

Supplementary data

Nitrogen doped carbon dots: mechanism investigation and their application for label free CA125 analysis

Yuanyuan Liu^a, Liping Jiang^a, Bijun Li^a, Xinyue Fan^c, Wei Wang^a, Pingping Liu^b, Shenghao Xu,^{a*} and

Xiliang Luo^{a*}

a. Key Laboratory of Optic-electric Sensing and Analytical Chemistry for Life Science, MOE; Shandong Key Laboratory of Biochemical Analysis; College of Chemistry and Molecular Engineering, Qingdao University of Science and Technology, Qingdao 266042, P. R. China

^b Zhengzhou Tobacco Research Institute, CNTC, Zhengzhou 450000, P. R. China

^c Purdue University, 610 Purdue Mall, West Lafayette, IN, 47907

*Corresponding author:

Shenghao Xu (xushenghao@qust.edu.cn); Xiliang Luo (xiliangluo@qust.edu.cn)

Key Laboratory of Optic-electric Sensing and Analytical Chemistry for Life Science, MOE; Shandong Key Laboratory of Biochemical Analysis; College of Chemistry and Molecular Engineering, Qingdao University of Science and Technology, Qingdao 266042, P. R. China

Contents List

Fig. S1.....Infrared spectroscopy of the N-CDs

Fig. S2.....The fluorescence stability of N-CDs

Fig. S3.....Fluorescence spectra of ethanediamine, CDs and N-CDs

Fig. S4.....The relative contents of C, N and O elements for CDs and N-CDs (determined
by XPS)

Fig. S5.....Zeta potentials of N-CDs, N-CDs+CA125-aptmer and N-CDs+ CA125-aptmer+
CA125

Fig. S6.....TEM image of the N-CDs after adding CA125-aptamer

Fig. S7.....AFM image of the heights or sizes of N-CDs after interaction with CA125-
aptamer.

Table S1.....Comparison of the performance of different methods for CA125

Table S2.....Detection of CA125 in human serum

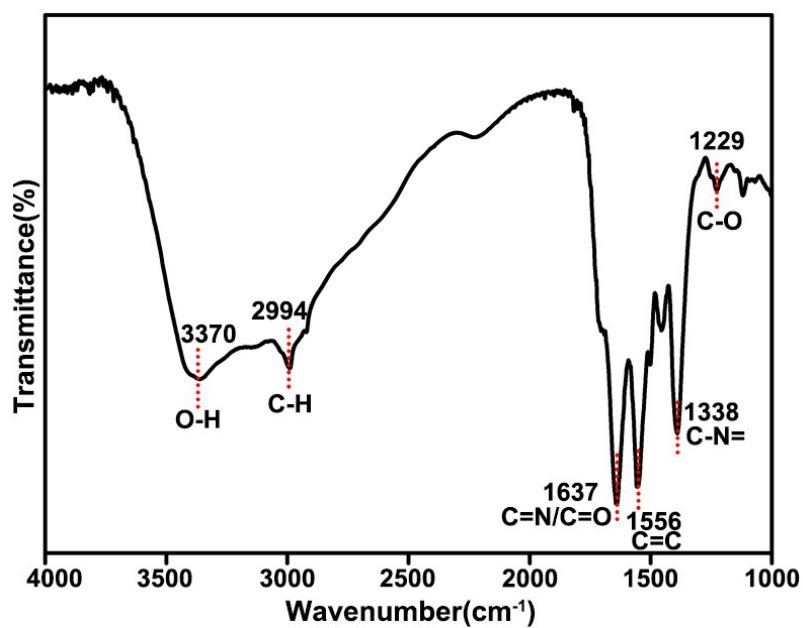


Fig. S1 Infrared spectroscopy of the N-CDs.

