Electronic Supporting Information

One-step synthesis of N, B-doped carbon dots and multifunctional applications in detection of tin ion and gallic acid and information encryption

Xiaopeng-Wang [a], Jianping-Zeng [a], Shixin-Xie [a], Liangliang-Tao [b], Xiangying-Sun [a]*

a. A College of Materials Science and Engineering, Huaqiao University, Key Laboratory of Molecular Designing and Green Conversions (Fujian University), Xiamen 361021, China.

b. A College of Chemical Engineering, Huaqiao University, Xiamen 361021, China.

* Corresponding authors.

E-mail addresses: sunxy@hqu.edu.cn

Experiment section

Electrochemical experiments

N, B-CDs (2 mg) was dissolved in 20 mL PBS buffer solution (10 mM, pH=7.5), with a platinum wire as counter electrode, and an Ag/AgCl (saturated in 3.0 M of KCl) as reference electrode, and a glassy carbon electrode as working electrode. The three-electrode system was formed, and then ranged from -1 V to 1 V potential scanning was performed and the scanning speed was set at 0.1V/s to measure the cyclic voltammetry curve of N, B-CDs. $SnCl_2$ (2 mg) was dissolved in 20 mL PBS buffer solution (10 mM, pH=4). The cyclic voltammetry curve test method of $SnCl_2$ as the same as N, B-CDs.

Actual sample collection and pretreatment

A sea water sample was collected from the East China Sea (Xiamen, China), the sample was centrifuged at 10000 rpm /min for 10 min, then the supernatant was collected and equal HEPES buffer (20 mM, pH=7.5) was added. A lake water sample was collected from Huaqiao University (Xiamen, China), the sample was centrifuged at 10000 rpm /min for 10 min, then the supernatant was collected and equal HEPES buffer (20 mM, pH=7.5) was added. Human urine sample was collected from a healthy person, the sample was centrifuged at 10000 rpm /min for 10 min, then 1mL supernatant was collected and 49 mL HEPES buffer (20 mM, pH=7.5) was added. A Liuwei Dihuang pill sample (0.18 g) was dissolved and get the yellow-brown solution, the solution was centrifuged at 10000 rpm /min for 10 min, then 1mL supernatant was collected and 49 mL HEPES buffer (20 mM, pH=7.5) was added. The powder was poured out from a Ningmitai capsule (0.38 g) and dissolved in ultrapure water, then the solution was centrifuged at 10000 rpm /min for 10 min, 1mL supernatant was collected and 49 mL HEPES buffer (20 mM, pH=7.5) was added. A Naru Sanwei pill was ground one (0.2 g) into powder, and then dissolved it to get the yellow-brown solution, the solution was centrifuged at 10000 rpm /min for 10 min, then 1 mL supernatant was collected and 49 mL HEPES buffer (20 mM, pH=7.5) was added. All samples were filtered through a 0.22 μm water system PES.

