Supporting information

Innovative fluorescence sensing platform for β-lactams based on acidity/basicity-sensitive graphdiyne quantum dots

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Experimental

Reagents and instruments

Hexa[(trimethylsilyl)ethynyl] benzene (HEB-TMS) and CuCl were purchased from Bide Pharmaceutical Technology Co., Ltd. N,N-dimethylformamide (DMF), tetrahydrofuran (THF), basic fuchsin, dichloromethane (DCM), methanol, PeG, ampicillin, amoxycillin, doxycycline, metronidazole, chloramphenicol, fluconazole, ciprofloxacin and β-lactamases were obtained from Macklin Biochemical Technology Co., Ltd. All the used solutions were prepared with ultrapure water. (18.2 MΩ cm)

Preparation of S-GDY QDs

Before preparing S-GDY QDs, the pure GDY nanosheets were synthesized according to the previous report (Angewandte Chemie International Edition, 2022, 61, e202210242) with minor modifications. The specific processes are list as follows: (a) 30 mg HEB-TMS and 5 mg CuCl were added into a glass bottle containing 6.0 mL DMF, heated in an oven to 60 ℃ for 24 h; (b) The mixtures were successively washed with DMF, DCM, THF and methanol, obtaining a black-brown powder (CuO/GDY) upon drying in a vacuum oven; (c) after treating CuO/GDY with 0.5 M HCl, the pure GDY can be obtained via filtration and drying.

Next, the as-proposed S-GDY QDs was synthesized through a simple one-pot hydrothermal method. In brief, a 20 mL of mixed solution containing basic fuchsin (4 mg) and GDY (20 mg) was transferred to a 50 mL Teflon equipped stainless steel autoclave for heating at 200 °C (8 h). Then, by filtering and dialyzing the resulted transparent yellow solution to remove the excess reactants, S-GDY QDs can be obtained. For comparison, the common GDY QDs without the acidity/basicity-sensitive capability was also prepared in the absence of basic fuchsin with similar method.

Smartphone coupled with test strips for β-LA detection

Firstly, the test strips were obtained by cutting the filter paper into 4 × 1cm and the S-GDY QDs solution were sprayed onto the strips evenly. Afterward, β-lactamases and different concentrations of β-LA were incubated for 30 minutes before being placed on test strips. Upon reacting for 5 min, the color change of the strips were captured by the smartphone, which were then analyzed via the Color Discrimination APP for the quantitative detection.

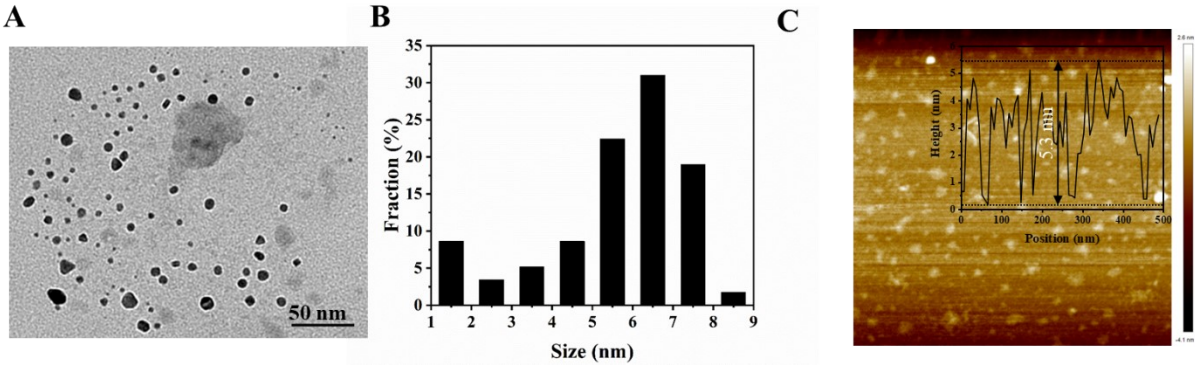

Figure S1. The (A) TEM, (B) size distribution and (C) AFM image of GDY QDs.

