Supplementary Material

A facile fluorescent sensor based on nitrogen-doped carbon dots derived from *Listeria monocytogenes* for highly selective and visual detection of iodide and pH

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**pH reversibility test**

The pH reversibility test referred to the previous literatures \(^1-^3\), and the method in detail is as follows:

The pH of NCDs-LM solution between pH 5 and pH 9 was adjusted back and forth by 2 M HCl or NaOH, and then measured by pH meter. The fluorescence spectra were recorded with \(\lambda_{\text{ex}} = 490\, \text{nm}\).

**The captions of figures and tables**

**Fig. S1** (a) The fluorescence emission spectra of the NCDs-LM, NCDs-LM-Hg\(^{2+}\) and NCDs-LM-Hg\(^{2+}\)-I\(^-\) mixture in aqueous solution. (b) The fluorescence stability of the NCDs-LM, NCDs-LM-Hg\(^{2+}\) and NCDs-LM-Hg\(^{2+}\)-I\(^-\) solutions.

**Fig. S2** (a) UV-vis absorption spectra of NCDs-LM (100 \(\mu\text{g/mL}\)), NCDs-LM-Hg\(^{2+}\) and NCDs-LM-Hg\(^{2+}\)-I\(^-\) mixture in aqueous solution. (b) Fluorescence decay curves of NCDs-LM (100 \(\mu\text{g/mL}\)), NCDs-LM-Hg\(^{2+}\) and NCDs-LM-Hg\(^{2+}\)-I\(^-\) mixture (\(\lambda_{\text{ex}}=490\, \text{nm}, \lambda_{\text{em}}=550\, \text{nm}\)).

**Table S1** Comparison of the LOD with the reported methods of I\(^-\) determination.

**Table S2** The fluorescence lifetimes of NCDs-LM (\(\lambda_{\text{ex}} =490\, \text{nm}, \lambda_{\text{em}} =550\, \text{nm}\)) at different pH.

**Table S3** Comparison of the pH range with the reported methods of pH determination.
Fig.S1.
| Detection methods | Strategy/Materials | Linear range | LOD       | Reference |
|-------------------|-------------------|--------------|-----------|-----------|
| HPLC-DAD          | Phosphatidylcholine column | 0.5-10.0 mg/L | 22.84 ng/mL | 4         |
| HPLC-MS/MS        | Ultrasonic extraction followed by HPLC-ESI-MS/MS | 0.5-200 ng/mL | 0.15 ng/mL | 5         |
| Cathodic stripping| Chitosan coating screen-printed carbon electrode | 0.15-500 μmol/L | 10 nmol/L | 6         |
| Capillary electrophoresis | UV detection | 0.20-4.0 μmol/L | 60 nmol/L | 7         |
| Chemiluminescence | KMnO₄/carbon dots | 3.0-100 μmol/L | 350 nmol/L | 8         |
| Fluorescence      | Carbon dots       | 0.5-20 μmol/L | 430 nmol/L | 9         |
| Fluorescence      | Nitrogen-doped carbon dots | 0.3-15 μmol/L | 69.4 nmol/L | 10        |
| Fluorescence      | Nitrogen-doped carbon dots | 0-2.0 mmol/L | 10 μmol/L | 11        |
| Colorimetry       | Histidine-mediated synthesis of gold nanoclusters | 0.8-60 μmol/L, 1.2-50 μmol/L | 60 nmol/L, 215 nmol/L | 12        |
| Colorimetry       | Catalase-like reaction of iodide ions and nitrogen-doped carbon dots | 0.09-50 μmol/L | 60 nmol/L | 13        |
| Fluorescence      | *Listeria monocytogenes*-derived nitrogen-doped carbon dots (NCDs-LM) | 0.5-10 μmol/L, 10-1000 μmol/L | 20 nmol/L | This work |
Table S2 The fluorescence lifetimes of NCDs-LM (λ_ex = 490 nm, λ_em = 550 nm) at different pH.

| pH  | τ_1 (ns) ( % ) | τ_2 (ns) ( % ) | τ_{avg} (ns) |
|-----|----------------|----------------|-------------|
| 1.81| 2.97(49%)      | 7.16(51%)      | 5.10        |
| 2.21| 3.44(47%)      | 7.10(53%)      | 5.37        |
| 3.29| 3.35(18%)      | 7.33(82%)      | 6.59        |
| 4.10| 3.41(16%)      | 7.63(84%)      | 6.93        |
| 5.32| 3.52(13%)      | 7.74(87%)      | 7.18        |
| 6.37| 3.93(18%)      | 7.95(82%)      | 7.24        |
| 7.24| 4.29 (27%)     | 8.58(73%)      | 7.43        |
| 8.36| 3.48(13%)      | 8.08(87%)      | 7.48        |
| 9.15| 4.81(31%)      | 8.70(69%)      | 7.51        |
| 10.38| 4.27(19%)    | 8.47(81%)      | 7.66        |
| 11.20| 4.73(25%)    | 8.69(75%)      | 7.68        |
| Detection methods | Materials | pH range | Reference |
|-------------------|-----------|----------|-----------|
| Fluorescence and colorimetry | Microsystem-assisted synthesis of carbon dots | 3.5-10.2 | 14 |
| Fluorescence lifetime | CdTeSe/ZnS quantum dots (QDs)-NIR carbocyanine dye conjugates | 2.0-8.0 | 15 |
| Fluorescence | p-aminothiophenol-coated CdSe/ZnS QDs | 3.2-6 | 16 |
| Luminescent dimetallic Eu(III)-based Probe | Dimetallic Eu(III)-containing complex | 4-8 | 17 |
| Fluorescence lifetime imaging microscopy | Mercaptopropionic acid-capped QDs | 5.3-9.0 | 18 |
| pH-sensitive release system | Basic cobalt carbonate nanovalves | 2-7.4 | 19 |
| pH electrode | Tungsten needle modified with polyaniline film | 2-12 | 20 |
| Fluorescent chemosensors | Catechol Derivatives | 8-24 | 21 |
| Fluorescence | Polyamines bearing anthracene and benzophenone units at the respective ends | 1-13 | 22 |
| Micromechanical technique | Modified silicon and silicon nitride microcantilevers | 2-8 | 23 |
| Fluorescence | NCDs-LM | 1.81-11.82 | This work |
References

