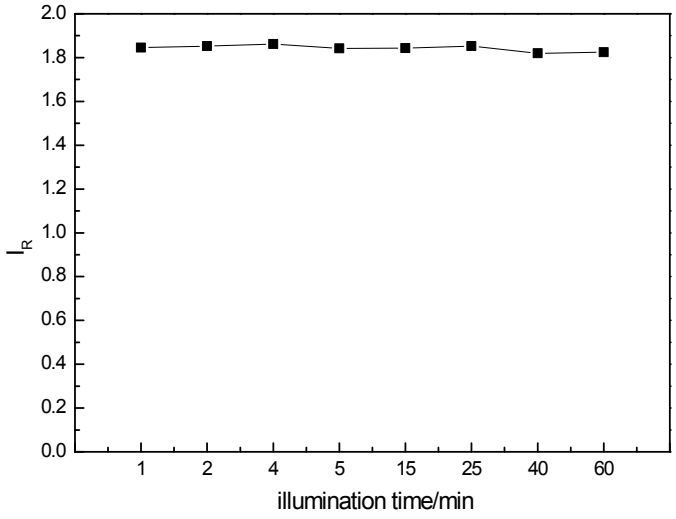

Fig. S4 Photostability of CDs illustrated with time-course study of fluorescence ratio of CDs at two different fluorescence wavelengths by illumination with a UV lamp (365nm). I_R is the fluorescence ratio of I_{420}/I_{352}.

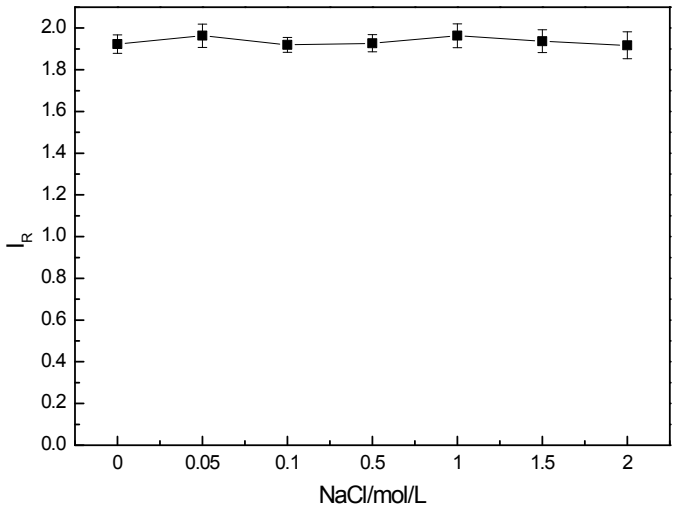

Fig. S5 Effect of salt on fluorescence of CDs. I_R is fluorescence ratio of I_{420}/I_{352}.

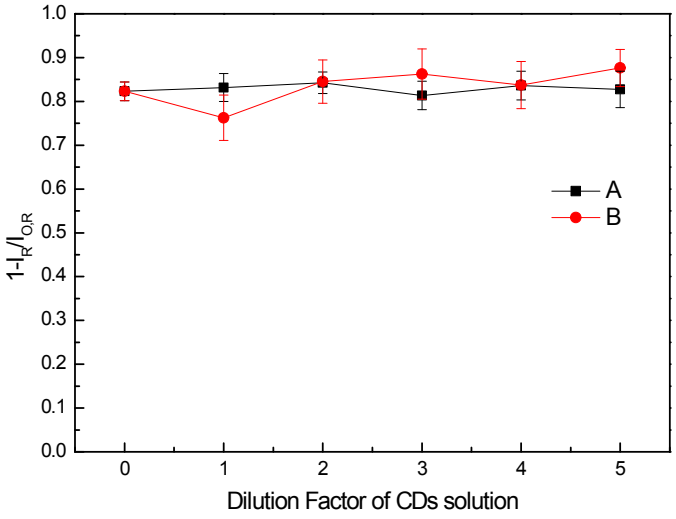

Fig. S6 Changes of (A) fluorescence intensity ratio of I_{420}/I_{352} and (B) fluorescence intensity of I_{420} only on CDs with different dilution factors in a given Cu(II) concentration of 1000 μg/L.

