

Facile preparation of orange-emissive carbon dots for highly selective detection of silver ions

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Experimental section

Chemicals and reagents

Unless other notation, all reagents were of analytical grade and used without purification. *p*-aminophenol and $\text{Ca}(\text{NO}_3)_2$ were bought from Shanghai Reagent Factory (Shanghai, China). *p*-aminobenzoic acid, KNO_3 and $\text{Cu}(\text{NO}_3)_2$ were purchased from Tianjin Guangfu Chemical Reagents Co. Ltd. (Tianjin, China). $\text{Fe}(\text{NO}_3)_3$ and $\text{Ni}(\text{NO}_3)_2$ were obtained from Chengdu Kelong Chemical Reagents Co. Ltd (Chengdu, China). $\text{Ba}(\text{NO}_3)_2$, $\text{Al}(\text{NO}_3)_3$ and ethylenediaminetetraacetic acid tetrasodium salt ($\text{Na}_2\text{H}_2\text{Y} \cdot 2\text{H}_2\text{O}$, i.e. EDTA) were bought from Xi'an Chemical Reagent Factory (Xi'an, China). $\text{Cr}(\text{NO}_3)_3$ and $\text{Ba}(\text{NO}_3)_2$ were purchased from Beijing Chemical Reagent Factory (Beijing, China). $\text{Zn}(\text{NO}_3)_2$ was bought from Tianjin Chemical Reagent Factory (Tianjin, China). $\text{Co}(\text{NO}_3)_2$ was obtained from Sinopharm Chemical Reagent Co. Ltd. (Shanghai, China). Ultrapure water was used throughout all the experiments from 18202V AXL water purification system (Chongqing, China).

Instruments

The ultraviolet-visible (UV-vis) absorption spectrum was surveyed on a TU-1901 UV-vis spectrophotometer with a 1 cm quartz cell (Beijing Purkinje General Instrument Co., Ltd., Beijing, China). Fourier transform infrared spectrum was carried out by a Nicolet Nexus 670 spectrometer (FT-IR, America) with KBr pellets. The FL spectra were recorded by a RF-5301PC FL spectrophotometer, and the slit width for excitation and emission were set at 5 nm with a 1 cm quartz cell (Shimadzu, Kyoto, Japan). The morphology and size of the prepared CDs were performed by a

transmission electron microscopy (TEM) with a Hitachi-600 transmission electron microscope (Hitachi, Japan). X-ray photoelectron spectra (XPS) measurements were made on a PHI 5702 spectrometer. The quantum yield and the fluorescent lifetime were conducted in a time-correlated-single-photon-counting (TCSPC) system from FLS920 spectrometer (Edinburgh Instruments Ltd., U.K.).

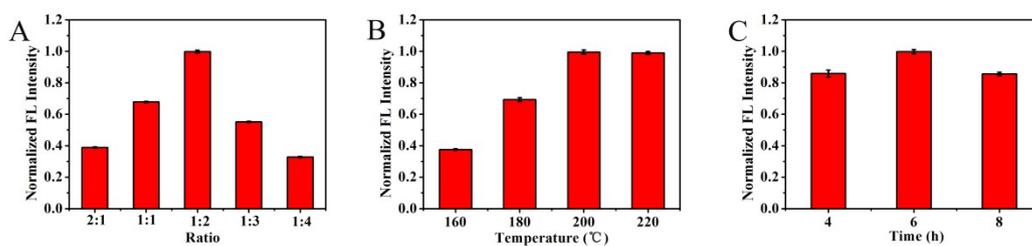


Fig. S1 Effects of (A) molar ratio of *p*-aminobenzoic acid/*p*-aminophenol, (B) reaction temperature, and (C) reaction time on the FL intensity of the CDs. All experiments were conducted in 10 mM pH 7.4 PBS buffer solution. Error bar were the standard deviation of three independent experiments.