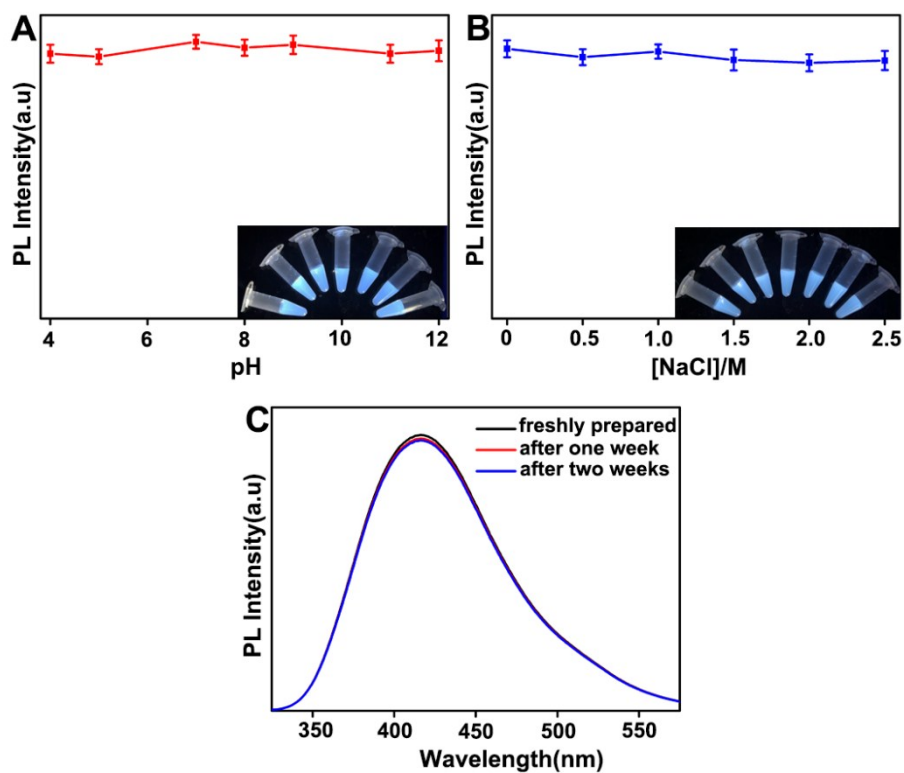


Fig. S2 The fluorescence stability of N-CDs under (A) various pH values, (B) different concentrations of NaCl. (C) Emission spectrum of N-CDs freshly prepared (black line) and after one week (red line) and two weeks storage (blue line) at room temperature.