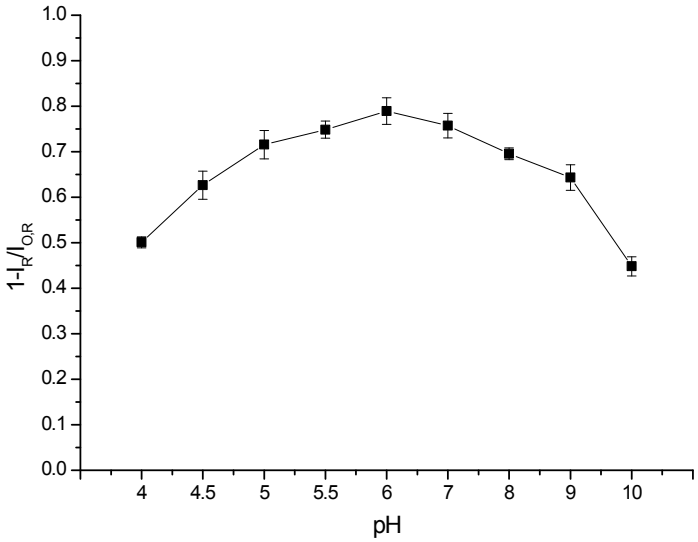

Fig. S7. pH effect of CDs-Cu(II) quenching system. Conditions: CDs concentration, 90ug/mL; Cu(II) concentration: 500 μg/L; incubation time: 5 min; fluorescence intensity ratio of CDs; I_o and I are ratio fluorescence intensity in the absence and presence of Cu(II), respectively.

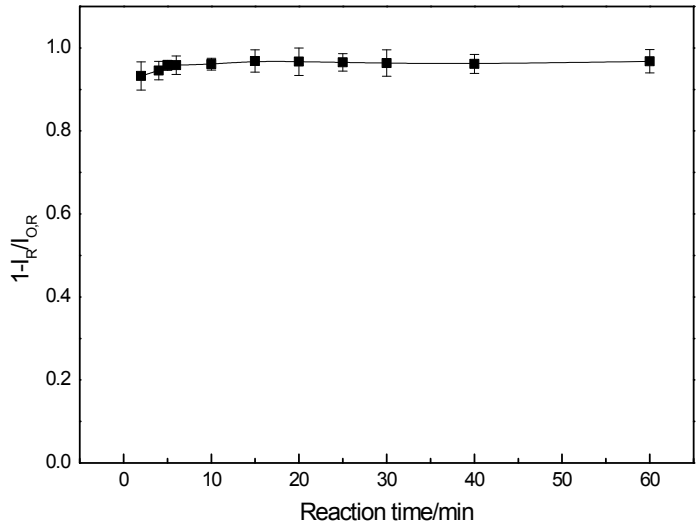

Fig. S8 Effect of reaction time on CDs/Cu(II) system. Conditions: CDs concentration, 90 μg/mL; Cu(II) concentration: 2000 μg/L; pH 6.0; fluorescence intensity ratio of CDs: $I_R=I_{420}/I_{352;}$ and I_o and I are fluorescence intensity in the absence and presence of Cu(II), respectively.

