Supplementary Material for

Portable smartphone platform based on Ti_3C_2 MQDs/CDs assembly for ratiometric fluorescence quantitative monitoring of crystal violet

Yuxuan Bai[1,#], Mingwang Liu[1,#],Yu He[1*], Gongwu Song[1]

1. Hubei Collaborative Innovation Center for Advanced Organic Chemical Materials, Ministry-of-Education Key Laboratory for the Synthesis and Application of Organic Functional Molecules, College of Chemistry and Chemical Engineering, Hubei University, Wuhan 430062, China.

[#]These authors contributed equally.

* Corresponding author: E-mail address: heyu@hubu.edu.cn

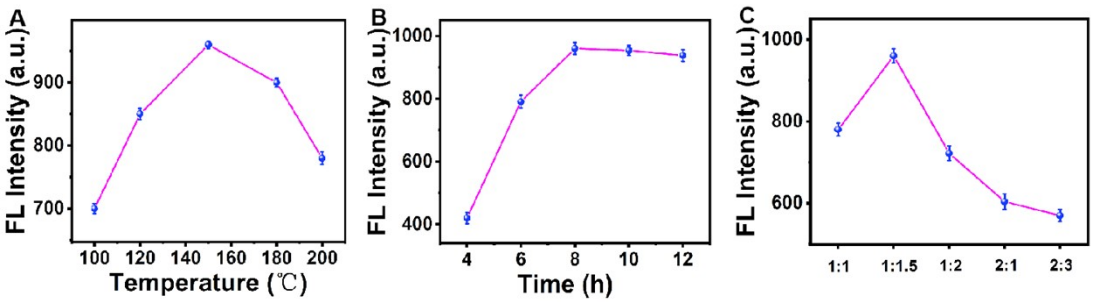

Fig. S1. Optimization of CDs synthesis conditions: (A) reaction temperature, (B) reaction time and (C) ratio of substances of 4-chloro-1,2-diaminobenzene to 3-hydroxytyramine hydrochloride.

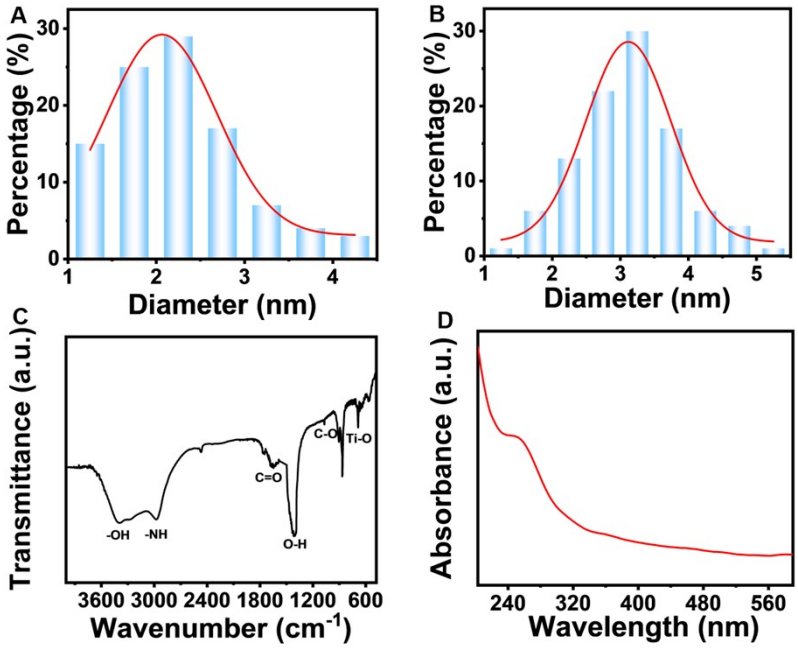

Fig. S2. The size distribution of (A) Ti_3C_2 MQDs and (B) CDs, (C) FT-IR spectrum and (D) UV-vis absorption spectra of Ti_3C_2 MQDs.

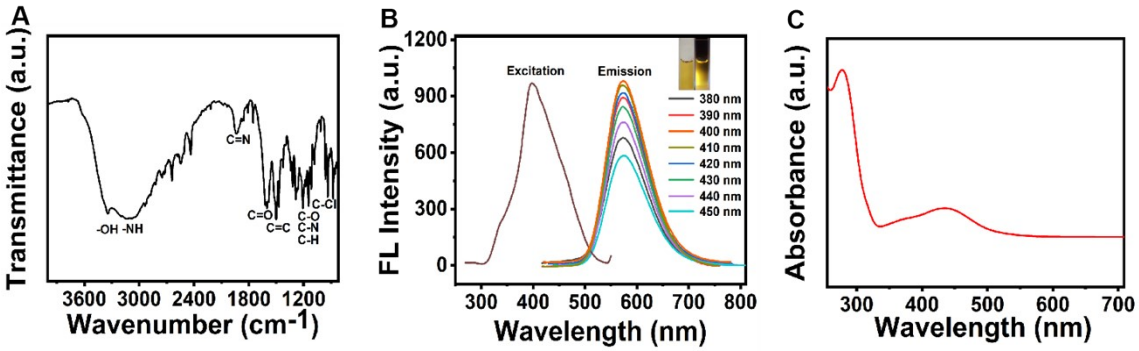

Fig. S3. (A) FT-IR spectrum, (B) fluorescence spectra and (C) UV-vis absorption spectra of CDs.