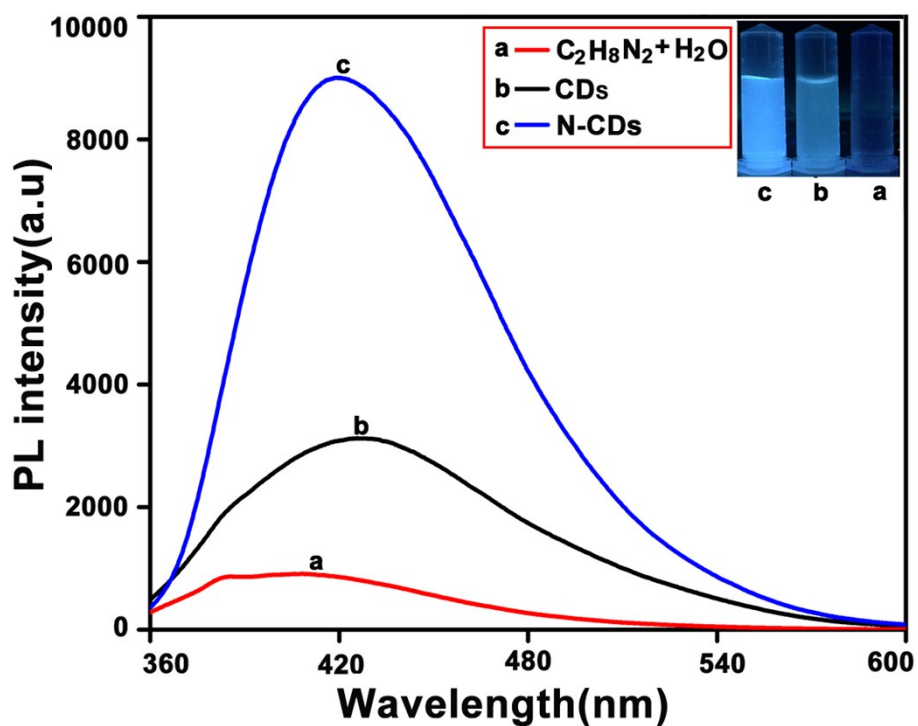


Fig. S3 Fluorescence spectra of (a) ethanediamine, (b) CDs and (c) N-CDs. Inset shows the corresponding fluorescent image under UV lamp.

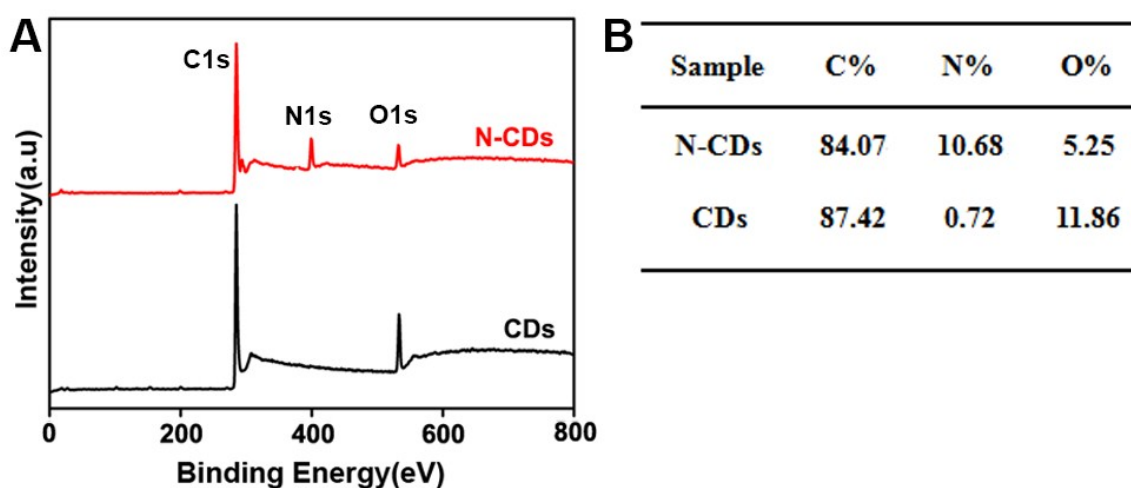


Fig. S4 (A) XPS survey of CDs and N-CDs. (B) the relative contents of C, N and O elements for CDs and N-CDs. (determined by XPS)

