Supporting Information

Nitrogen-doped carbon quantum dots for fluorescence sensing, anti-counterfeiting and logic gate operation

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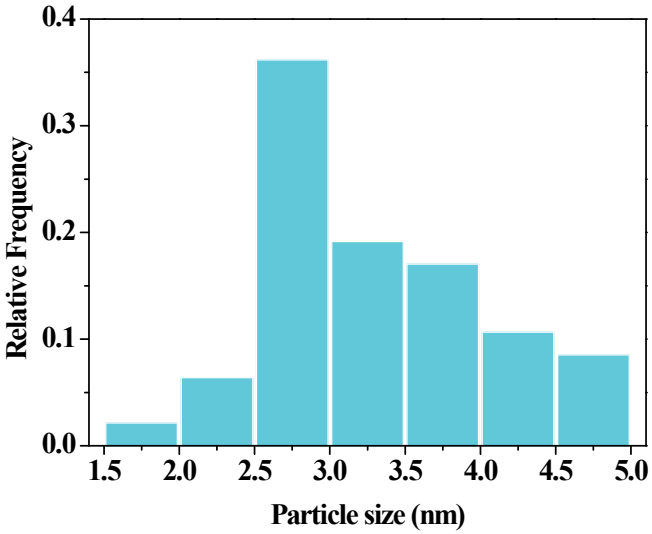

Fig. S1 Average particle size of N-CQDs (3.27 ± 0.69 nm)