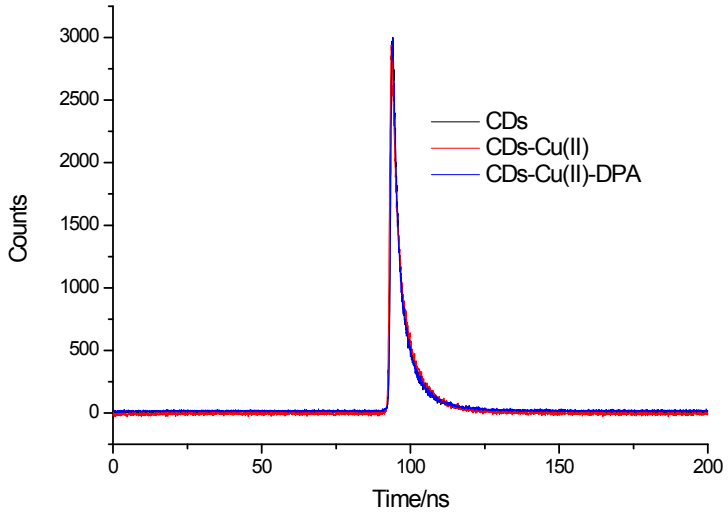

Fig. S9 Fluorescence life-time decay plot for CDs, CDs-Cu(II) and CDs-Cu(II)-DPA.

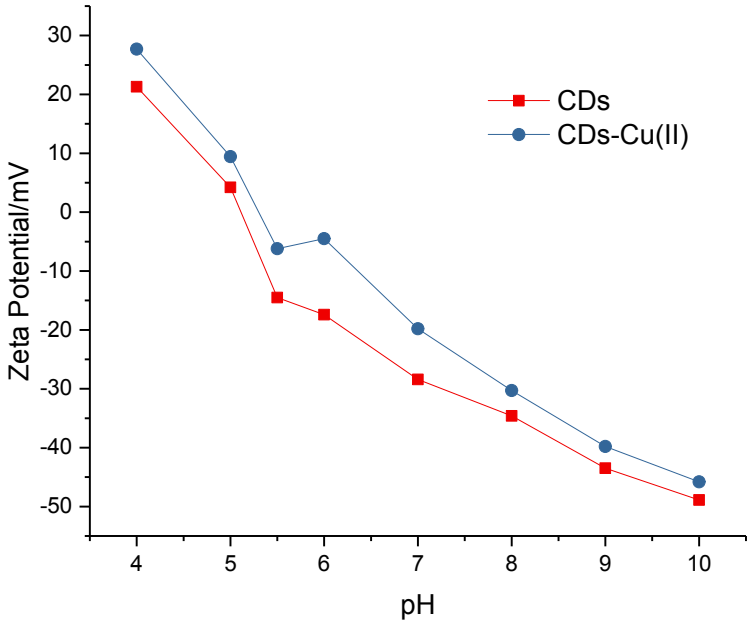

Fig. S10 Zeta potential of CDs with and without 1000 μg/L of Cu(II) at different pH.