Results

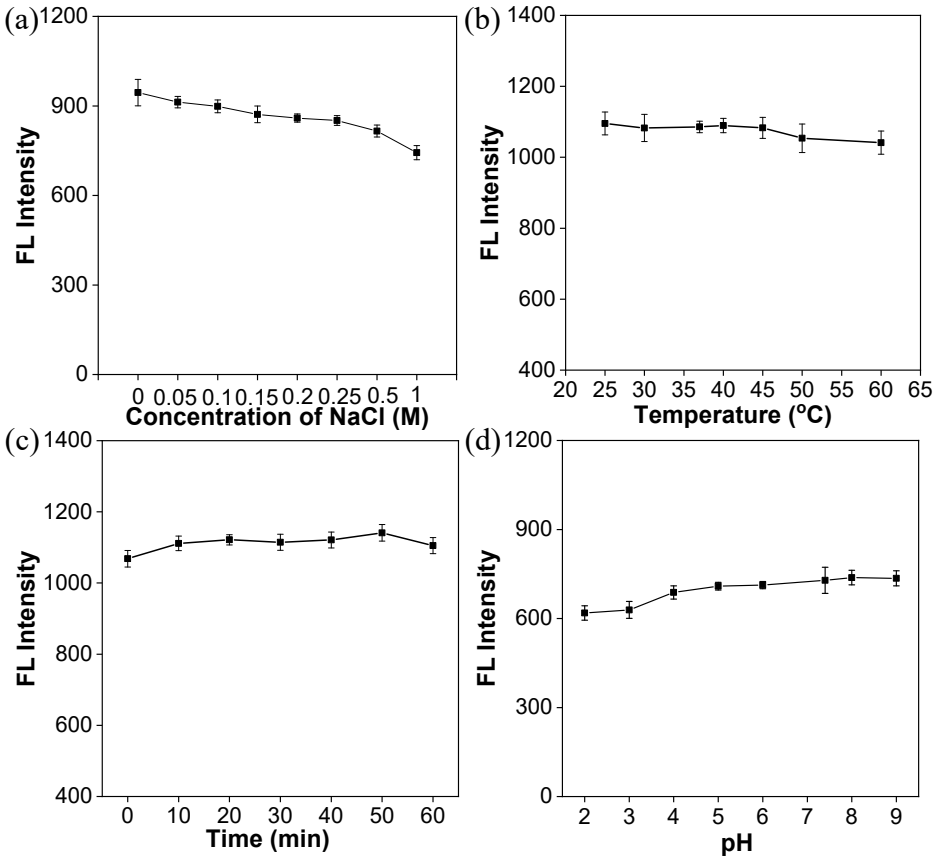

Fig. S1. (a) Fluorescence intensity variation of N, B-CDs (0.4 mg mL^{-1}) under the different concentration of NaCl, (b) Fluorescence intensity variation of N, B-CDs (0.4 mg mL^{-1}) under the conditions of: different temperature, (c) Fluorescence intensity variation of N, B-CDs (0.4 mg mL^{-1}) under the conditions of different illumination time, (d) Fluorescence intensity variation of N, B-CDs (0.4 mg mL^{-1}) under the conditions of different pH (λ_{ex}=300 nm, λ_{em}=370 nm).

Visual recognition of metal ions (0.5×10^{-3} M) with the probe N, B-CDs (0.4 mg mL^{-1}) in the aqueous medium.

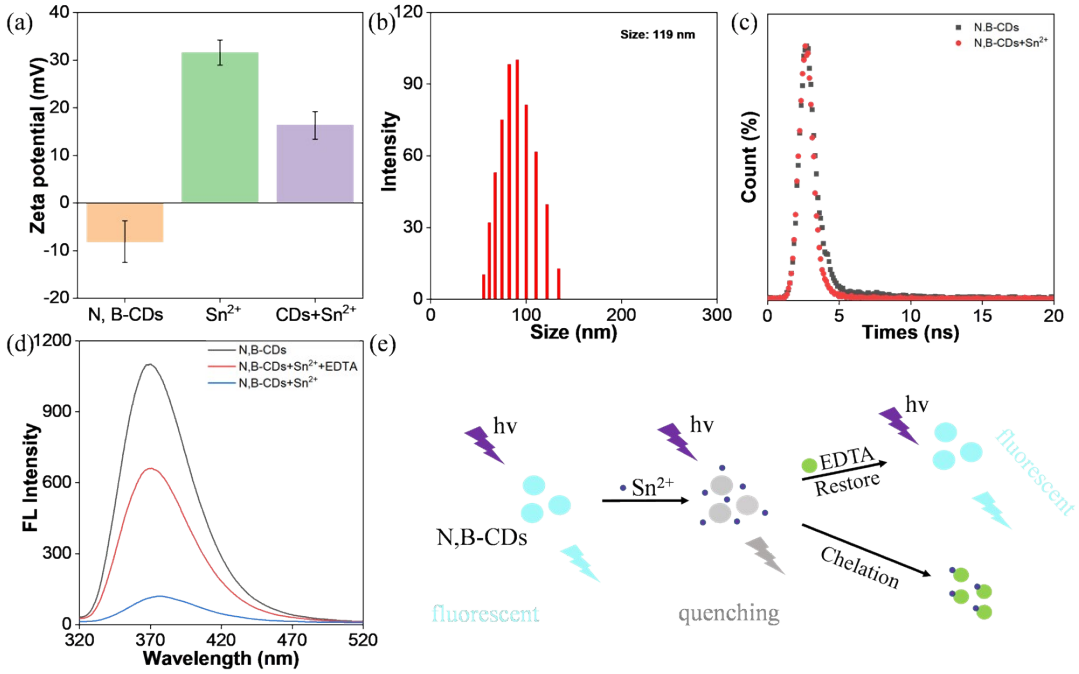

Fig. S2. (a) Zeta potential of N, B-CDs and Sn^{2+} , (b) Hydrodynamic diameter of N, B-CDs and Sn^{2+}, (c) Fluorescence lifetime decays of N, B-CDs (0.4 mg mL^{-1}) in the presence and absence of Sn^{2+} (100 μM), (d) Fluorescence spectra of N, B-CDs (0.4 mg mL^{-1}) with the addition of Sn^{2+} (100 μM) and EDTA (100 μM), (e) a schematic diagram of the on-off-on process in Sn^{2+} sensing.