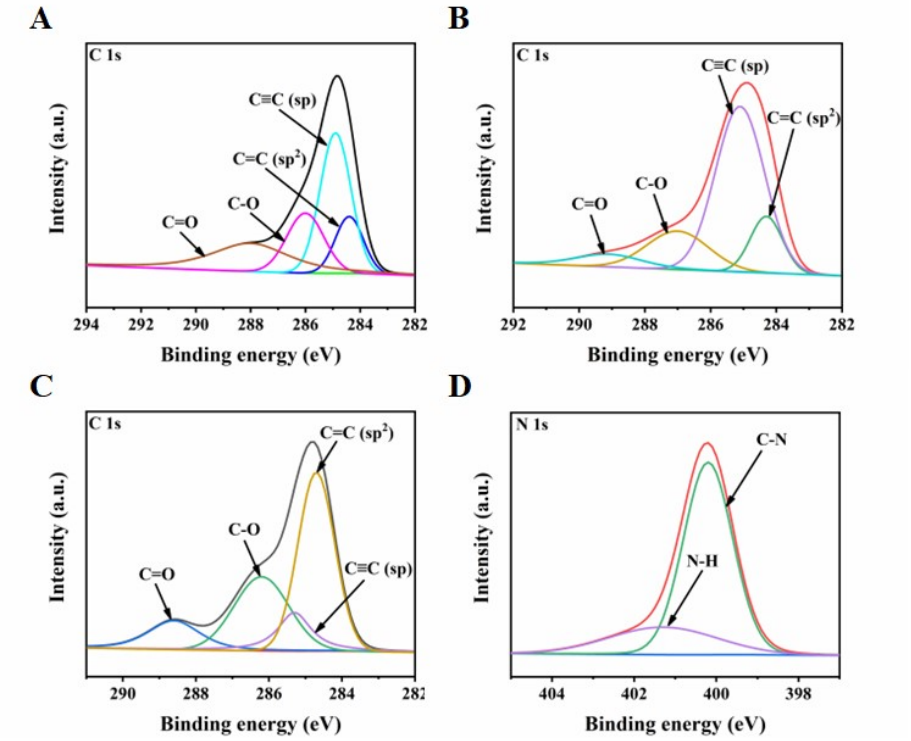

Figure S2. High-resolution C 1s spectra of (A) GDY, (B) GDY QDs and (C) S-GDY QDs. (D) High-resolution N 1s spectra of S-GDY QDs.

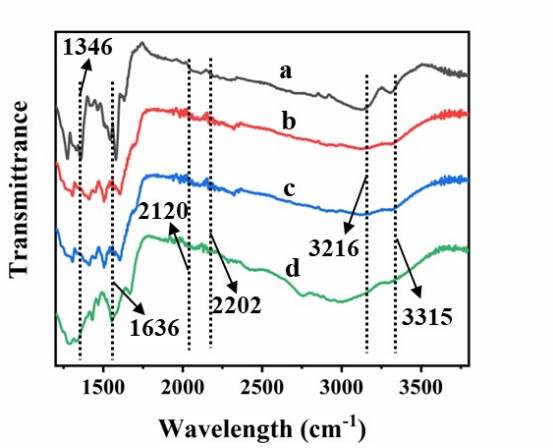

Figure S3. The FT-IR spectrum of (a) basic fuchsin, (b) GDY and (c) GDY QDs (d) S-GDY QDs.

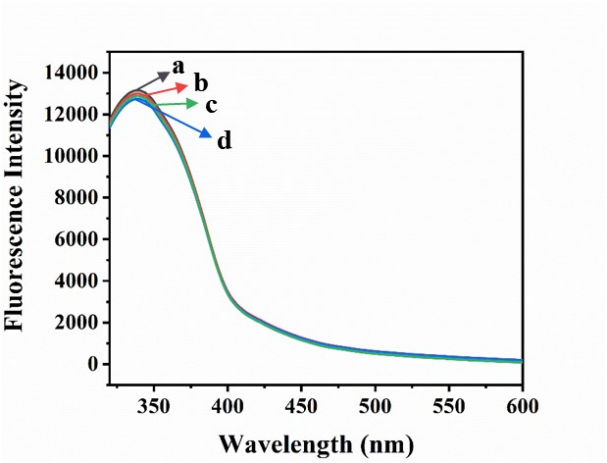

Figure S4. The fluorescent spectra of (a) GDY QDs, (b) GDY QDs + PeG + β-lactamases, (c) GDY QDs + PeG, (d) GDY QDs + β-lactamases.

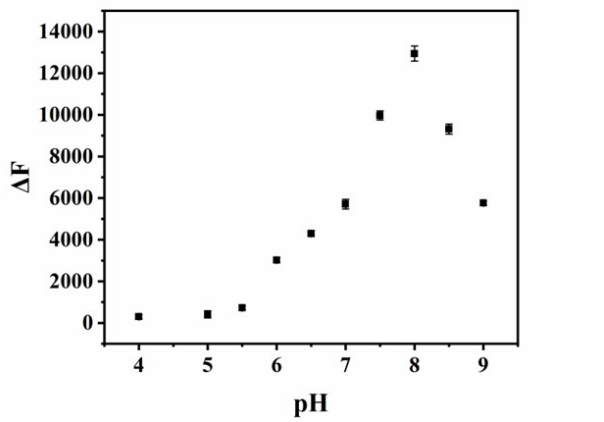

Figure S5. The effect from the pH value of the sensing system.

