Supplementary Information

Effective synthesis of highly fluorescent nitrogen doped carbon nanoparticles for selective sensing of Hg^{2+} in food and cosmetics samples

Juanjuan Liu[1,2], Yonglei Chen**[1,2], Weifeng Wang[1,2], Jie Feng[1,2], Shoujiao Peng[1,2], Sudai Ma[1,2], Hongli Chen[1,2] and Xingguo Chen*[1,2,3]

[1] State Key Laboratory of Applied Organic Chemistry, Lanzhou University, Lanzhou 730000, China

[2] Department of Chemistry, Lanzhou University, Lanzhou 730000, China

[3] Key Laboratory of Nonferrous Metal Chemistry and Resources Utilization of Gansu Province, Lanzhou University, Lanzhou 730000, China

* Corresponding author. Department of Chemistry, Lanzhou University, Lanzhou, Gansu, China.

** Corresponding author. State Key Laboratory of Applied Organic Chemistry, Lanzhou University, Lanzhou 730000, China.

E-mail addresses: yongleichen@126.com (Y. Chen),
chenxg@lzu.edu.cn (X. Chen)

Tel: 86-931-8912763

Fax: 86-931-8912582

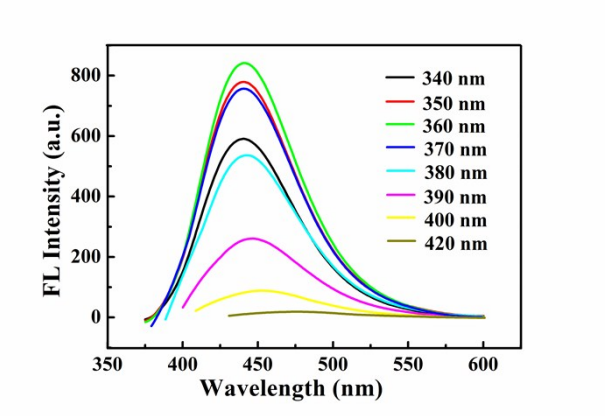


Fig. S1. Fluorescent emission spectra (with progressively longer excitation wavelength) of N-doped CNPs.

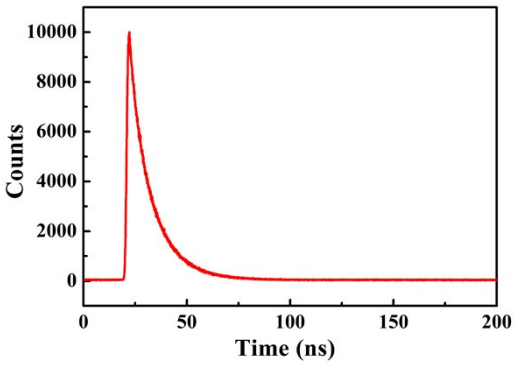


Fig. S2. Time-resolved decay of the N-doped CNPs.

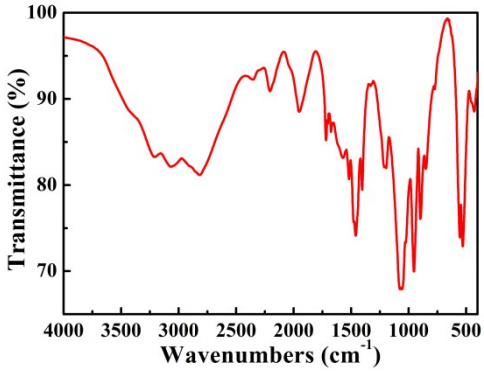


Fig. S3. FT-IR spectrum of the N-doped CNPs.

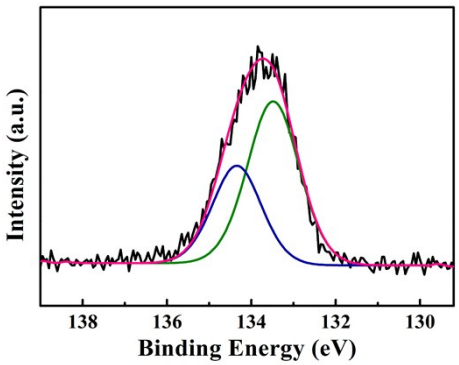
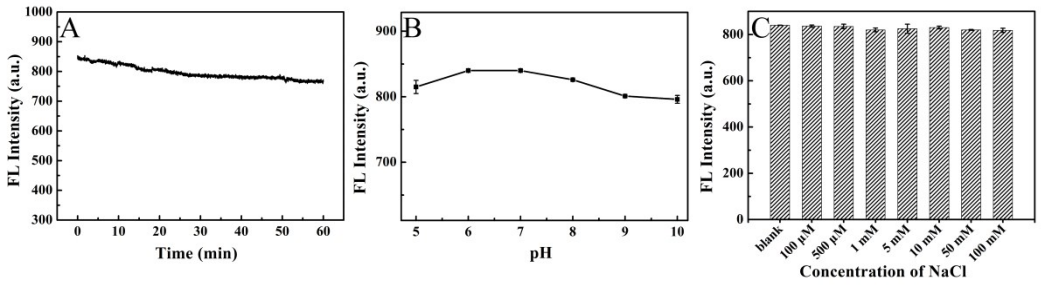