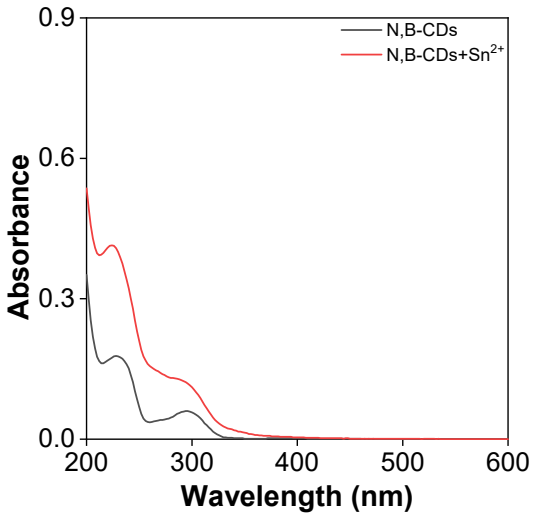

Fig. S3. UV absorbance spectra of N, B-CDs (0.40 mg mL^{-1}) in HEPES buffer (20 mM pH=7.4) and N, B-CDs (0.4 mg mL^{-1}) +Sn^{2+} (20 μM) in HEPES buffer (20 mM pH=7.4).

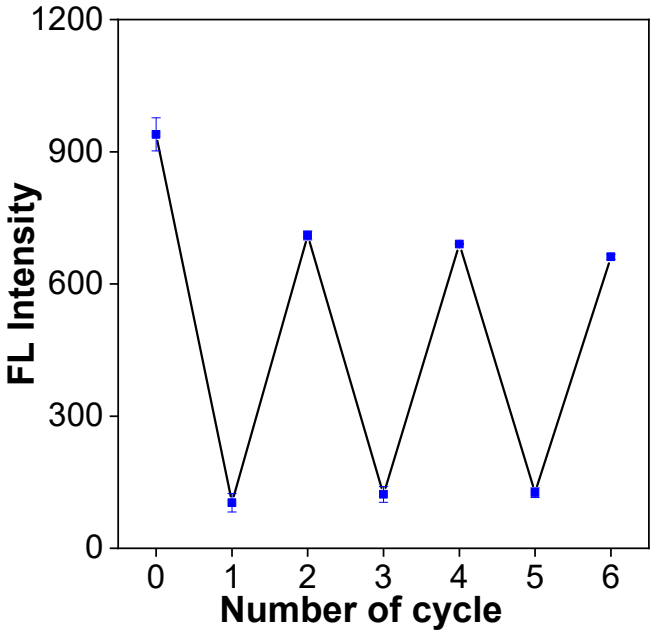

Fig. S4. Reversibility cycle analysis of N, B-CDs (0.4 mg mL^{-1}) with Sn^{2+} (0.5 mM) in the presence of EDTA (0.5 mM) in the HEPES buffer (20 mM, pH = 7.4); λ_{ex}=300 nm; λ_{em}=370 nm.