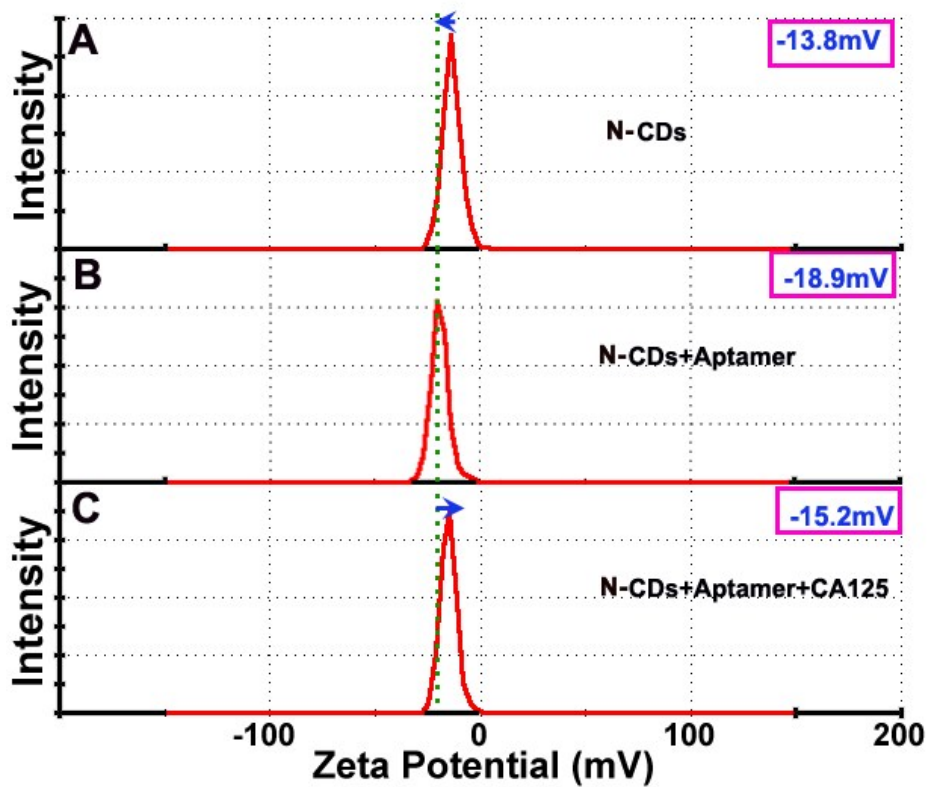


Fig. S5 Zeta potentials of N-CDs, N-CDs+CA125-aptmer and N-CDs+ CA125-aptmer+ CA125.

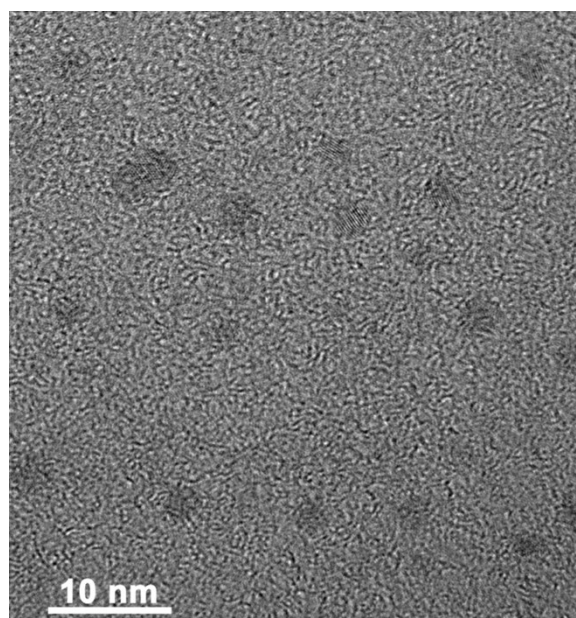


Fig S6 TEM image of the N-CDs after adding CA125-aptamer.