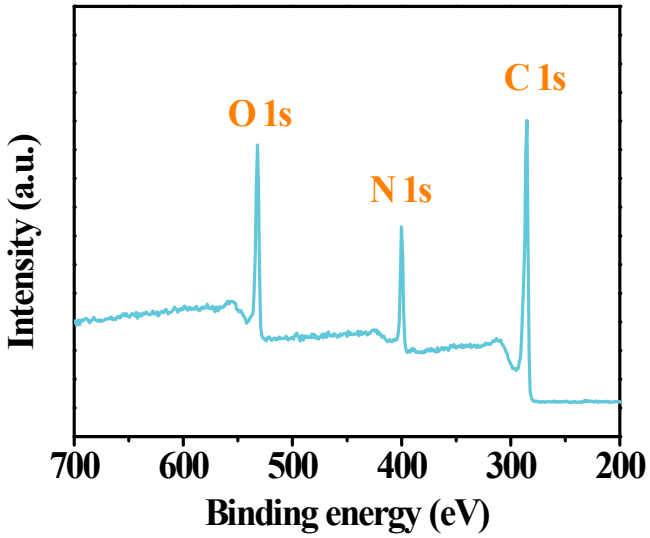

Fig. S2 XPS survey spectrum of N-CQDs

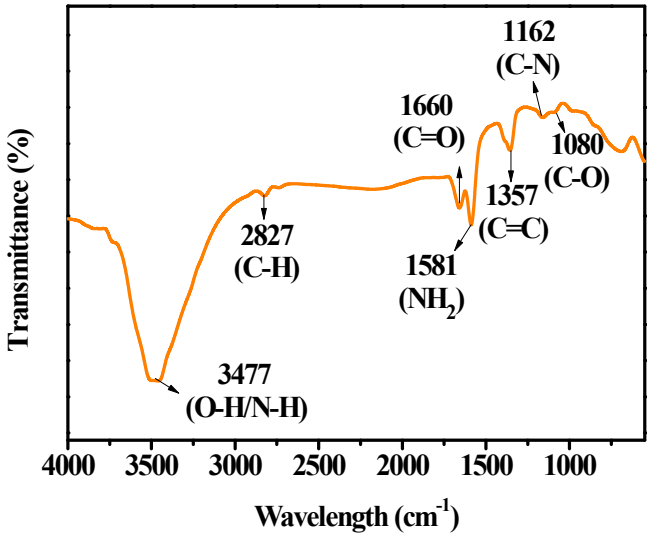

Fig. S3 FT-IR spectrum of N-CQDs

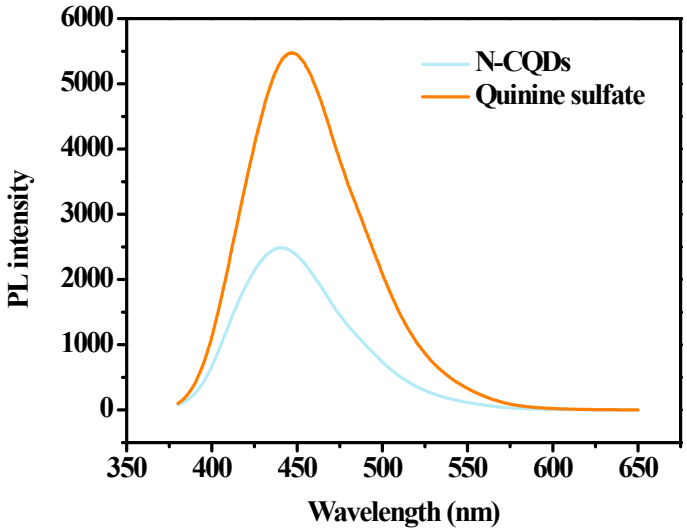

Fig. S4 PL spectrum of N-CQDs and quinine sulfate

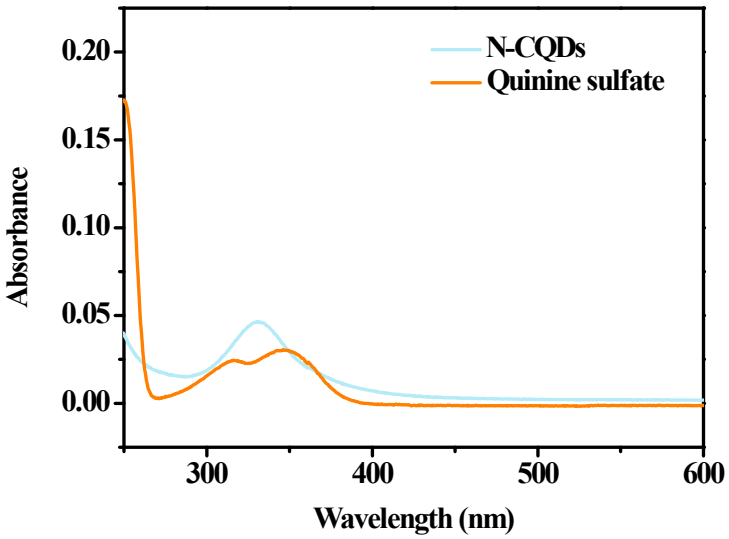

Fig. S5 UV-vis spectrum of N-CQDs and quinine sulfate

Table S1. Quantum yield of the N-CQDs

Sample	Abs. at 360nm	PL Integrated intensity	Refractive index of solvent (n)	PLQY (%)
Quinine sulfate	0.0298	448518.3	1.33	54
N-CQDs	0.0292	196834.1	1.33	25.9

Table S2 Comparison of the fluorescence quantum yield (QY) of CQDs.

Quantum dots	QY (%)	References
Nitrogen-doped carbon quantum dots (N-CQDs)	18	[1]
N-doped carbon quantum dots (N-CQDs)	21.9	[2]
Boron-nitrogen co-doped carbon quantum dots (B, N-CQDs)	14.5	[3]
Nitrogen modifed carbon quantum dots (N-CQDs)	16.8	[4]
Nitrogen doped carbon quantum dot (N-CQDs)	14.81	[5]
Nitrogen-rich carbon quantum dots (N-CQDs)	25	[6]
Nitrogen doped carbon quantum dots (N-CQDs)	12.33	[7]
Nitrogen-doped carbon quantum dots (N-CQDs)	17.5	[8]
Nitrogen-doped carbon quantum dots (N-CQDs)	22.14	[9]
N-doped carbon quantum dots (CQDs)	9	[10]
Nitrogen, phosphorus codoped carbon quantum dots (N, P-CQDs)	21.7	[11]
N-CQDs	25.9	This work