Fig. S4. High resolution XPS spectrum of P 2p.



Figjure S5. (A) Fluorescence intensity variation of the N-doped CNPs as a function of time under 360 nm light illumination. (B) Fluorescence intensity of the N-doped CNPs at different pH values. (C) Fluorescence intensity of the N-doped CNPs after adding various concentrations of NaCl solutions. All experiments were conducted in 10 mM pH 6.0 PBS buffer solutions. Error bars were the standard deviation of three independent experiments.

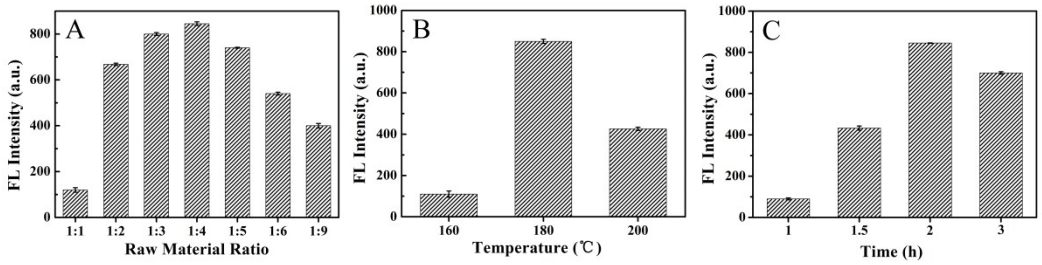


Fig. S6. Effect of (A) different molar ratios of citric acid/ammonium phosphate, (B) different reaction temperature, and (C) different reaction time on the fluorescence intensity of N-doped CNPs. All experiments were conducted in 10 mM pH 6.0 PBS buffer solutions. Error bars were the standard deviation of three independent experiments.

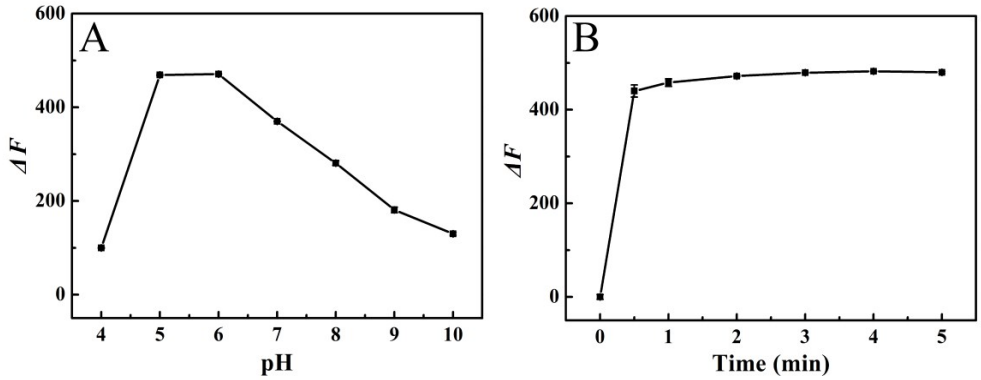


Fig. S7. (A) Effects of pH values of buffer solution on the fluorescence intensity of the N-doped CNPs solution in the presence and absence of 5 μM Hg^{2+}. (B) Time-dependent fluorescence intensity of N-doped CNPs with the addition of 5 μM Hg^{2+} at room temperature. All experiments were conducted in 10 mM pH 6.0 PBS buffer solutions. Error bars were the standard deviation of three independent experiments.