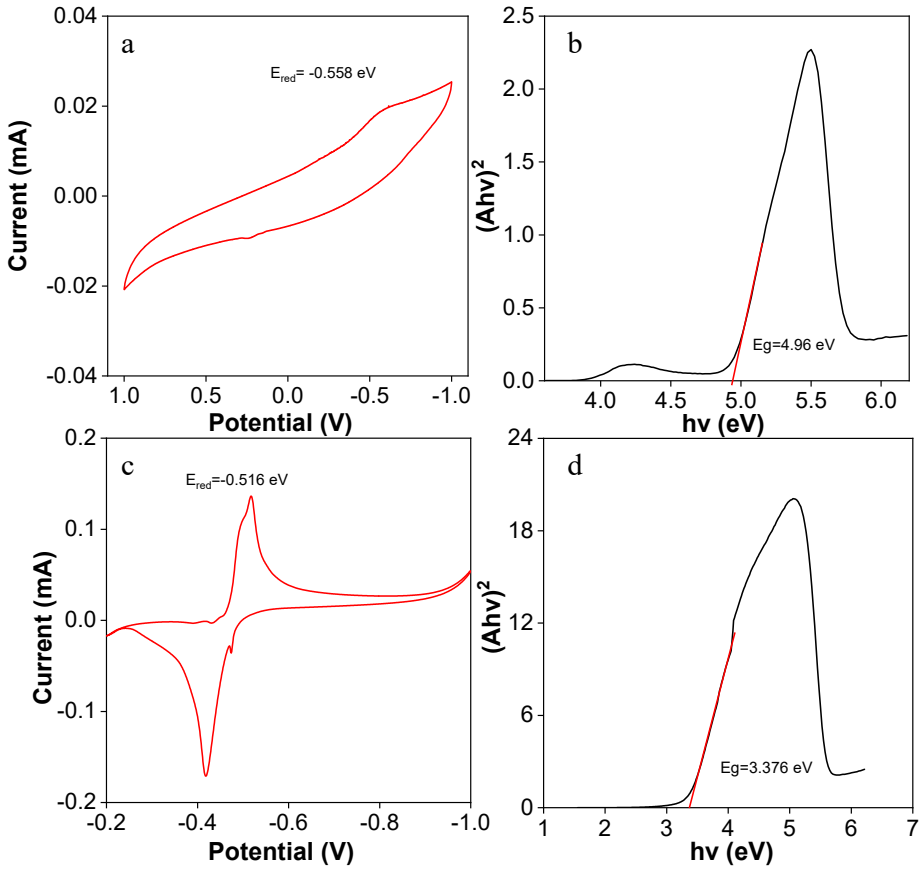

Fig. S5. a. The CV curve of N, B-CDs, b. Band gap calculated from the UV spectrum of N, B-CDs, c. The CV curve of Sn^{2+}, d. Band gap calculated from the UV spectrum of Sn^{2+}.

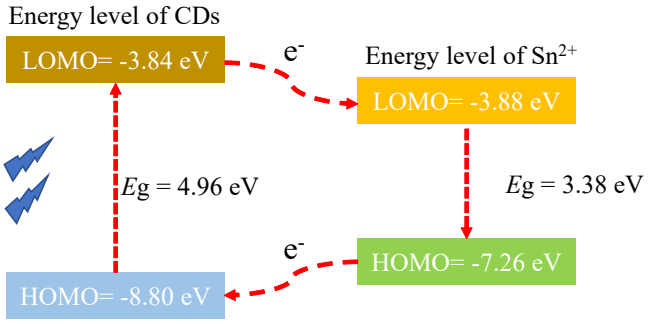

Fig. S6. Energy levels of the LUMO and HOMO of N, B-CDs and Sn^{2+}.

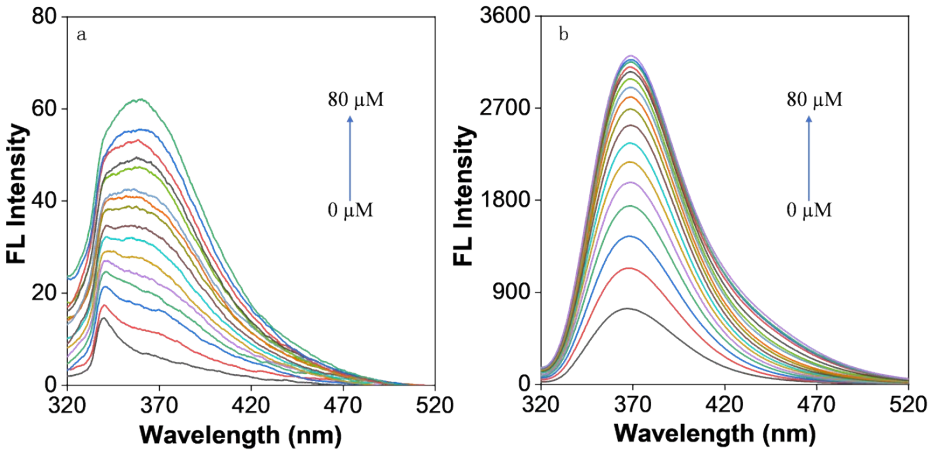

Fig. S7. a. Gallic acid gradually increases the change of fluorescence intensity in HEPES buffer (20 mM pH=7.4), b. After the addition of N, B-CDs, the concentration of gallic acid increased the change of fluorescence intensity in HEPES buffer (20 mM pH=7.4).

