Yellow emissive nitrogen-doped carbon dots as fluorescence probe for sensitive and selective detection of silver ions

Juan Hou,[a*] Xu Gao,[b] Siqi Bao,[a] Shuqi Liu [b] and Guang Yang[b*]

[a] *Key Laboratory of Applied Chemistry and Nanotechnology at Universities of Jilin Province, Changchun University of Science and Technology, Changchun 130022, China*
[b] *Department of Chemistry, Chemical Engineering and Resource Utilization, Northeast Forestry University, 26 Hexing Road, Harbin 150040, PR China*

Email: houjuan0503@126.com; guangyang@nefu.edu.cn

Materials

Hydrazine hydrate and common biomolecules were purchased from Aladdin Reagent Co., Ltd. (Shanghai, China). Catechol, silver nitrate and sulforhodamine 101 were purchased from Yi'en Technology Co., Ltd. (Shanghai, China). Metal ion salts were purchased from Tianjin Tianda Chemical Reagent Factory (Tianjin, China). Other reagents and chemicals were all purchased from Beijing Chemical Reagent Company (Beijing, China).

Characterization methods

Transmission electron microscopy (TEM) images were photographed by a JEM-2100 transmission election microscope operated at 200 kV accelerating voltage. Scanning electron microscopy (SEM) images were recorded on a JEM-6700F scanning electron microscope at 10.0 kV. Powder X-ray diffraction (XRD) patterns were obtained on a Shimadzu XRD-6100 spectrometer. Surface chemistry features were obtained by the Fourier transform infrared spectrometry (FT-IR, Nicolet 360 FT-IR) and X-ray

photoelectron spectroscopy (XPS, Thermo Fisher K-Alpha spectrometer). Fluorescence spectra were recorded by a Hitachi F-4500 spectrophotometer. UV-vis absorption spectra were obtained by a Shimadzu UV-2550 spectrophotometer.

Determination of fluorescence quantum yield

The fluorescence quantum yield (QY) of prepared Y-CDs was measured according to the method reported in literature. The reference sample was Rhodamine 101 (QY=95% in ethanol), and the fluorescence emission range was 500~700 nm. The quantum yield of CDs was calculated according to formula (2-1) :

$$QY_\chi = QY_R \frac{I_\chi}{I_R} \frac{OD_R}{OD_\chi} \frac{n_\chi^2}{n_R^2}$$

QY is the fluorescence quantum yield, I is integral area of fluorescence emission peak, n is refractive index of solvent (n/n_R=1 in this system), OD is UV absorbance (less than 0.05).

Determination of Ag$^+$

For a typical procedure, 500 μL Y-CDs solution, 3 mL BR buffer solution (pH=7) add 100 μL Ag$^+$ solution with different concentrations were mixed, and then distilled water was injected to 10 mL. After incubation for 10 minutes, the obtained solution was measured by fluorescence spectrum, and the fluorescence emission intensity at Ex=420 nm was recorded. During the detection process, the excitation and emission slit were set at 5 nm, and the response time was 0.2 s.

