Supporting Information for

Hydrothermal synthesis of nitrogen- and sulfur-co-doped carbon quantum dots from rice straw for fluorescent detection of Hg^{2+} in aqueous media

Duc Cuong Nguyen[a], Bao Long Hoang[a], Van Duong Pham[b],
Hop Bao Tung Nguyen[a], Tuan Anh Pham[a], Thi Thao Vu[*,a]

[a] Faculty of Engineering Physics and Nanotechnology,
VNU University of Engineering and Technology (VNU-UET),
144 Xuan Thuy Street, Cau Giay, Hanoi, 100000, Vietnam
[b] Institute of Physics, Vietnam Academy of Science and Technology,
10 Dao Tan Street, Giang Vo, Hanoi, 100000, Vietnam

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[*]Corresponding author: e-mail: vtthao@vnu.edu.vn, Phone: +84-866-182-682

Table S1: FT-IR peak assignments of rice straw, carbonized rice straw, and NS-CQDs

Wavenumber (cm^{-1})	Sample	Assignment	Remarks
3200–3500	Rice straw	O–H stretching	Weak and poorly resolved
2920–2850	Rice straw	C–H stretching	Low intensity
∼1035	Rice straw	Si–O–Si stretching	Dominant vibration
∼459	Rice straw	Si–O–Si bending	Confirms silica-rich structure
3200–3500	Carbonized rice straw	O–H stretching	Weakened due to dehydration
∼2920	Carbonized rice straw	C–H stretching	Reduced intensity after carbonization
1600–1700	Carbonized rice straw	C=O / C=C stretching	Aromatization and conjugated structures
∼1035	Carbonized rice straw	Si–O–Si stretching	Silica preserved after carbonization
∼459	Carbonized rice straw	Si–O–Si bending	Confirms silica enrichment
∼3368	NS-CQDs	O–H / N–H stretching	Surface hydroxyl and amine groups
∼2880	NS-CQDs	C–H stretching	Residual aliphatic carbon
∼1648	NS-CQDs	C=O stretching	Amide and/or carboxyl groups
∼1580	NS-CQDs	C=N stretching	Nitrogen-doped carbon domains
∼1405	NS-CQDs	C–N / N–H bending	Amine or amide functionalities
∼1303	NS-CQDs	C–N stretching	Amine or amide functionalities
∼1014	NS-CQDs	C–O–C stretching	Ether or epoxy groups on CQDs surface
∼952	NS-CQDs	S=O stretching	Sulfur-containing functional groups

Table S2: Comparison of the analytical performance of CQD-based nanoprobes derived from non-biomass precursors for Hg^{2+} detection with the NS-CQDs developed in the present study. References are listed in order of increasing LOD values

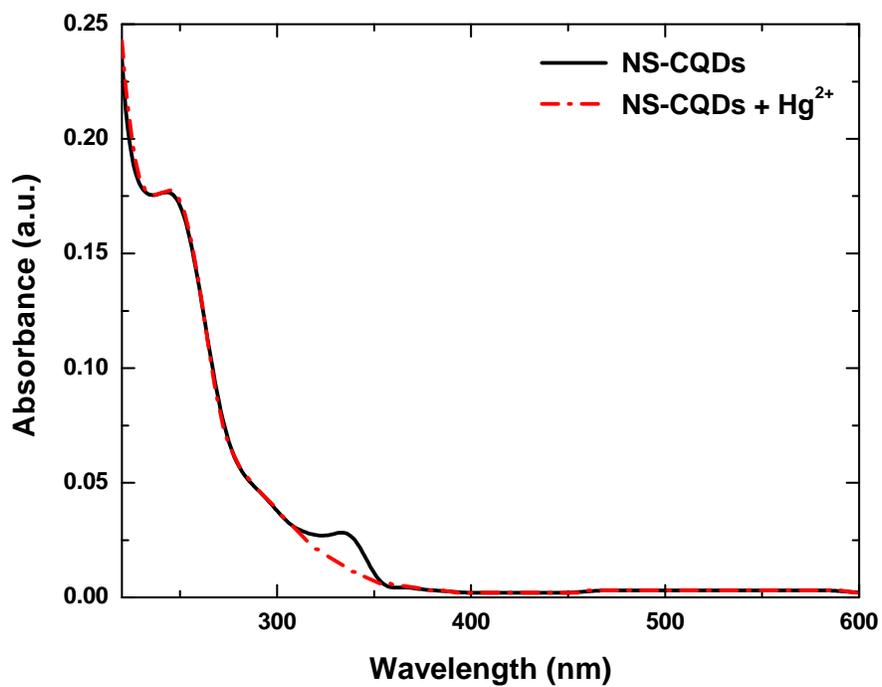| References	Probe	Precursor	QY (%)	Linear range (μM)	LOD (μM)
[1]	Ag-S-CN-CQDs	AgNO$_3$ and Thiourea	36.5	0.1–0.6	0.130
[2]	N-CQDs	Citric acid and urea	15	0–40	0.138
[3]	NS-CQDs	Citric acid and thiourea	36.8	0–80	0.16
[4]	N-CQDs	Folic acid and Ethylene glycol	15.7	0–25	0.23
[5]	NS-CQDs	Citric acid, glutamine, Na$_2$S	10.35	0–20	0.289
This work	NS-CQDs	Rice straw, gelatin, DMSO	39.7	0–100	0.148