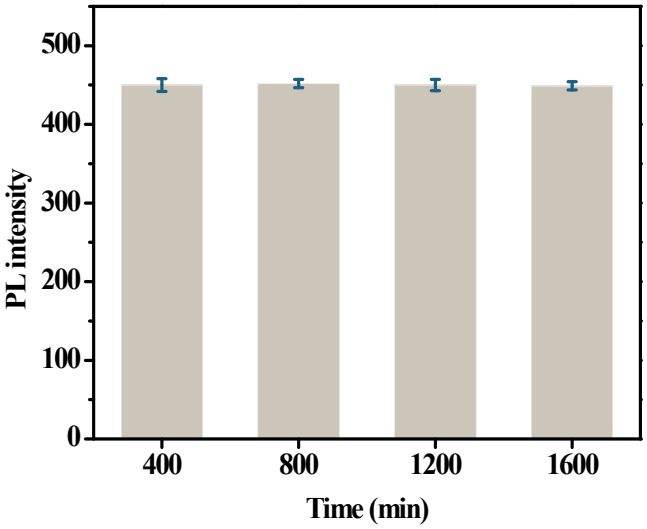

Fig. S6 Stability testing of N-CQDs

Fig. S7 Fluorescence photos of different metal ions detected by N-CQDs

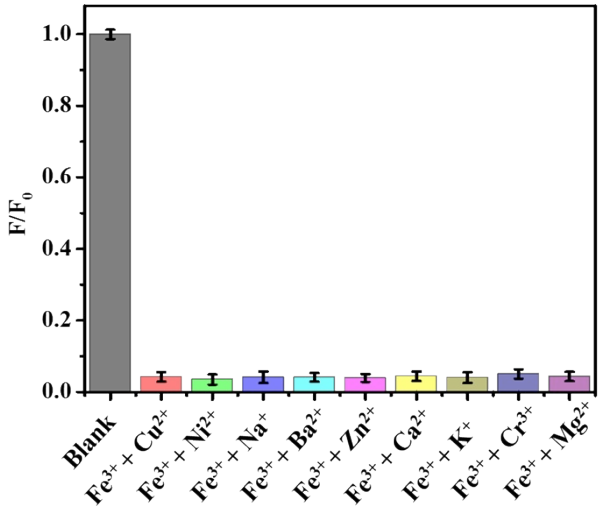

Fig. S8 Interference diagram for Fe^{3+} detection. The Fe^{3+} concentration is 100 μM, and the other ions are 300 μM.

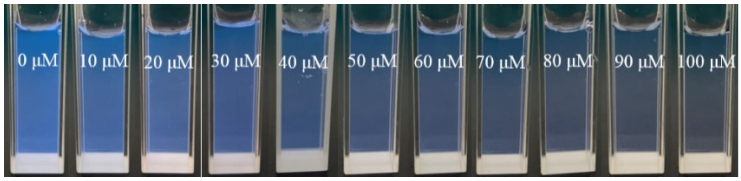

Fig. S9 Fluorescence photos of N-CQDs detecting different concentrations of Fe^{3+}

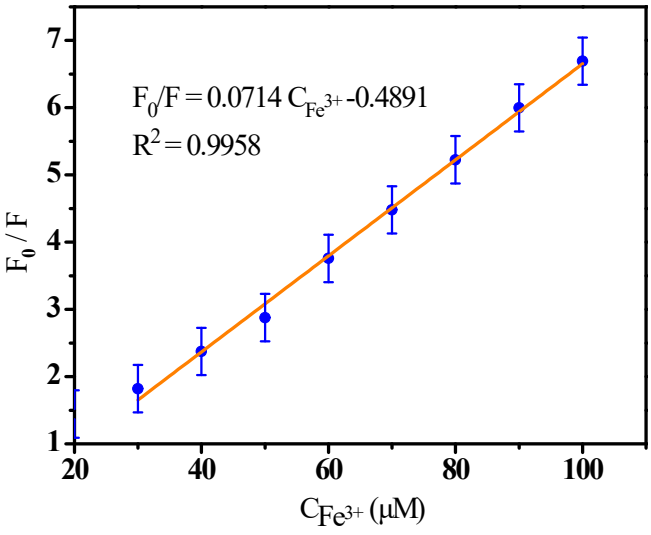

Fig. S10 Linear relationship of fluorescence intensity as a function of Fe^{3+} concentration in the range of 30-100 μM.