In order to study the selectivity of Y-CDs to Ag$^+$, the fluorescence responses of various metal ions, small molecules and anions were recorded under the above experimental conditions.
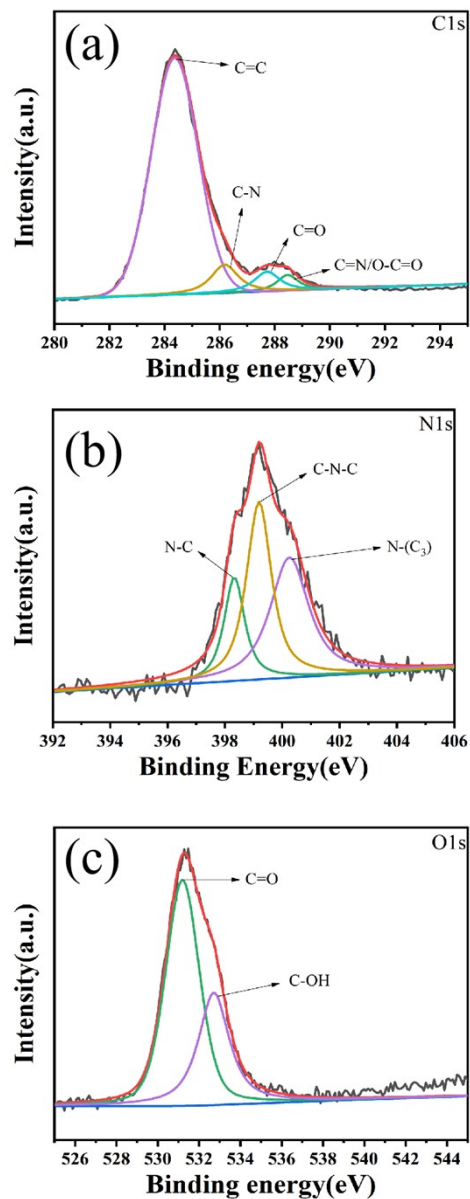
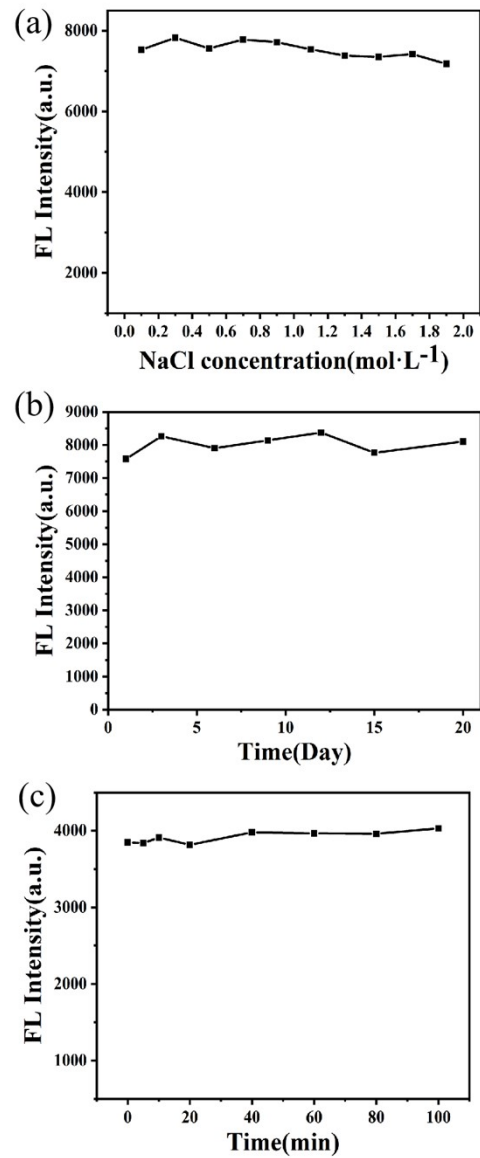Fig. S1 High resolution XPS spectra of C1s (a), N1s (b) and O1s (c).

