Supporting Information for

Carbon dots/layered zirconium phosphate composites for the adsorption-detection integration of iron ions

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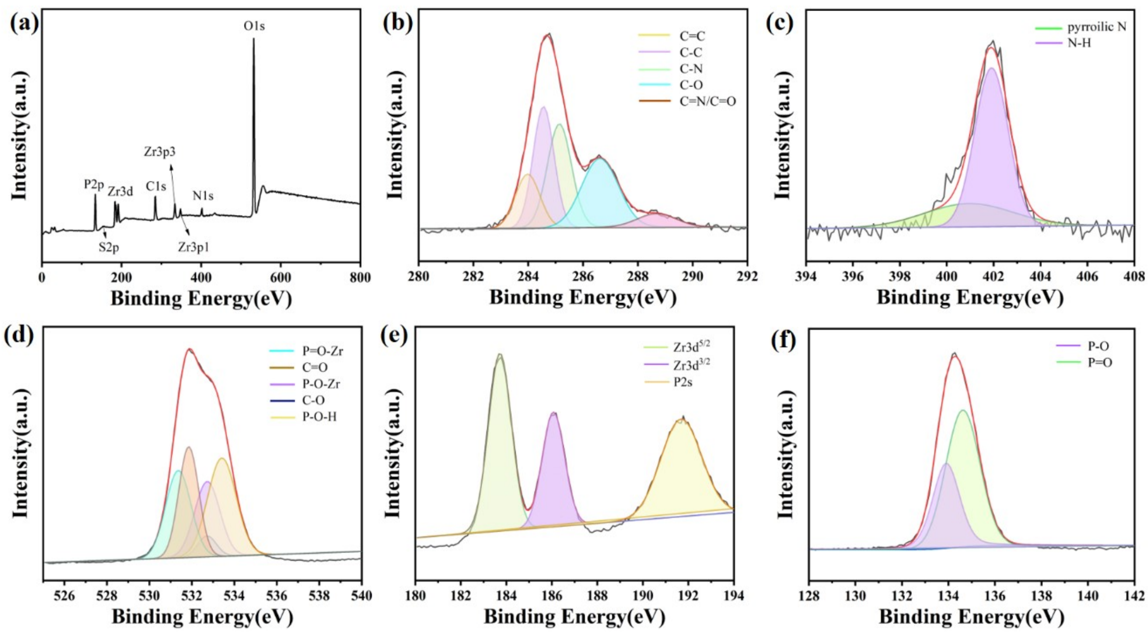

Fig. S1 Full survey (a) and high-resolution XPS of C_{1s} (b), N_{1s} (c), O_{1s} (d), Zr_{3d} (e) and P_{2p} (f) of CDs/ZrP composites.

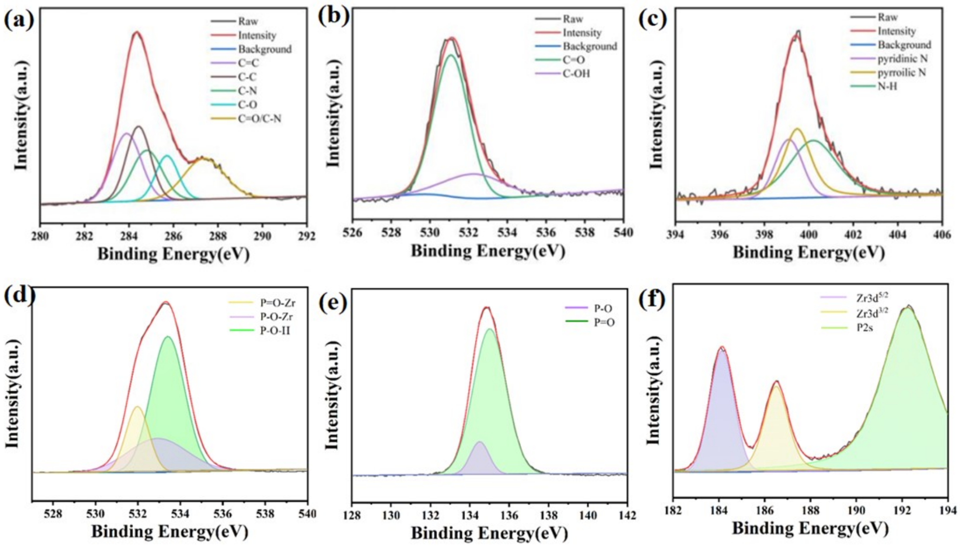

Fig. S2 C1s (a), O1s (b) and N1s (c) XPS spectrum of the CDs and O1s (d), P1s (e) and Zr (f) XPS spectrum of the ZrP.

