-*Supporting Information*-

**Dual recognition strategy for ultra-sensitive fluorescent detection of Hg2+ at femto-molar level based on aptamer functionalized sulfur quantum dots**

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**Fig. S1.** The DLS spectra of SQDs.



**Fig. S2.** UV-vis absorption spectra of aptamer.



**Fig. S3.** FT-IR spectra of the Apt-SQDs (blue curve), NH2-SQDs after adding into Hg2+ (black curve) and Apt-SQDs after adding into Hg2+ (red curve).



**Fig. S4.** XRD spectra of SQDs.



**Fig. S5.** The lifetime spectra of SQDs, NH2-SQDs and Apt-SQDs.



**Fig. S6.** Zeta potential of SQDs, NH2-SQDs and Apt-SQDs without Hg2+ (white column) and zeta potential of SQDs, NH2-SQDs and Apt-SQDs with Hg2+ (gray column).

**Fig. S7.** FT-IR spectra of aptamer.



**Fig. S8.** Optimization results for different experimental conditions: (A) different reaction time and inset was the fluorescence spectra of Apt-SQDs without Hg2+ (red curve) and with Hg2+ (blue curve). (B) different pH of this sensing platform. (C) the fluorescence spectra of SQDs with different concentration (10-1, 1, 2, 4, 6, 8 and 10 mg mL-1). (D) the influence of ion strength.



**Fig. S9.** (A) The signal response of the proposed fluorescent aptasensor for detecting various concentrations of Hg2+ and the corresponding concentrations of Hg2+ (10-11, 10-10, 10-9, 10-8 and 10-7 M, from top to bottom, n = 8). (B) Linear relationship between the fluorescence intensity and the logarithm of Hg2+ concentrations.



**Fig. S10.** The dependence of F0/F on the concentrations of Hg2+.



**Fig. S11.** Selectivity toward other interfering substances in the presence 1.0 × 10-8 M Hg2+: CO32-, Cl-, PO43-, SO42-, NO3-, SO32- and Ac- (the concentration of each of the aforementioned interferents was 1.0 × 10-7 M).



**Fig. S12.** Photographs of the test paper based on Apt-SQDs toward Hg2+ with different concentrations.

**Table S1.** Comparison of parameters of other published methods used for Hg2+ detection.

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| --- | --- | --- | --- |
| Method | Linear range | LOD | Ref. |
| SERSa | 0.1 pM-10 nM | 80 fM | [Zhang et al., 2018] |
| Electrochemiluminescence | 0.8 fM-1 nM | 0.3 fM | [Jian et al., 2018] |
| Electrochemistry | 1 fM-1 nM | 0.62 fM | [Zhang et al., 2018] |
| Electrochemistry | 10 fM-100 nM | 4.8 fM | [Zhang et al., 2020] |
| Fluorescence | 0.035-0.2 and 8.0-120.0 pM | 0.035 pM | [Zhou et al., 2021] |
| Fluorescence | 1 fM-0.1 µM | 0.3 fM | This work |

a Surface Enhancement Raman Spectroscopy

**References**

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**Table S2.** The method of Hg2+ detection based on carbon quantum dots.

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| Material | Linear range | LOD | Ref. |
| PP-CQDsa | 0.1 µM-1.4 µM | 2.0 nM | [Duan et al., 2019] |
| N-CQDsb | 1 nM-100 nM | 7.7 nM | [Li et al., 2017] |
| Au/N-CQDsc | 0 nM-41.86 nM | 0.12 nM | [Meng et al., 2018] |
| N-CQDsd | 15 nM-104 nM | 8.0 nM | [Zou et al., 2021] |
| CQDse | 0 nM-5 µM | 3.2 nM | [Zhou et al., 2021] |

a Pyrophosphate-modified carbon quantum dots.

b N doped carbon quantum dots

c Au/N doped carbon quantum dots.

d N doped carbon quantum dots.

e carbon quantum dots

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