Table S3. Fe^{3+} sensing properties with different fluorescent probes. Limit of detection LOD = 3σ/K (where σ is the standard deviation of the blank sample and K is the slope of the linear equation).

Fluorescent probes	Synthesis Method	Excitation/Emission wavelength	Quantum yield	LOD	References
Carbon quantum dots (CQDs)	Hydrothermal method	340/420 nm	22.7 %	0.2 µM.	[12]
Mopan persimmons derived carbon quantum dots (MP-CQDs)	Hydrothermal method	376/458 nm	8.39 %	0.324 µM	[13]
Nitrogen-doped carbon quantum dots (N-CQDs)	Hydrothermal method	350/425 nm	22 %	3 µM	[14]
Carbon quantum dots (CQDs)	Hydrothermal method	340/476 nm	23.68 %	0.77 µM	[15]
Phosphorus-doped carbon quantum dots (N, P-CQDs)	Hydrothermal method	320/425 nm	17.74 %	0.447 µM	[16]
Carbon quantum dot (CQDs)	Hydrothermal method	330/400 nm	18.1 %	4 µM	[17]
N-CQDs	Solvothermal method	340/442 nm	25.9 %	0.28 µM	This work

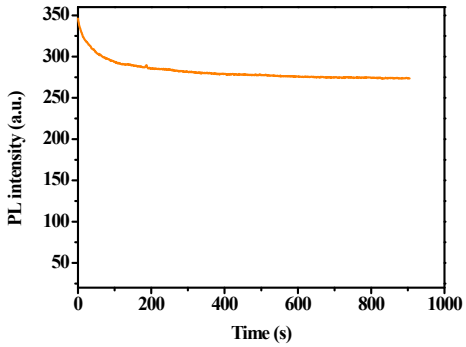

Fig. S11 Time dependent fluorescence graph after adding Fe^{3+}

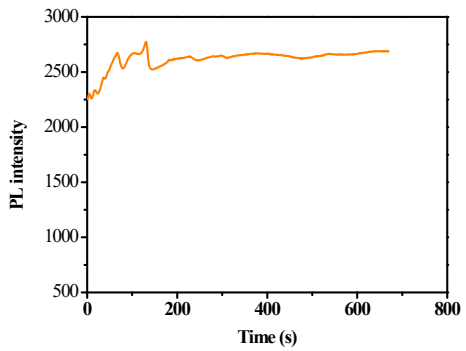

Fig. S12 Time dependent fluorescence graph after adding AA

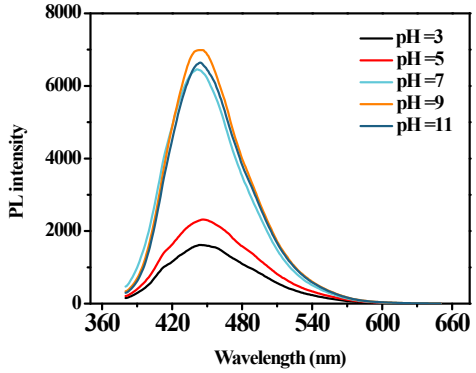

Fig. S13 The fluorescence intensity of N-CQDs as a function of pH Values

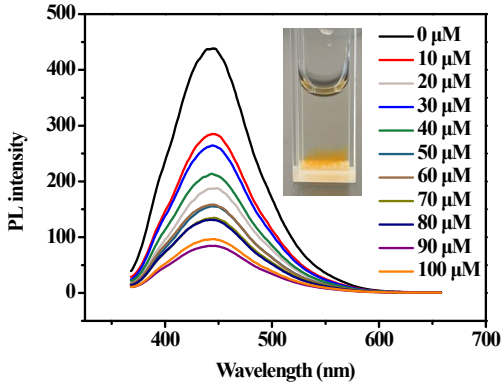

Fig. S14 Detection of Fe^{3+} in a solution with pH=9.18, brown precipitates appeared at the bottom of the cuvette (inset)