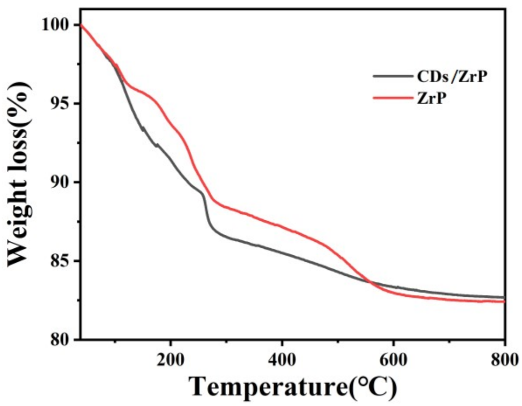

Fig. S3 The TG curves of ZrP and CDs/ZrP composites.

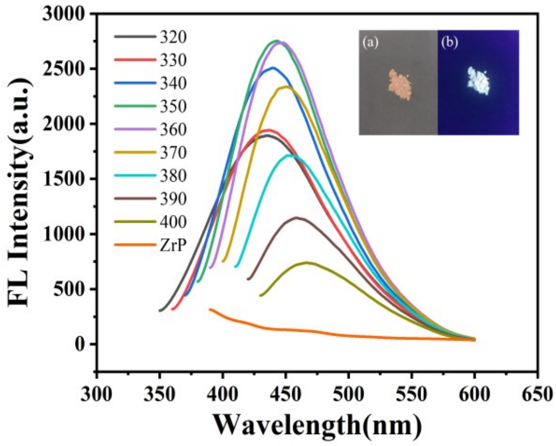

Fig. S4 Fluorescence spectra of CDs/ZrP at λ_{ex}=320~400 nm. Inset shows photographs of CDs/ZrP under visible light (a) and 365 nm UV beam (b).

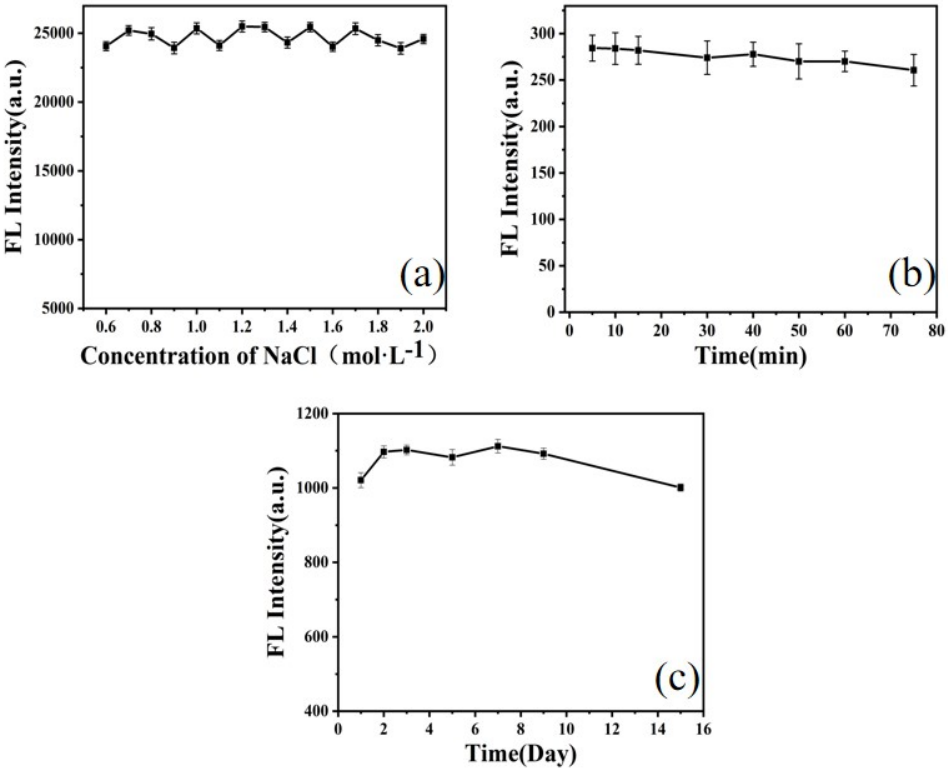

Fig.S5 Effect of ion strength (a), continuous irradiation of 365 nm UV beam (b) and storage for 15 days at room temperature (c) on the fluorescence intensity of the CDs/ZrP composites.