Fig. S2 Effect of high concentrations of NaCl solution (a), UV illustration time (b) and long-time storage (c).
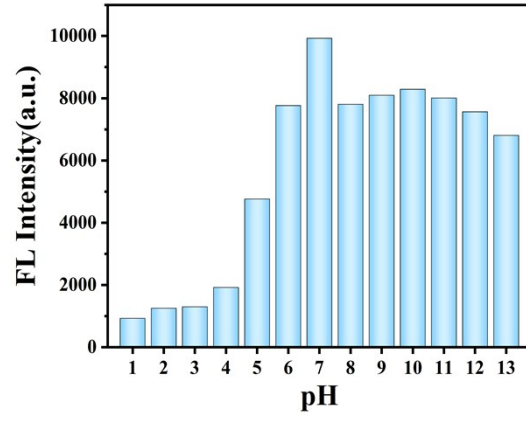
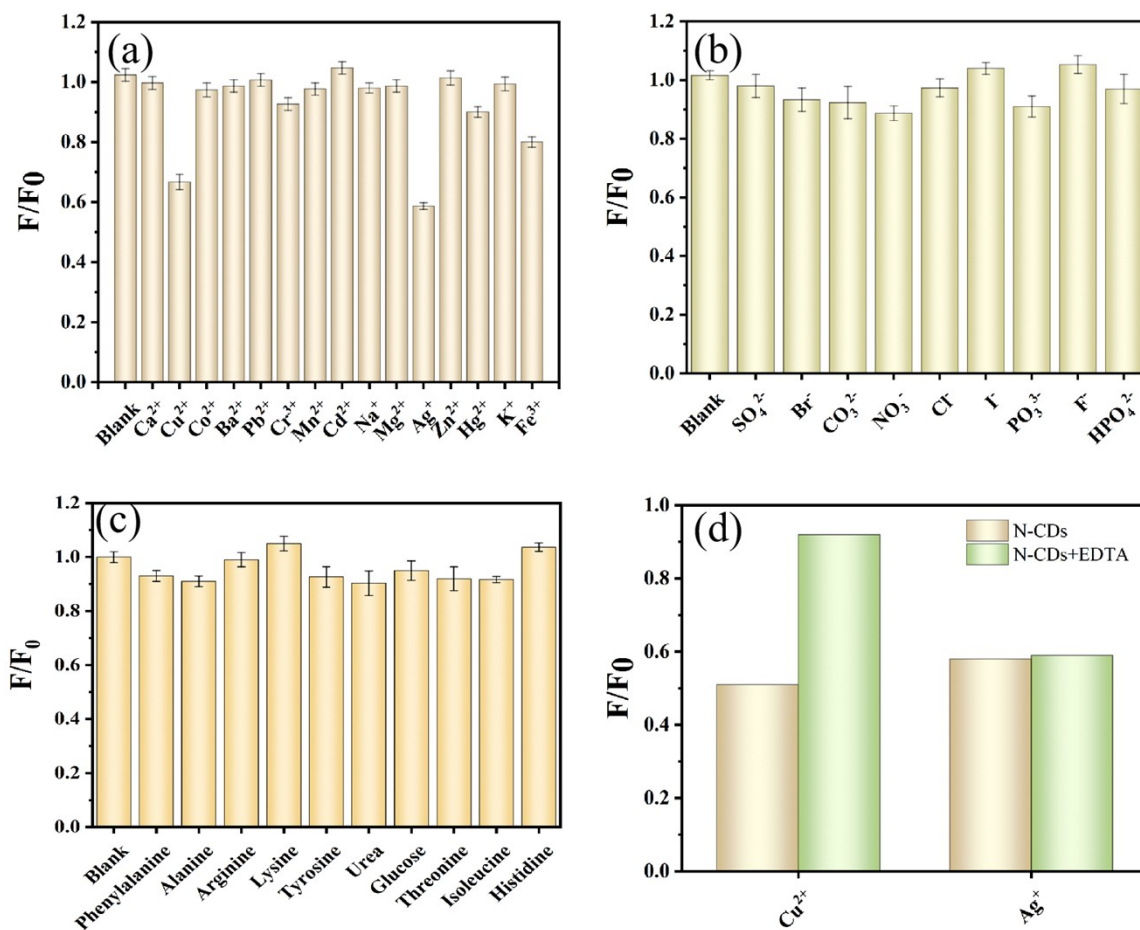Fig. S3 Effect of pH on the fluorescence of the Y-CDs.
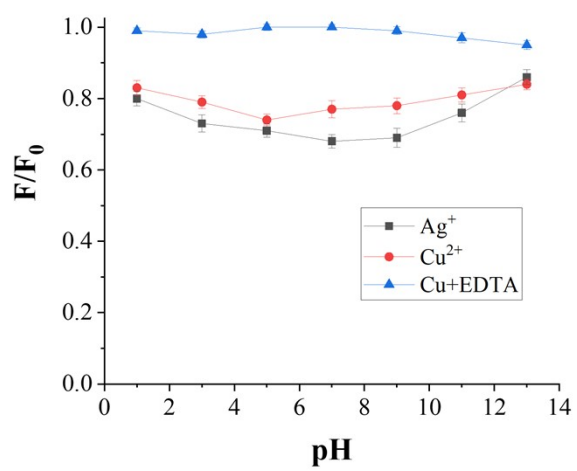
Fig. S4 Selectivity of Y-CDs towards Ag$^+$