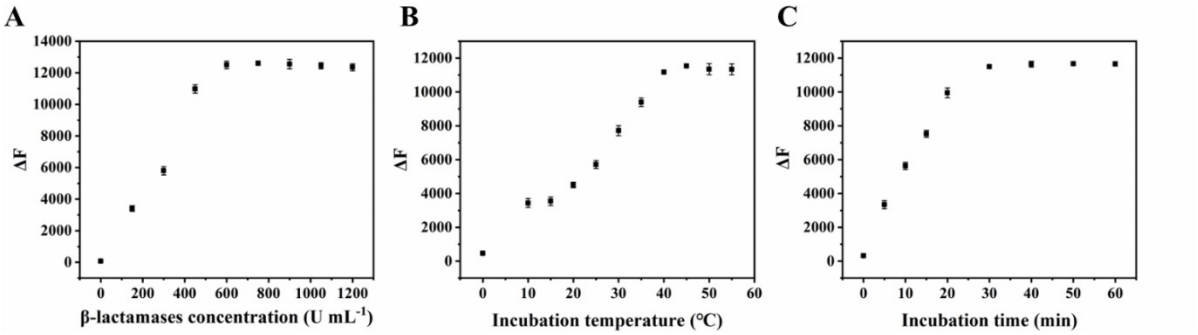

Figure S6. The effect from the (A) β-lactamases concentration, (B) incubation temperature and (C) incubation time.

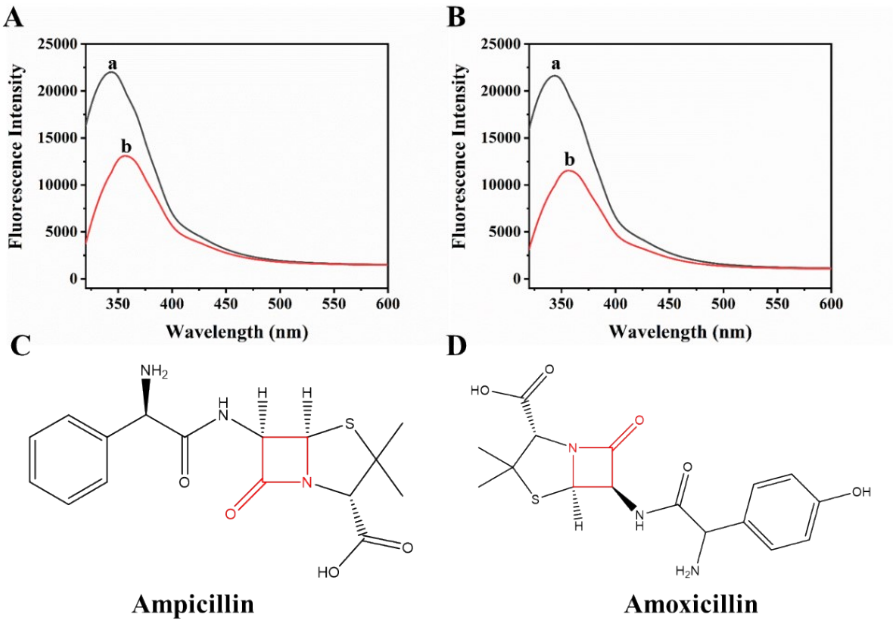

Figure S7. The fluorescent response of S-GDY QDs sensing system in the absence (a) and presence (a) of ampicillin (A) and amoxicillin (B); the chemical structure of ampicillin (C) and amoxicillin (D).