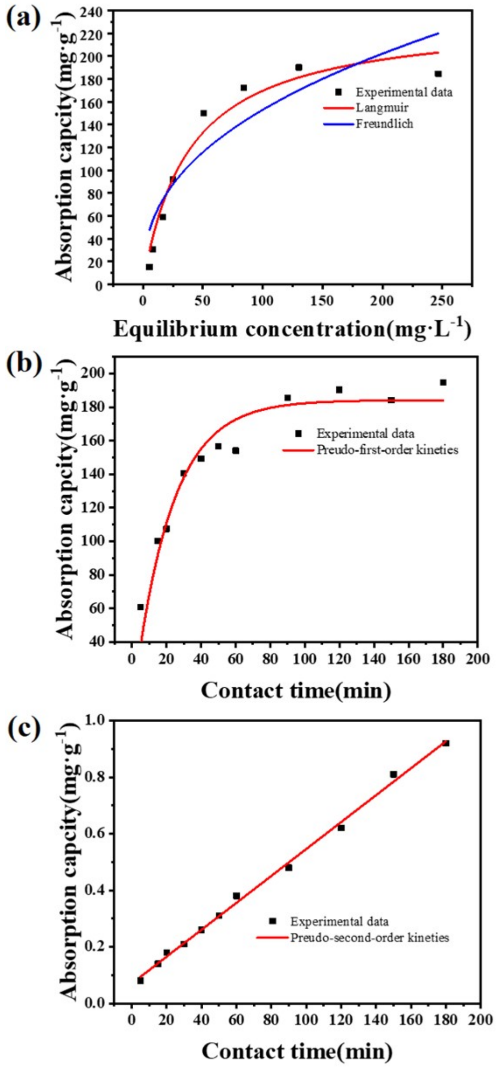

Fig.S6 (a) The adsorption isotherms of ZrP fitted by Langmuir and Freundlich model; (b-c) Adsorption kinetics of ZrP fitted by pseudo-first-order and pseuso-second-order models.

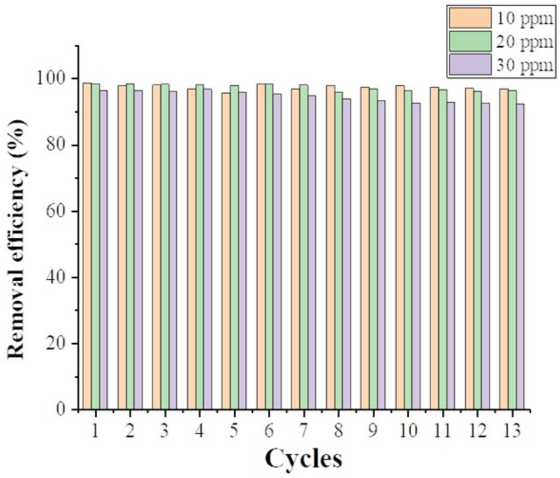

Fig. S7 Removal efficiency for durability test of CDs/ZrP.

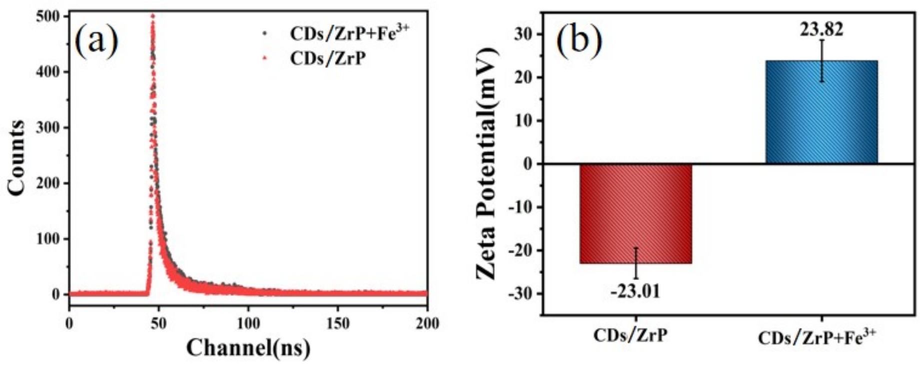

Fig. S8 FL decay spectra (a) and Zeta potential (b) of CDs/ZrP before and after Fe^{3+} addition.