1. The narrow-scan spectra of C, N, Ti in Ti_3C_2 MQDs

Specifically, the XPS spectra of C 1s (Fig. S3A) display the peaks for C=C /C-C (284.8 eV), C-O (286.33 eV), C=O (287.05 eV) and N-C=N (288.9 eV). As for the N 1s spectrum (Fig. S3B)， the peaks centered at 398.89, 399.63 and 401.56 eV belong to C-N-C, N-$(C)_3$ and N-H, respectively. As shown in Fig. S3C, the peaks at 458.1 461.43, 464.94 eV and 468.29 eV correspond to Ti-C 2p3/2, Ti-O 2p3/2, Ti-O 2p1/2 and Ti-C 2p1/2, respectively, indicating that the synthesized Ti_3C_2 MQDs possess typical characteristic peaks.

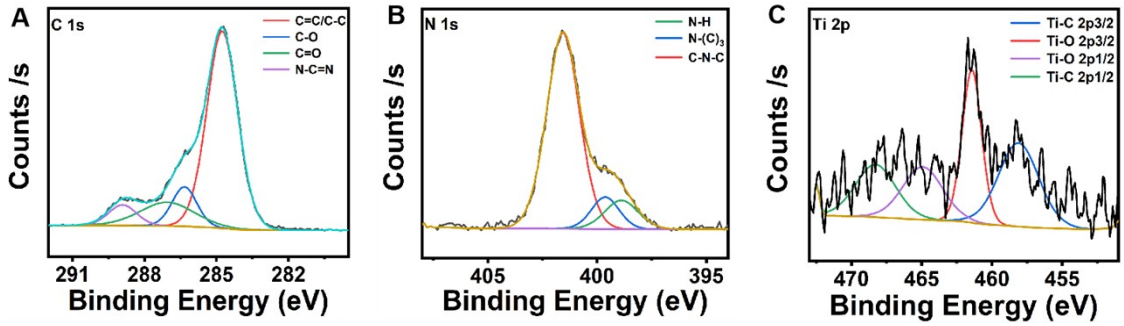

Fig. S4. The high-resolution XPS spectra of (A) C 1s, (B) N 1s, (C)Ti 2p of the Ti_3C_2 MQDs.

2. The narrow-scan spectra of C, N, Cl in CDs

As for CDs, further analysis by high-resolution XPS shows that C 1s contains three fitting peaks of 284.8eV 285.3eV and 286.6eV, which belong to C=C C-C and C-O, respectively. The peaks of N 1s at 398.8 eV 399.52 eV and 402.1eV correspond

to N-C N-$(C)_3$ and N-H, respectively. The Cl 2p XPS spectrum contains three peaks, which are 196.2 eV (Cl 2p3/2) 199.4 eV (Cl 2p) and 201.41 eV (Cl 2p1/2) respectively.