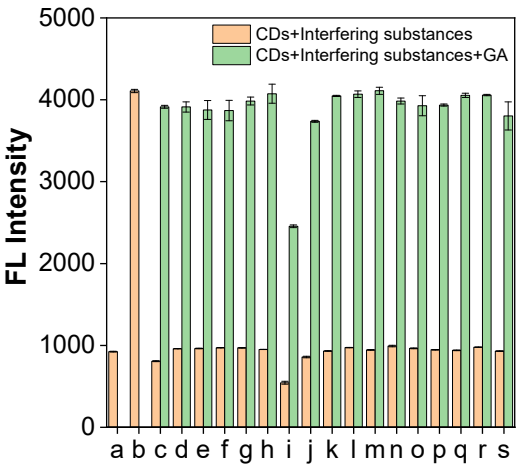

Fig. S8. Complexometric titration of N, Bd-CDs (0.4 mg mL^{-1}) and gallic acid (60 μM) with the coexistence of other metal ions (100 μM) in HEPES buffer (20 mM, pH=7.5); a. N, B-CDs b. gallic acid c. Mandelic acid d. Ribose e.

pyrogenic gallic acid f. Tartaric acid g. Uridine h. glucose i. ascorbic acid j. Dopamine k. Cys l. Ala m. Gly n. Asp o. Glu p. Arg q. Val r. Leu s. Met. (λ_{ex}=300 nm; λ_{em}=370 nm).

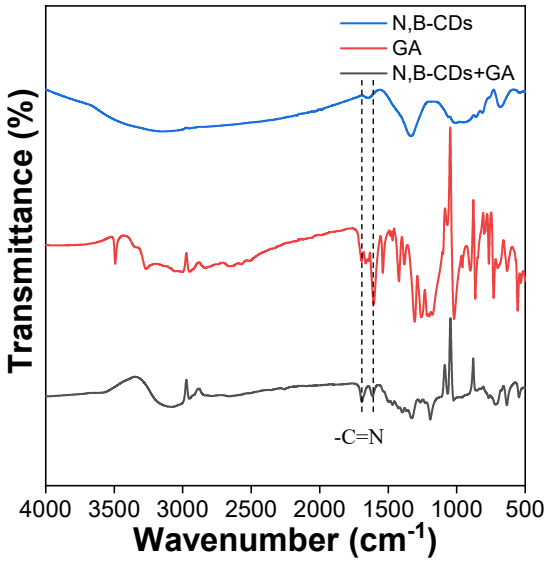

Fig. S9. FT-IR spectra of N, B-CDs, GA and N, B-CDs (0.4 mg mL^{-1}) and GA (60 μM).

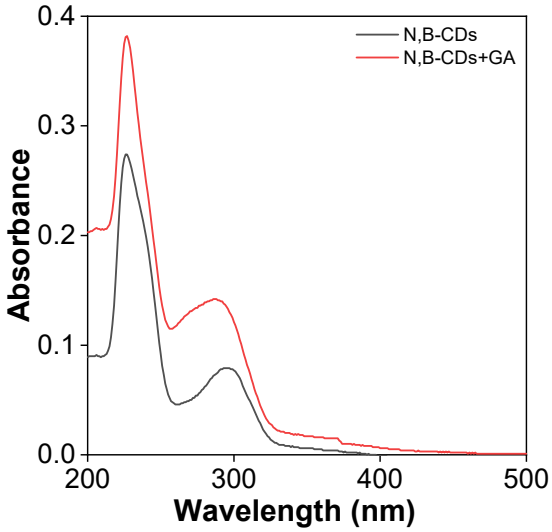

Fig. S10. The absorbance spectrum of N, B-CDs (0.40 mg mL^{-1}) in HEPES buffer (20 mM pH=7.4) and N, B-CDs (0.40 mg mL^{-1}) +GA (30 μM) in HEPES buffer (20 mM pH=7.4).