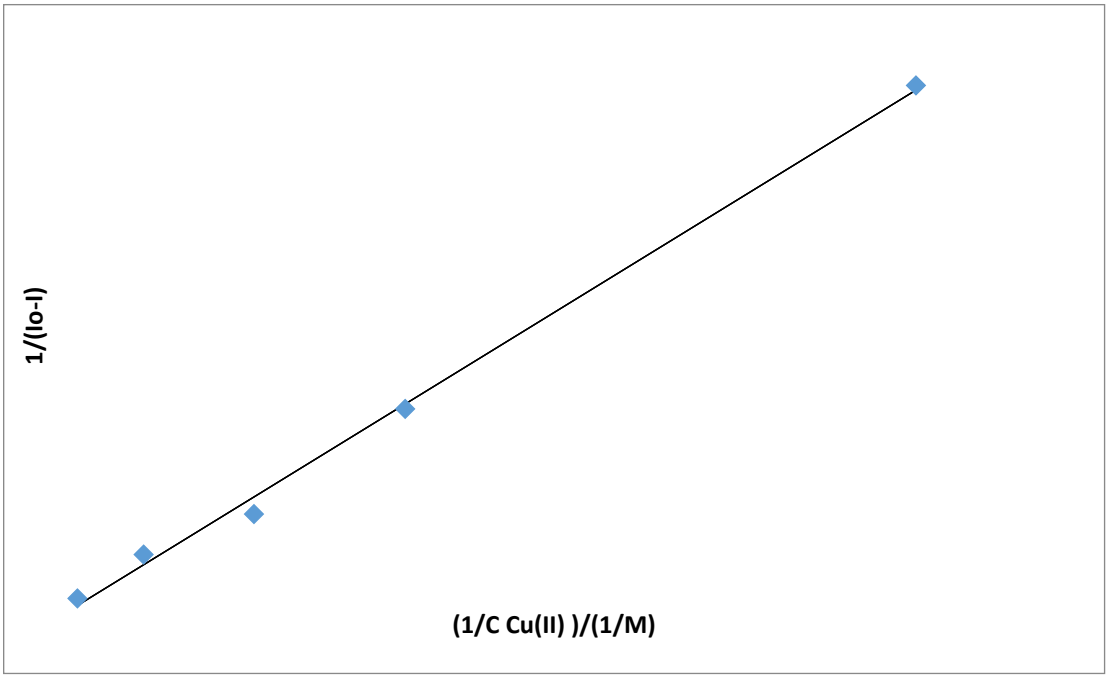

Fig S11. The relationship curve of $1/(I_0 - I)$ and $1/C_{Cu(II)}$ for CDs. (R = 0.9962)

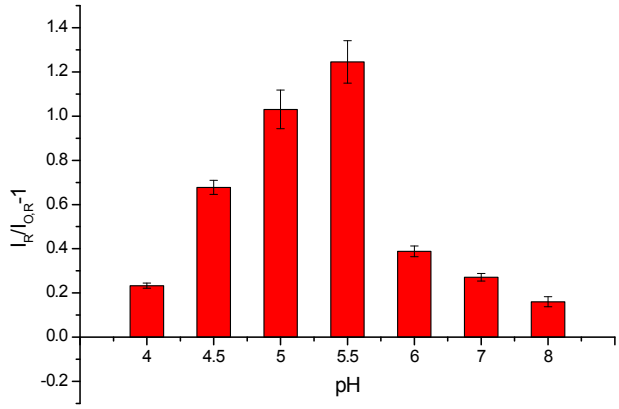

Fig. S12. pH effect on restoration of CDs-Cu(II) system with addition of DPA. Conditions: CDs concentration, 90 μg/mL; Cu(II) concentration: 2000 μg/L; DPA concentration, 10 μmol/L; incubation time: 2 min; fluorescence intensity ratio of CDs: $I_R=I_{420}/I_{352;}$ and I_o and I are fluorescence intensity in the absence and presence of DPA in CDs-Cu(II) sensor system, respectively.

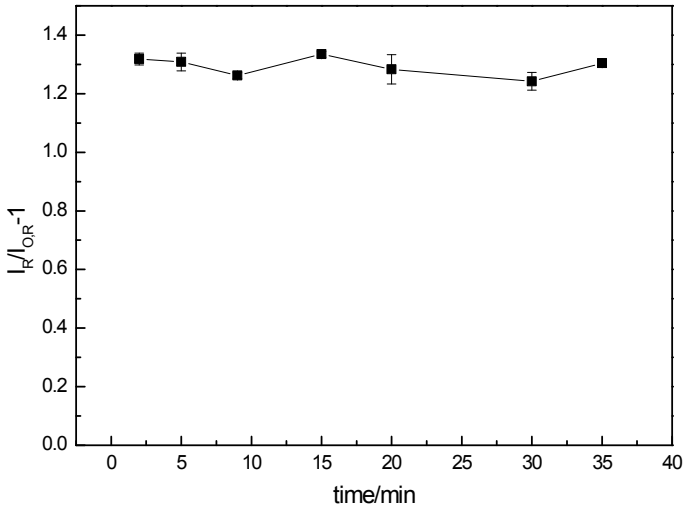

Fig. S13. Incubation time effect on the restoration of CDs-Cu(II) system with addition of DPA. Conditions: CDs concentration, 90 μg/mL; Cu(II) concentration: 2000 μg/L; DPA concentration, 10 μmol/L; pH 5.5; the fluorescence intensity ratio of CDs $I_R=I_{420}/I_{352;}$ and I_o and I are fluorescence intensity in the absence and presence of DPA in CDs-Cu(II) sensor system, respectively.