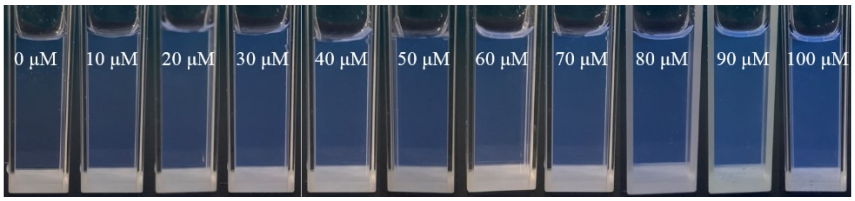

Fig. S15 Fluorescence photos of N-CQDs/Fe^{3+} detecting different concentrations of AA

Table S4. AA sensing properties with different fluorescent probes. Limit of detection LOD = 3σ/K (where σ is the standard deviation of the blank sample and K is the slope of the linear equation).

Fluorescent probes	Linear range (μmol/L)	Applications	LOD	References
N,S co-doped carbon dots (N,S-CDs)-Fe^{3+}	10-200	Fruits	4.69 μM.	[18]
Nitrogen, phosphorus co-doped carbon quantum dots (N, P-CQDs)-Fe^{3+}	1-200	Fruits	0.84 μM	[19]
Red-carbon quantum dots (R-CQDs)-Fe^{3+}	1-50	Human body fluids and vitamin C tablets	0.42 μM	[20]
Nitrogen-doped carbon quantum dots (N-CQDs)-Fe^{3+}	10-100	Medical tablet	1.8 μM	[21]
Cobalt-doped carbon quantum dots (Co-CQDs)-Fe^{3+}	10-400	Fruits	0.27 μM	[22]
Carbon quantum dots (CQDs)-Fe^{3+}	0-350	Human biological samples	5.34 μM	[23]
N-CQDs-Fe^{3+}	30-90	Fruits	0.81 μM	This work

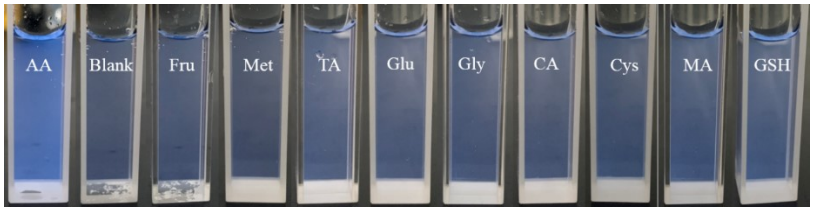

Fig. S16 Fluorescence photos of different substances detected by N-CQDs/Fe^{3+}

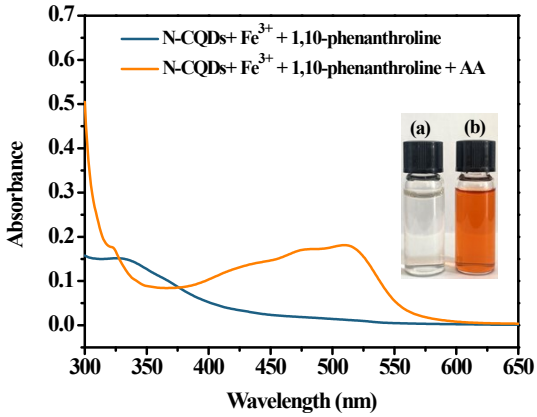

Fig. S17 UV-vis absorption spectra of the N-CQDs + Fe^{3+} +1,10-phenanthroline and the N-CQDs + Fe^{3+} + 1,10-phenanthroline + AA. Inset: Photographs of solutions (a) N-CQDs + Fe^{3+} +1,10-phenanthroline and (b) N-CQDs + Fe^{3+} + 1,10-phenanthroline + AA (b) under daylight.

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