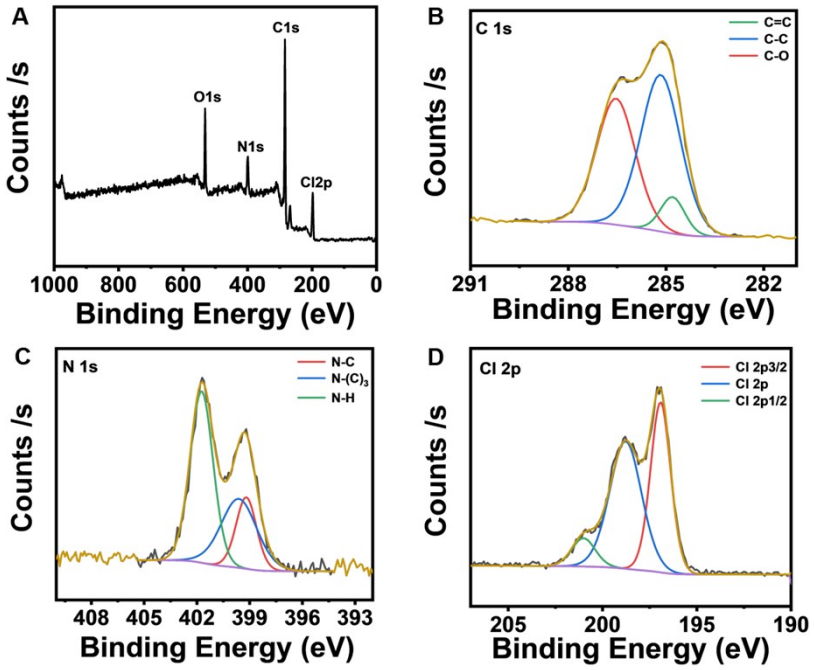

Fig. S5. (A) XPS full spectrum of CDs. The high-resolution XPS spectra of (B) C 1s, (C) N 1s, (D) Cl 2p of the CDs.

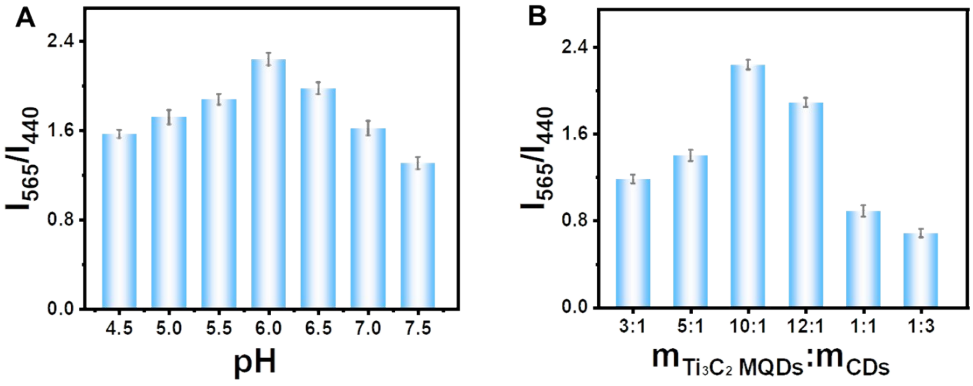

Fig. S6. The effects of (A) pH and (B) coupling mass ratio of Ti_3C_2 MQDs/CDs.

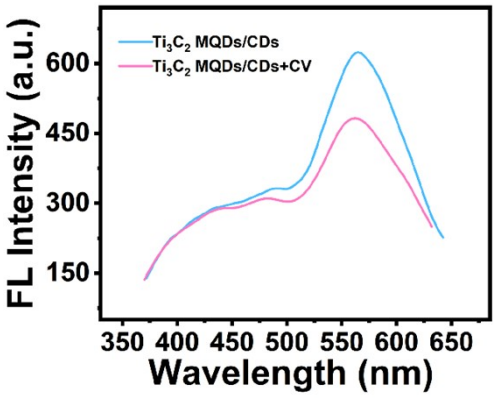

Fig. S7. Feasibility of CV detection with Ti_3C_2 MQDs/CDs probe

Table S1 Fitting fluorescence lifetime parameters for Ti_3C_2 MQDs/CDs

Sample	Nanomaterial	Fluorescence lifetime τ (ns)
1	Ti_3C_2 MQDs (alone)	4.68
2	Ti_3C_2 MQDs (Ti_3C_2 MQDs/CDs)	3.37
3	CDs (alone)	2.25
4	Ti_3C_2 MQDs (Ti_3C_2 MQDs/CDs)	3.48

Table S2 Comparison of different fluorescence detection methods for CV

Methods	Linear range	Detection limit	Ref.
Fluorescence	0.02-1.6 μM	7.3 nM	[1]
Fluorescence	0.3-12 μM	83 nM	[2]
Fluorescence	0.182-37 μM	61 nM	[3]
Fluorescence	0.1-11 μM	20 nM	[4]
Fluorescence	0.02-2.0 μM	8.6 nM	This work

References

[1] Y. Hu, Z. Gao, Yellow emissive Se, N-codoped carbon dots toward sensitive fluorescence assay of crystal violet, *J Hazard. Mater*., 2020, 388, 122073.

[2] K. Yi, A Novel Method for the Quantitative Determination of Crystal Violet Utilizing $YVO_4:Eu^{3+}$ Nanoparticles, *Chem. Lett*., 2017, 46, 520-523.

[3] Y. Han, Y. Chen, J. Liu, et al. Room-temperature synthesis of yellow-emitting fluorescent silicon nanoparticles for sensitive and selective determination of crystal violet in fish tissues, *Sens. Actuator B-Chem*., 2018, 263, 508-516.

[4] D. Zhao, X. Liu, Z. Zhang, et al. Synthesis of Multicolor Carbon Dots Based on Solvent Control and Its Application in the Detection of Crystal Violet, *Nanomaterials (Basel)*, 2019, 9, 11.