Figure S1: Effect of Hg^{2+} ions on the absorption spectra of NS-CQDs.
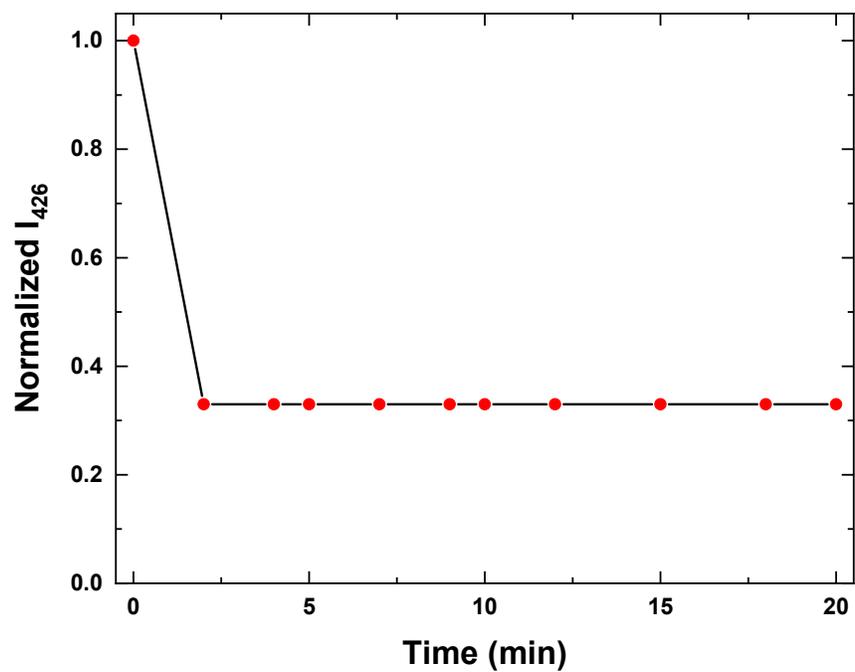

Figure S2: Effect of incubation time on the fluorescence intensity of NS-CQDs.

3

Table S3: Comprehensive comparison of biomass-derived carbon quantum dot (CQD)–based fluorescent sensors for Hg^{2+} detection with respect to biomass precursors, dopant types, synthesis conditions, sensing performance, selectivity/interference behavior, response time, and real-sample applicability. References are listed in order of increasing LOD values

Ref.	Biomass precursor	Dopants	Synthesis conditions (T, time)	QY (%)	Detection method	Linear range (μM)	LOD (μM)	Selectivity / interference	Response time	Real-sample matrix	Recovery (%)
[6], Bavya et al. 2025	Bamboo cellulose	S (sodium thiosulfate)	Hydrothermal, 180 °C, 24 h	1.5	Fluorescence enhancement	0.0005–0.001	0.00516	Excellent (15 ions)	Within seconds	Tap water	95.3–100.54
[7], Pan et al. 2026	Waste lemon peel	N,S (GSH)	DMF hydrothermal, 180 °C, 10 h	15.2	Fluorescence quenching	0.0176–20	0.0176	Good (12 ions)	∼ 10 min	Lake water	101.78 ± 2.54
[8], Gu et al. 2016	Lotus root	N (amino acids)	Microwave-assisted	19.0	Fluorescence quenching	0.1–60.0	0.0187	Good (13 ions)	150 s	Tap water	96.9–99.0
[9], Khare et al. 2025	Triticum aestivum (wheatgrass)	N, Cl (choline chloride-urea)	Microwave-assisted, 150 °C, 40 min	∼ 36	Fluorescence quenching	0–0.85	0.039	Excellent (14 ions)	Not provided	River water	97.5–102.5
This work	Rice straw	N,S (gelatin, DMSO)	Hydrothermal, 200 °C, 8 h	39.7	Fluorescence quenching	0–100	0.148	Excellent (16 ions)	∼ 2 min	To Lich River water	101.34–105.07

4

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