1 W. Shi, X. Li and H. Ma, *Angew. Chem. Int. Ed.*, 2012, **51**(26), 6432-6435.

2 S. Pedro, A. Salinas-Castillo, M. Ariza-Avidad, A. Lapresta-Fernández, C. Sánchez-González, C. Martínez-Cisneros, M. Puyol, L. Capitan-Vallvey and J. Alonso-Chamarro, *Nanoscale*, 2014, **6**(11), 6018-6024.

3 H. Liu, Y. Sun, Z. Li, R. Yang, Jie. Yang, A. Aryee, X. Zhang, J. Ge, L. Qu and Y. Lin, *Chin. Chem. Lett.*, 2019, **30**(9), 113-117.

4 M. Tatarczak-Michalewska, J. Flieger, J. Kawka, W. Flieger and E. Blicharska, *Molecules*, 2019, **24**(7), 1243-1256.

5 U. Kim and K. Kannan, *Anal. Chem.*, 2018, **90**(5) 3291-3298.

6 H. Cunha-Silva and M. Arcos-Martinez, *Talanta*, 2019, **199**, 262-269.

7 A. Macedo, K. Teo, A. Mente, M. Mcqueen, J. Zeidler, P. Poirier, S. Lear, A. Wielgosz and P. Britz-Mckibbin, *Anal. Chem.*, 2014, **86**(20) 10010-10015.

8 S. Han, B. Liu, Z. Fan, L. Zhang and F. Jiang, *Luminescence*, 2017, **32**(7), 1192-1196.

9 F. Du, F. Zeng, Y. Ming and S. Wu, *Microchim. Acta*, 2013, **180** (5), 453-460.

10 X. Tang, H. Yu, B. Bui, L. Wang, C. Xing, S. Wang, M. Chen, Z. Hu and W. Chen, *Bioact. Mater.*, 2021, **6**(6), 1541-1554.

11 H. Zhang, Y. Li, X. Liu, P. Liu, Y. Wang, T. An, H. Yang, D. Jing and H. Zhao, *Environ. Sci. Technol. Lett.*, 2014, **1**(1), 87-91.

12 Y. Wang, H. Zhu, X. Yang, Y. Dou and Z. Liu, *Analyst*, 2013, **138**(7) 2085-2089.

13 H. Wang, Q. Lu, Y. Liu, H. Li, Y. Zhang and S. Yao, *Sensor Actuat. B-Chem.*, 2017, **250**, 429-435.

14 S. Pedro, A. Salinas-Castillo, M. Ariza-Avidad, A. Lapresta-Fernández, C. Sánchez-González, C. Martínez-Cisneros, M. Puyol, L. Capitan-Vallvey and J. Alonso-Chamarro, *Nanoscale*, 2014, **6**(11), 6018-6024.

15 R. Tang, H. Lee and S. Achilefu, *J. Am. Chem. Soc.*, 2012, **134**(10), 4545-4548.

16 L. Dong, H. Xu, D. Li and Y. Wang, *Talanta*, 2017, **166**, 54-62.

17 J. Moore, R. Lord, G. Cisneros and M. Allen, *J. Am. Chem. Soc.*, 2012, **134** (42), 17372-17375.

18 A. Orte, J. Alvarez-Pez and M. Ruedas-Rama, 2013, *ACS Nano*, **7**(7), 6387-6395.
19 Z. Zheng, X. Huang and D. Shchukin, *Chem. Commun.*, 2014, **50**(90), 13936-13939.

20 C. Wang, G. Cai, J. Zhang and S. Du, *Appl. Mech. Mater.*, 2012, **105-107**, 1831-1834.

21 E. Evangelio, J. Hernando, I. Imaz, A. Ramón, B. Félix and R. Daniel, *Chem. Eur. J.*, 2008, **14**(31), 9754-9763.

22 G. Nishimura, Y. Shiraishi and T. Hirai, *Chem. Commun.*, 2005, **42**, 5313-5315.

23 H. Ji, K. Hansen, Z. Hu and T. Thundat, *Sensor Actuat. B-Chem.*, 2001, **72**, 3233-238.