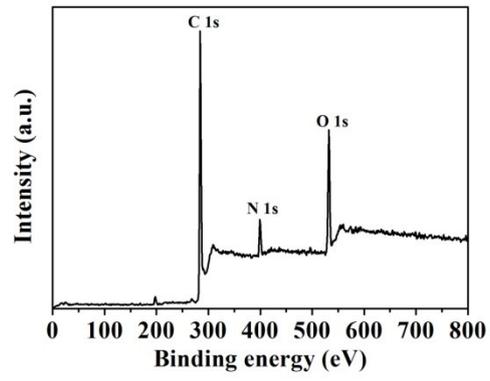


Fig. S2 XPS spectrum of the CDs.

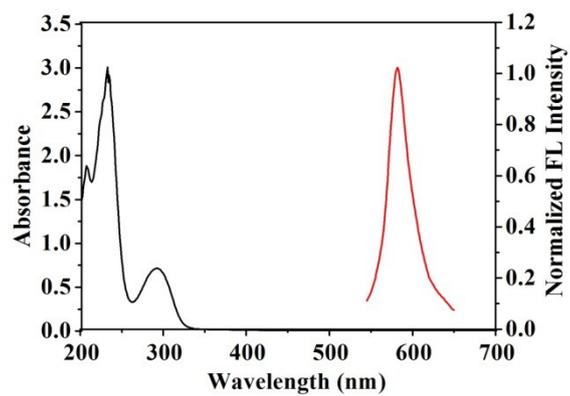


Fig. S3 UV-vis absorption spectrum (black line) and fluorescence emission spectrum (red line) of the CDs.

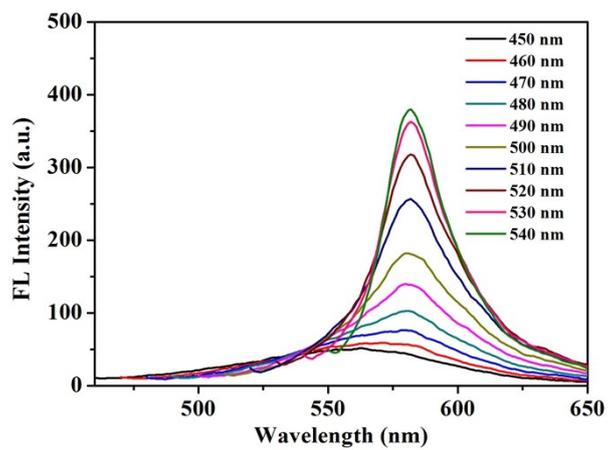


Fig. S4 Fluorescence emission spectra of the CDs with different excitation wavelengths.

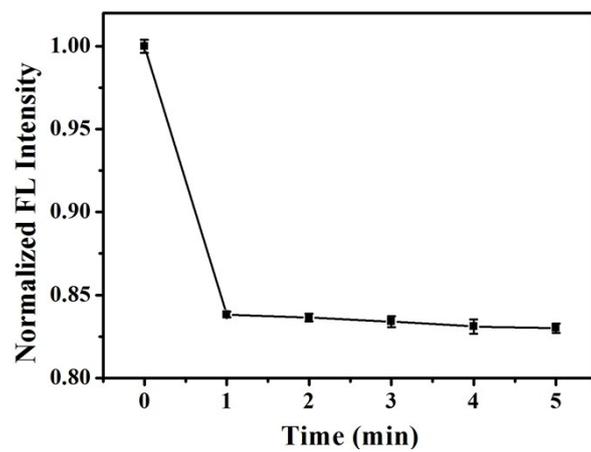


Fig. S5 Time-dependent FL intensity of the CDs with the addition of 30 μM Ag^+ at room temperature.