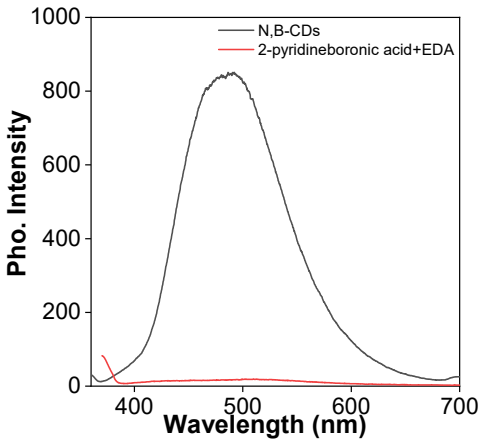

Fig. S11. The phosphorescent spectrum of N, B-CDs and 2pyridineboronic acid +EDA.

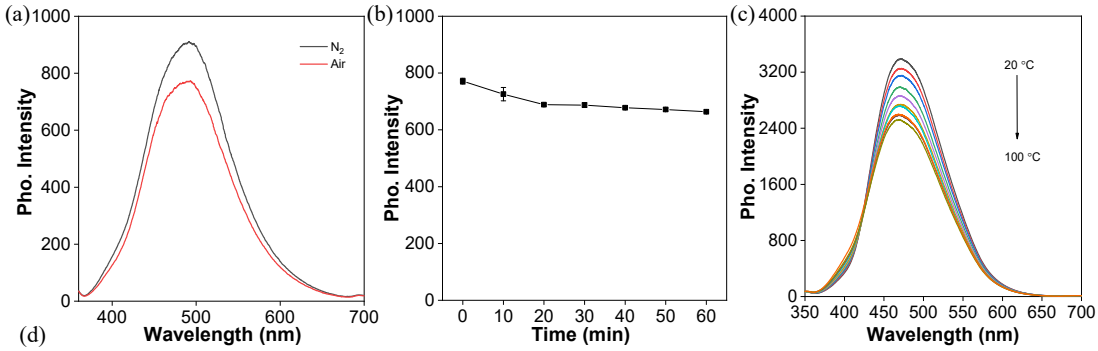

Fig. S12. (a) Phosphorescence intensity spectra of N, B-CDs powder in N_2 and Air, (b) Phosphorescence intensity of N, B-CDs powder Under different UV-irradiation (365nm) time (0-60 min). (c) Phosphorescence intensity spectra of N, B-CDs powder at different temperatures from 20 ℃ to 100 ℃.

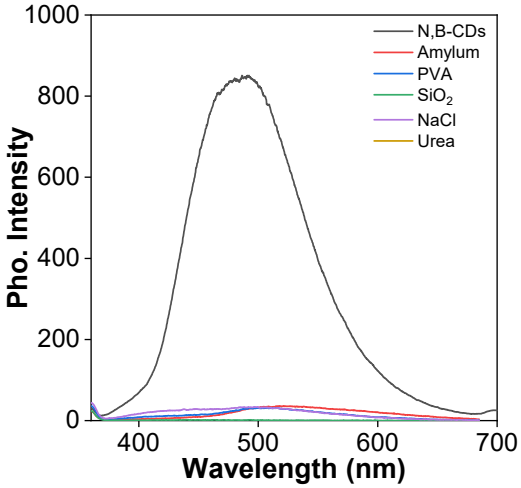

Fig. S13. The phosphorescent spectrum of N, B-CDs and other different substrates.

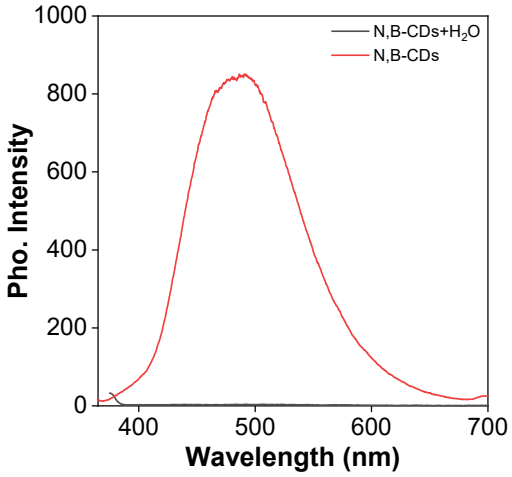

Fig. S14. The phosphorescent spectrum of N, B-CDs powder and water solution of N, B-CDs.