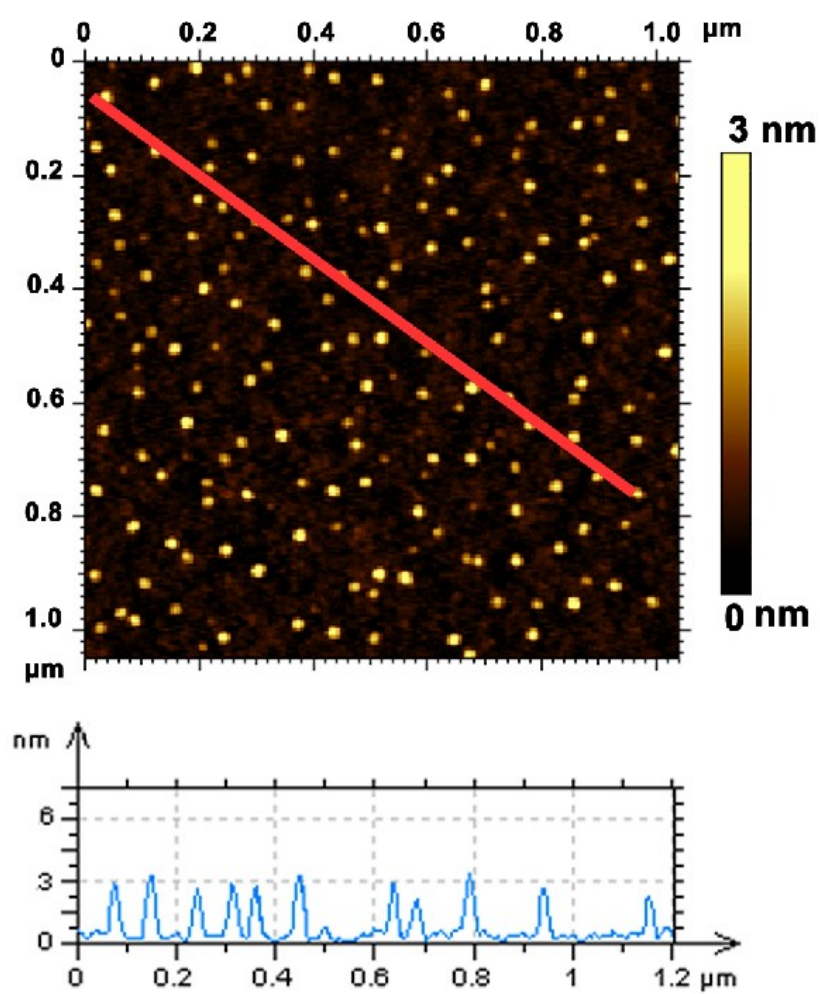


Fig. S7 AFM image of the heights or sizes of N-CDs after interaction with CA125-aptamer.

Table S1. Comparison of the performance of different methods for CA125.

Method	Material	Detection limit	Ref.
Amperometric	Sandwich chip	0.1 U/mL	S1
Fluorescence	Ag ₂ S quantum dots	0.07 ng/mL	S2
electrochemical	Gold nanostructures	5.5 U/mL	S3
GMR biosensor	Giant Magnetoresistive	3.7 U/mL	S4
Fluorescence	Cy5-DNA/GO	0.05 U/mL	S5
Fluorescence	DNA-AgNCs	1.26 ng/mL	S6
Amperometric	Molecular imprinted biosensor	0.5 U/mL	S7
Fluorescence	Magnetic nanoparticles	0.26 U/mL	S8
Fluorescence	N-CDs	0.035 U/mL	This work

Reference

S1 Das, J.; Kelley, S. O. *Anal. Chem.* **2011**, *83*, 1167-1172.

S2 Jin, H.; Gui, R.J.; Gong, J.; Huang, W. X.; *Biosens. Bioelectron.* **2017**, *92*, 378-384.

S3 Torati, S. R.; Kasturi, K. C.S.B.; Lim. B.; Kim, C. G. *Sens. Actuators B: Chem.* **2017**, *243*, 64-71.

S4 Klein, T.; Wang, W.; Yu, L. N.; Wu, K.; Boylan, K. L.M.; Vogel, R. I.; Skubitz, A. P.N.; Wang, J. P. *Biosens. Bioelectron.* **2018** (<https://doi.org/10.1016/j.bios.2018.10.046>).

S5 Chen, F.; Liu, Y.; Chen, C. Y.; Gong, H.; Cai, C. Q.; Chen, X. M. *Sens. Actuators B: Chem.* **2017**, *245*, 470-476.

S6 Wang, Y. Y.; Wang, S. S.; Lu, C. S.; Yang, X. M. *Sens. Actuators B: Chem.* **2018**, *262*, 9-16.

S7 Viswanathan, S.; Rani, C.; Ribeiro, S.; Delerue-Matos, C.; *Biosens. Bioelectron.* **2012**, *33*, 179-183.

S8 Pal, M. K.; Rashid, M.; Bisht, M. *Biosens. Bioelectron.* **2015**, *73*, 146-152.

Table S2 Detection of CA125 in human serum.

Sample	CA 125 (U/mL)	
	Detected in hospital	This method
Healthy people	1	5.7
	2	9.8
	3	12.3
ovarian cancer patients	4	312
	5	557
	6	924