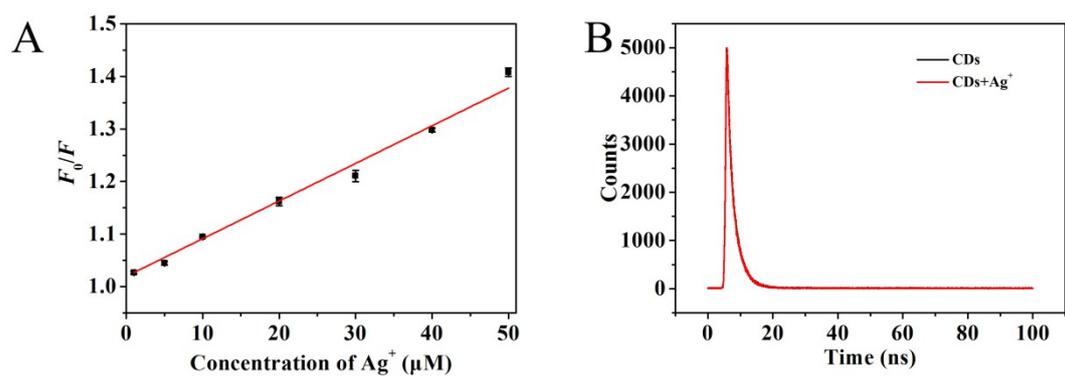


Fig. S6 (A) Stern-Volmer plot between F_0/F and $[Ag^+]$; (B) FL decay curve of the CDs in the absence (black line) and in the presence (red line) of Ag^+ with excitation at 520 nm.

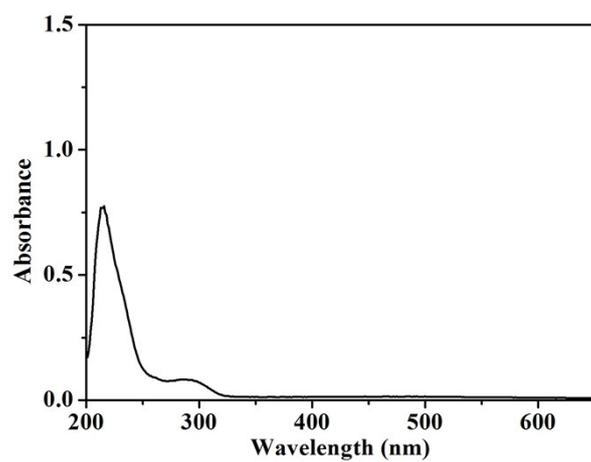


Fig. S7 UV-vis absorption spectrum of Ag⁺.

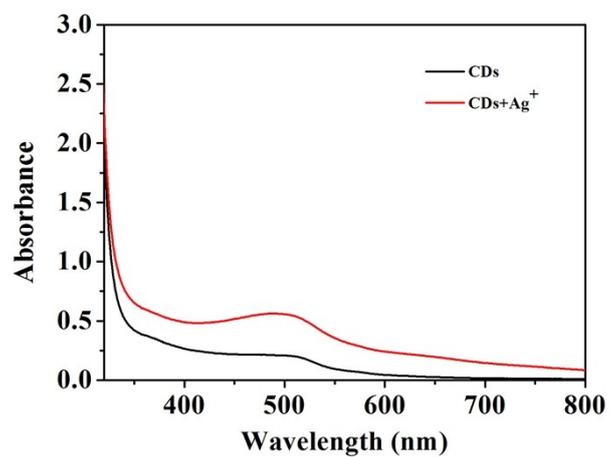


Fig. S8 UV-vis absorption spectra of the CDs and CDs+Ag⁺.

Table S1. Comparison of sensing performance of different CDs-based fluorescence sensors for Ag⁺ detection

Type of probe	Detection wavelength (nm)	Interference ions	Linear range (μM)	LOD (μM)	Ref.
N-CQDs	400	Fe ³⁺	1–100	1	1
CDs	472	Pb ²⁺	/ ^a	0.38	2
ONPCRs	420	Hg ²⁺	2.0–60	6.8x10 ⁻⁴	3
bio-dots	275	Hg ²⁺	0.5–6	0.31	4
DNA-AgNCs	485	Fe ³⁺ , Hg ²⁺	0.05–0.5	0.01	5
CDs	580	No interference	1–100	0.36	This work

^a: Not mentioned

Table S2. Double-exponential fitting of the CDs and the CDs/Ag⁺ decay curves

Sample name	CDs	CDs/Ag ⁺
$\tau_1(\text{ns})/A_1(\%)$	0.59/15.36	0.58/16.38
$\tau_2(\text{ns})/A_2(\%)$	2.51/84.64	2.52/83.62
Average τ (ns)	2.42	2.43

References

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