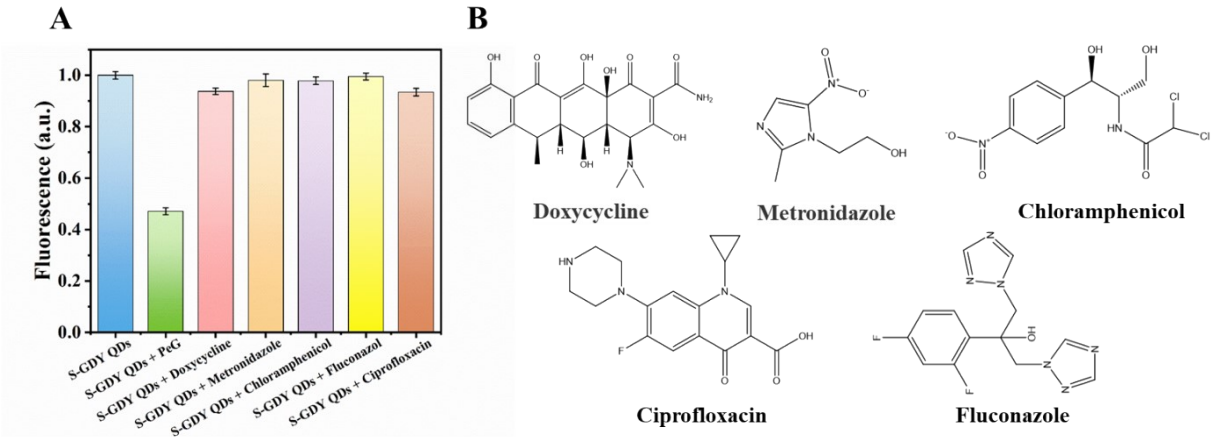

Figure S8. (A) The selectivity of S-GDY QDs for non-β-LA detection and (B) the chemical structures of five non-β-LA molecules.

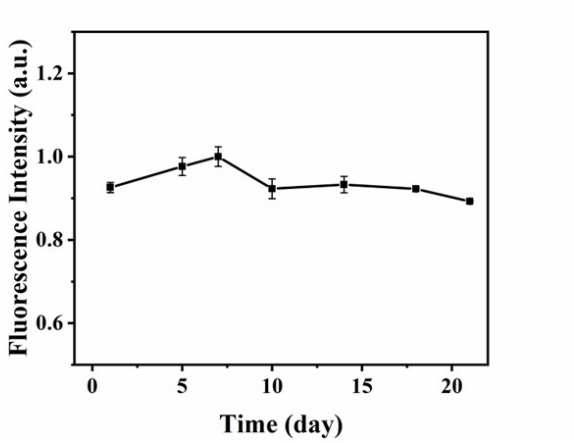

Figure S9. The fluorescence stability of S-GDY QDs.

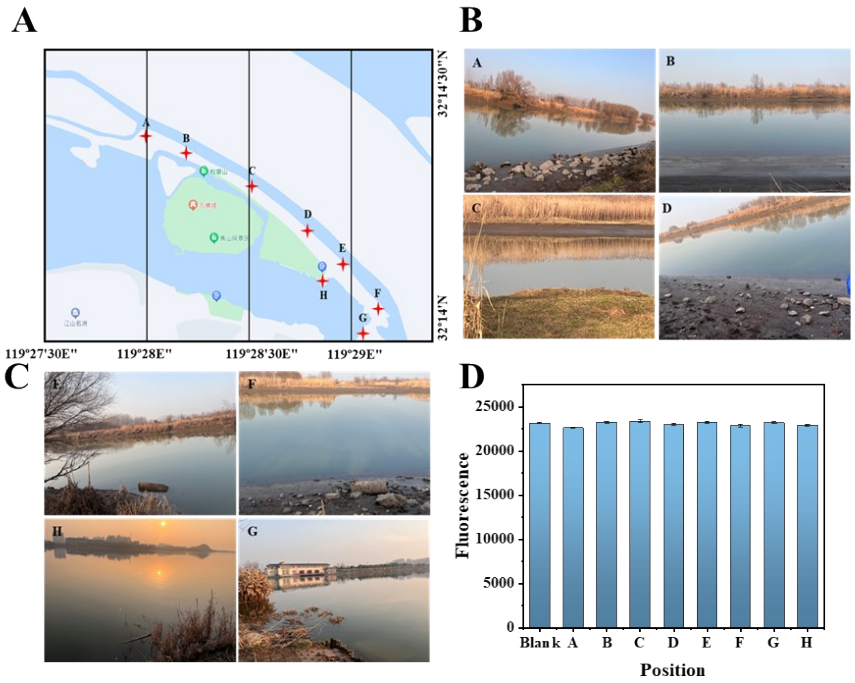

Figure S10. (A) Design of actual water sampling sites in the Changjiang River; (B) and (C) Photo of the corresponding location of the water sample point. (D) The fluorescence value of the sampling points shown.

Table S1. The detection results of PeG in real samples by the standard addition method (n=3).

Samples	Spiked (nM)	Detection (nM)	Recovery (%)	RSD (%)
water	0	0	-	-
	200	195.6	97.8	3.31
	300	304.7	101.6	2.19
	500	506.8	101.4	1.48
Soil	0	0	-	-
	200	201.0	100.5	4.97
	300	309.5	103.2	3.50
	500	497.3	99.5	1.41