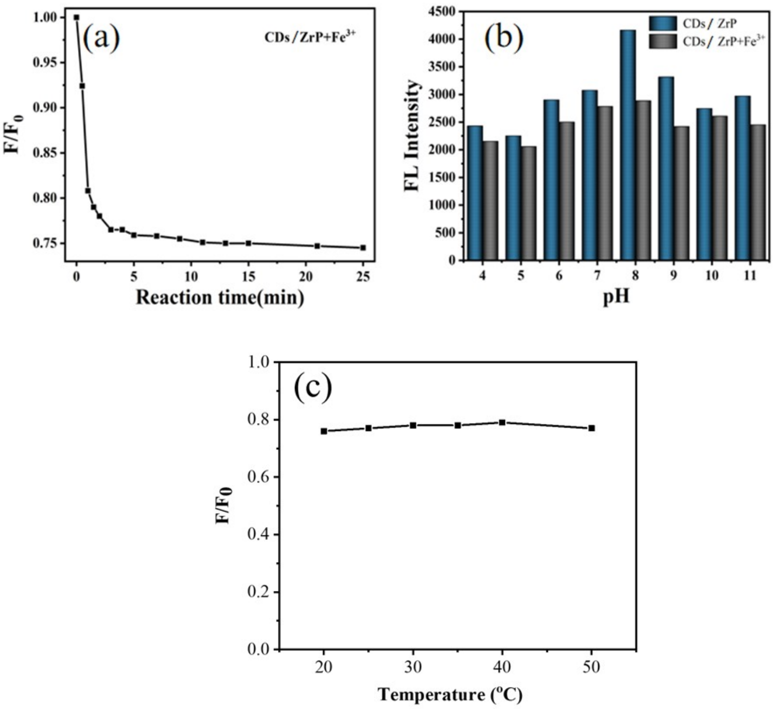

Fig. S9 The effect of reaction time (a), pH value (b) and temperature (c) on the quenching performance.

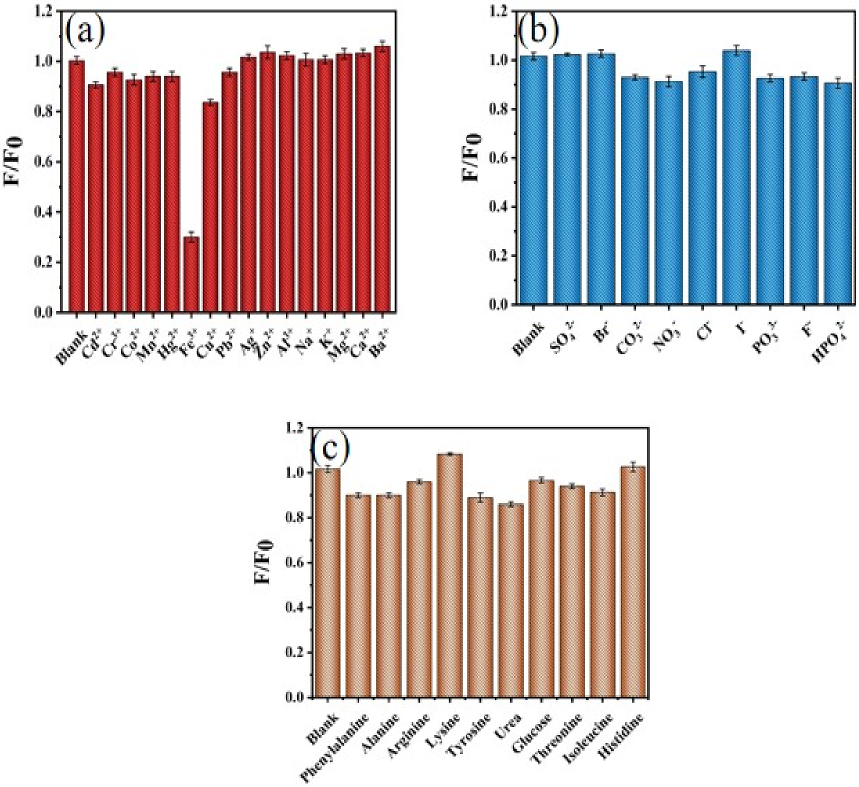

Fig. S10 Selectivity experiments of CDs/ZrP towards cation ions (a), anions (b) and small molecules (c) (concentration= 500 μM).

Table S1 Langmuir and Freundlich models fitting parameters of CDs/ZrP

Sample	Langmuir			Freundlich		
CDs/ZrP	Qmax(mg/g^{-1})	K_L(L/g^{-1})	R^2	K_F(L^n/mg^{n-1})	n	R^2
	93.02	0.0662	0.9903	25.46	4.671	0.8808

Table S2 The Pseudo-first-order and Pseudo-second-order dynamics fitting parameters of CDs/ZrP

Sample	Pseudo-first-order model			Pseudo-second-order model		
CDs/ZrP	Q_e(mg/g)	K_1(min^{-1})	R^2	Q_e(mg/g^{-1})	K_2(g/mg^{-1}/min^{-1})	R^2
	92.53	0.0571	0.9303	101.9	0.0081	0.9990