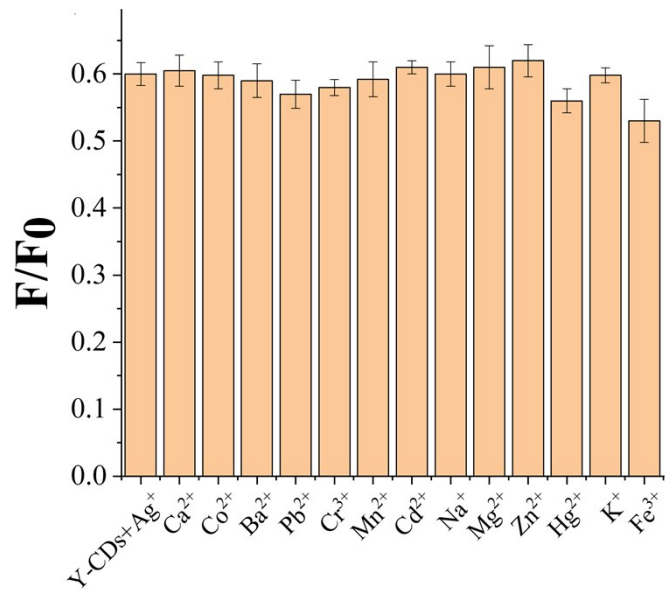Fig. S5 Effect of pH (1~13) on the F/F_0 of Y-CDs towards Ag^+, Cu^{2+} and Cu-EDTA.

Fig. S6 The influence co-existing metal ions on the fluorescence of Y-CDs/Ag$^+$ system

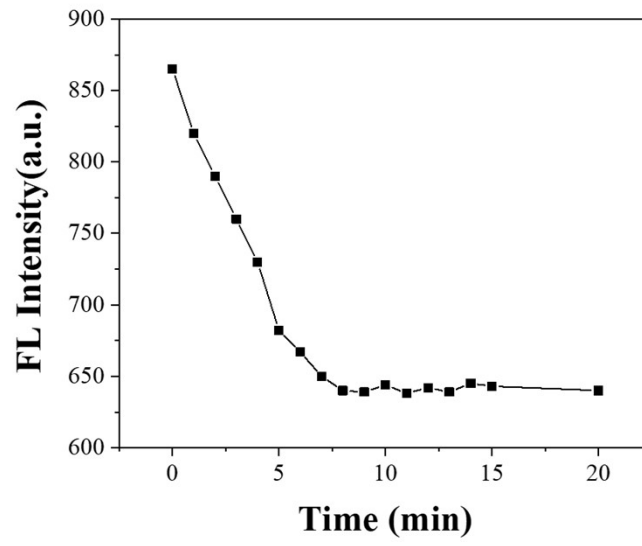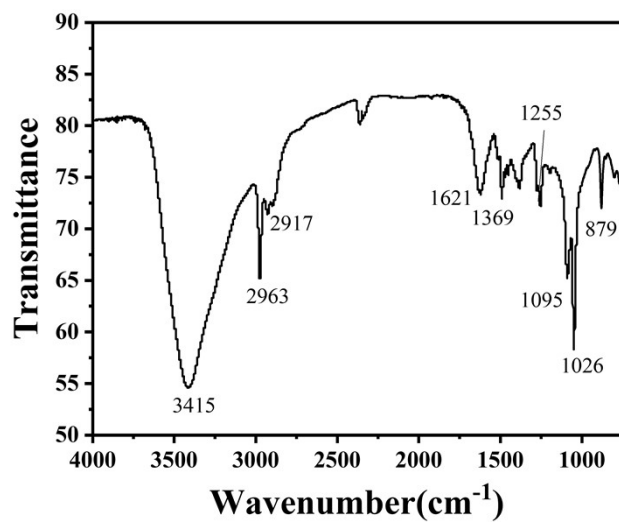Fig. S7 Effects of incubation time on the detection of Ag$^+$.

Fig. S8 FTIR spectrum of Y-CDs-Ag$^+$ system.