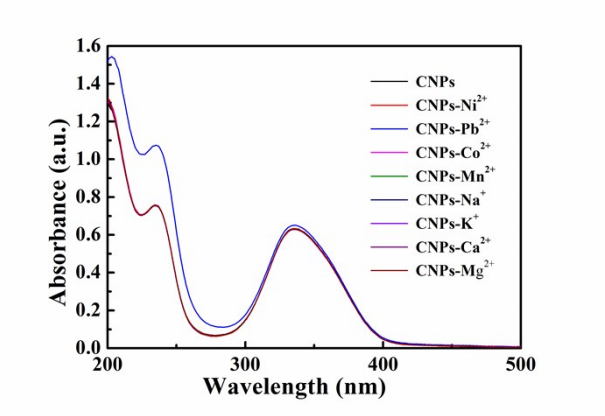


Fig. S8. The UV-vis absorption spectra of N-doped CNPs in the absence and presence of other metal ions.

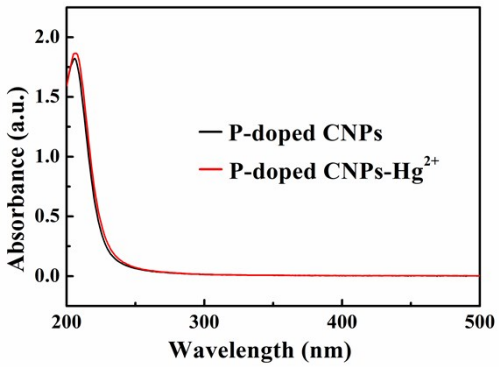


Fig. S9. The UV-vis absorption spectra of P-doped CNPs in the absence and presence of Hg^{2+}.

Quantum yield (QY) measurements.

QY of the obtained N-doped CNPs was determined by the method mentioned in our previous work.[1] The absolute photoluminescence quantum yield can be represented simple in the equation below:

$$QY = \frac{\int L_{emission}}{\int E_{solvent} - \int E_{sample}} \qquad (1)$$

where QY was the absolute quantum yield, $L_{emission}$ was the fluorescence (FL) emission spectrum of the N-doped CNPs sample, collected using the sphere; E_{sample} was the spectrum of the light used to excite the sample, collected using the sphere; $E_{solvent}$ was the spectrum of the light used for excitation with only the solvent in the sphere, collected using the sphere. The solvent in this experiment was deionized water.

Table S1. Comparison of different fluorescent nanoparticles-based methods for Hg^{2+} detection.

Method	Synthesis material	Synthesis temperature (℃)	Synthesis time (h)	Reaction time (min)	Linear range (μM)	LOD (nM)	Selectivity	Ref.
Mg,N-CDs	citric acid, $Mg(OH)_2$, ethylenediamine	200	3	10	0.05-5	20	low	2
N-CDs	citric acid, ethylenediamine	200	5	/	0-12	226	low	3
CDs	plant rhizome	200	3	8	0.05-100	8.2	low	4
N-CDs	citric acid, urea	180	4	5	0-50	2.91	high	5
N-CDs	folic acid, ethylene glycol	180	12	/	0-25	230	low	6
S,N-CDs	ethylenediaminetetraacetic acid salt, thiourea	180	10	20	0-0.3	1.37	low	7
CDs	citric acid, N-(b-aminoethyl)-c -aminopropylmethyl-dimethoxysilane	150	4	30	0-0.05	1.35	low	8
N-CNPs	citric acid, triammonium phosphate	180	2	2	0.0060-0.9 , 0.9-12.0	2.3	high	this work

References

1. J. Feng, Y. Chen, Y. Han, J. Liu, C. Ren and X. Chen, *Analytica Chimica Acta*, 2016, **926**, 107-117.
2. T. Liu, N. Li, J. X. Dong, H. Q. Luo and N. B. Li, *Sensors and Actuators B: Chemical*, 2016, **231**, 147-153.
3. F. Yan, Y. Zou, M. Wang, X. Mu, N. Yang and L. Chen, *Sensors and Actuators B: Chemical*, 2014, **192**, 488-495.
4. D. Wu, X. Huang, X. Deng, K. Wang and Q. Liu, *Analytical Methods*, 2013, **5**, 3023-3027.
5. Y. Zhang, Y. He, P. Cui, X. Feng, L. Chen, Y. Yang and X. Liu, *RSC Advances*, 2015, **5**, 40393-40401.
6. R. Zhang and W. Chen, *Biosensors and Bioelectronics*, 2014, **55**, 83-90.
7. Z. Fu, M. Yao, X. Niu and F. Cui, *Sensors and Actuators B: Chemical*, 2016, **226**, 486-494.
8. W. Wang, T. Kim, Z. Yan, G. Zhu, I. Cole, N.-T. Nguyen and Q. Li, *Journal of Colloid and Interface Science*, 2015, **437**, 28-34.