Table S1. Quantum yield (QY) calculation of the CDs at 365 nm excitation.

Sample	integrated fluorescence intensity(F)	UV Absorbance	Quantum yield (ϕ)/%
Quinine sulfate	65465432	0.063	54
CDs-1(pH 3.0)	4918567	0.018	14.2
CDs-2(pH 5.0)	14734533	0.031	24.7
CDs-3(pH 7.2)	3694698	0.015	12.8
CDs-3(pH 8.5)	2035933	0.023	4.6

Table S2 Performance evaluation of CDs for Cu(II) and DPA detection.

	Cu(II)	DPA
Linear Range	1-500 μg/L	0.25-20 μmol/L
Equation	y=(0.0846±0.0008)x+(6.8852 ±0.1987)	y=(0.1589±0.0110)x+(1.1214±0.109)
R-square	0.9919	0.9971
LOD 3s(blank)/slope	0.16 μg/L	0.079 μmol/L
RSD (n=11)		
	2.75%[a]	1.52%[d]
	0.58%[b]	2.22%[e]
	0.62% [c]	1.78% [f]

Cu(II) concentration for RSDs: [a], 20 μg/L; [b], 100 μg/L; [c], 500 μg/L.

DPA concentration of RSDs: [d], 1 μmol/L; [e], 10 μmol/L; [f], 20 μmol/L

Table S3. Average lifetime fit by Origin software using ExpDecay2

	R-square	α_1	t_1	α_2	t_2	τ/ns
DA	0.99791	961.8555	6.65839	2397.678	1.90147	4.68
DA-Cu	0.99866	1860.916	2.00249	887.8286	6.47747	4.72
DA-Cu-DPA	0.99787	2382.681	1.69077	1084.085	6.22592	4.53

Table S4 Zeta potential, conductivity and average size of CDs, CDs-Cu(II), and CDs-Cu(II)-DPA at pH 5.5.

	Zeta potential /mV	Conductivity /mS/cm	Average size measured by DLS /nm
CDs	-15.8	6.9	39.3
CDs-Cu(II)	-6.2	10.1	420.4
CDs-Cu(II)-DPA	-8.89	9.11	109.5

Table S5: Concentration of Cu(II) and DPA in real water samples (n=3).

	Cu(II)			DPA		
	Added /μg/L	Found / μg /L	Recovery /%	Added /μmol/L	Found /μmol/L	Recovery /%
Tap water	0	11.41±0.97	-	0	N.D.	-
	40	49.12±2.37	94.3	2	1.87±0.07	93.4
	400	381.20±21.08	95.3	15	14.15±0.83	94.3
Rain water	0	9.82±0.63	-	0	N.D.	-
	40	49.20±1.98	98.5	2	1.83±0.06	91.3
	400	391.60±28.31	97.9	15	13.88±1.02	92.5
Reservoir water	0	23.10±1.21	-	0	N.D.	-
	40	59.62±3.23	91.3	2	1.75±0.07	87.4
	400	357.60±19.32	89.4	15	13.59±0.85	90.6

Recovery = (amount found in spiked sample - amount found in original sample) × 100 / amount added.

N. D. : not detected

Table S6. Determination of DPA in fetal bovine serum samples (n=3).

Added standard DPA /μmol/L	Founded DPA (10^{-6}M)	Recovery (%)
0	N.D.	-
2	1.83 ± 0.05	91.5
10	9.24± 0.19	92.4