Table S3. Fe^{3+} detection in real water samples

Samples	Found without spiking/μM	Spiked/μM	Found/μM	Recovery(%)	RSD
Purified water	/	1	0.939	93.9	2.7
		20	20.04	100.2	2.3
		50	52.40	108	1.6
Tap water	18.13	20	37.88	98.8	2.4
		50	73.41	110.1	1.7
Majiagou river	2.73	3	5.71	99.3	3.2
		15	16.63	92.7	2.1
		100	104.3	101.6	1.4
Nanhu lake	4.21	5	9.14	98.6	3.2
		10	13.98	97.7	2.9
Yitong river	8.11	10	19.02	109.1	1.7
		50	57.72	99.2	2.1

Table S4. Comparison of linear range and detection limit for Fe^{3+} assays recently reported in other literatures.

Probe	Linear range	Detection limit	RSD (%)	Recovery (%)	Reuse times	Adsorption capacity ($mg \cdot g^{-1}$)	Removal efficiencies (%)	Ref.
N, P-CDs	5-100 nM	1.8 nM	<3.2	88.4−102.4	_	_	_	[2]
CDs-MoF	0-100 ppm	2.3 ppb	_	_	_	_	_	[3]
1,3,4-oxadiazole derivative	_	3 μM	_	94.85-106.11	_	_	_	[4]
N, S-CDs	6-200 μM	80 nM	<4.12	_	_	_	_	[5]
Tb-MOF	3.3×10^{-4}-0.02 mM	80 nM	<1.051	93.57-106.67	>5	_	_	[9]
S-CDs	1-500 μM	100 nM	_	_	_	_	_	[10]
Graphitic CQDs	2 nM-5 μM	2 nM	_	_	_	_	_	[11]
CDs@OMS	25-750 μM	_	_	_	_	_	_	[19]
WBPU-N,CDs film	0-200 μM	2.19 μM	_	_	_	_	_	[20]
TPA-SO-OH	0-50 μM	13 nM	_	_	_	_	_	[S1]

Chitosan nanoparticles-Rhodamine B	10^{-5}-10^{-2} M	10^{-5} mol/mL	_	_	_	_	_	[S2]
Dual-emission CDs	2..5-30 μM	0.8 μM	<4.7	93-107	_	_	_	[S3]
UCNPs@CDs	5-80 μM	1.53 μM	<3.65	96.07-110.03	_	_	_	[S4]
Eu(BTB)MOFs	0.5-80 μM	0.5 μM	_	_	_	_	_	[S5]
Eu:Y_2O_3	10-90 μM	63.2 nM	<5.41	95-105	_	_	_	[S6]
ZnMOF-74	0.1-100 μM	40 nM	_	104.1-108.9	_	_	_	[S7]
CDs/ZnO/CdS	1-50 μM	172 nM	<3.4%	98.8-103.8	_	_	_	[S8]
Graphene QDs	3.5-670 μM	1.6 μM	<6%	_	_	_	_	[S9]
CDs/ZrP	0.25-80 μM	80 nM	<3.2	92.7-110.1	>13 cycles	93.01 mg·g^{-1}	92.3-98.6	proposed method

S1 J. Yu, S. Qiu, K. Zhang, T. Zhou, X. Ban, Y. Duan, D. Jia, Q. Zhu and T. Zhang, *J. Mol. Struct.,* 2022, **1251,** 132074.
S2 Z. Liu, N. Li, P. Liu, Z. Qin and T. Jiao, *ACS Omega,* 2022, **7**. 5570-5577.

S3. Y. Wang, S. Lao, W. Ding, Z. Zhang and S. Liu, *Sensor. Actuat. B-Chem.*, 2019, **284**, 186-192.
S4. Y. Sun, X. Zhang, C. Zhao, X. Liu, Y. Shu, J. Wang and N. Liu, *Anal. Chim. Acta,* 2021, **1183,** 338973.
S5. X. Hou, X. Wen, J. He and X. Hou, *Luminescence,* 2022, **37**, 2050-2058.
S6. A. Dwivedi, M. Srivastava, A. Srivastava and S. K. Srivastava, *Spectrochim. Acta A.*, 2021, **260,** 119942.
S7. L. Hou, Y. Song, Y. Xiao, R. Wu and L. Wang, *Microchem. J.*, 2019, **150,** 104154.
S8. Z. Nan, C. Hao, X. Zhang, H. Liu and R. Sun, *Spectrochim. Acta A.*, 2020, **228,** 117717.
S9. Y. Zhang, X. Yang, Y. Pu, W. Cheng, S. Lin, Z. Shao and X. Liao, *J. Fluoresc.,* 2019, **29**, 541-548.