Electronic Supplementary Information

Magnetic Functional Heterojunction Reactors with 3D Specific Recognition: Towards Selective Photocatalysis and Synergistic Photodegradation in Binary Antibiotic Solution

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1. Synthesis of other samples

Magnetic functional heterojunction reactor without FAC was synthesized in accordance with the synthetic process of magnetic functional heterojunction reactor, but without the addition of FAC.

Functional heterojunction reactor without SiO_2@Fe_3O_4/FAC was synthesized in accordance with the synthetic process of magnetic functional heterojunction reactor, but without the addition of SiO_2@Fe_3O_4/FAC.

TiO_2/SiO_2 was synthesized in accordance with the synthetic process of TiO_2/SiO_2@Fe_3O_4/FAC, but without the addition of Fe_3O_4 and FAC.

Functional heterojunction reactor without Fe_3O_4 was synthesized in accordance with the synthetic process of magnetic functional heterojunction reactor, but without the addition of Fe_3O_4.

Fe_3O_4/FAC was synthesized as follows: 0.2 g of modified FAC was dissolved in 25 mL of ethylene glycol with ultrasonication for 20 min, afterwards, 1.24 g of $Fe(NO_3)_3 \cdot 9H_2O$ was added into above mixture with ultrasonication for another 20 min, subsequently, 1.5 g of sodium acetate, 0.4 g of PEG 1500 and 0.01 g of polyvinylpyrrolidone were added, after ultrasonication for 20 min, above mixed solution was transferred into a Teflon-lined stainless steel autoclave and heated at 200 °C. After 12 h of reaction, the autoclave was cooled to room temperature. Finally, the product was washed with DI water and anhydrous ethanol several times, and then dried at 30 °C overnight.

Magnetic functional heterojunction reactor without SiO_2 was synthesized in accordance with the synthetic process of magnetic functional heterojunction reactor, but SiO_2@Fe_3O_4/FAC was replaced with Fe_3O_4/FAC.

2. Supporting figures and tables

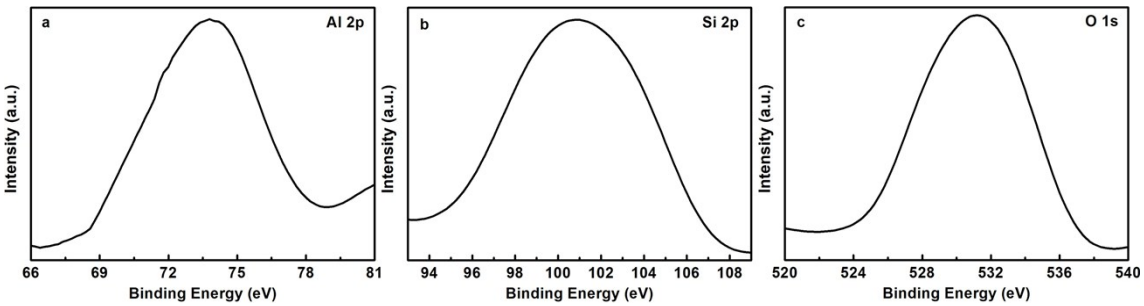

Fig. S1. XPS spectra of FAC (Al 2p, Si 2p and O 1s).

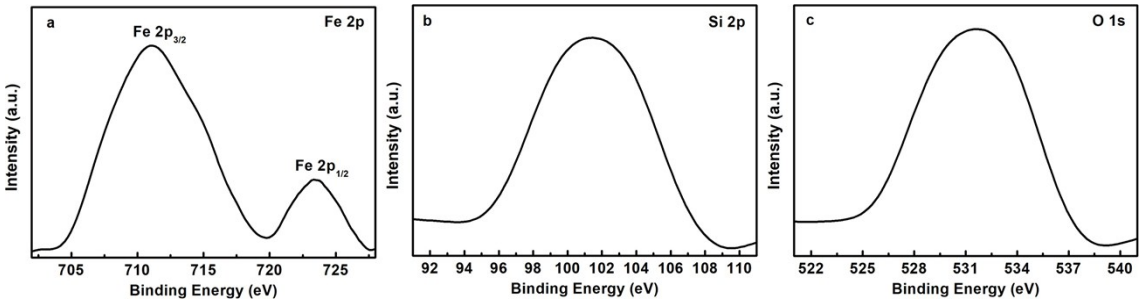

Fig. S2. XPS spectra of SiO_2@Fe_3O_4/FAC (Fe 2p, Si 2p and O 1s).

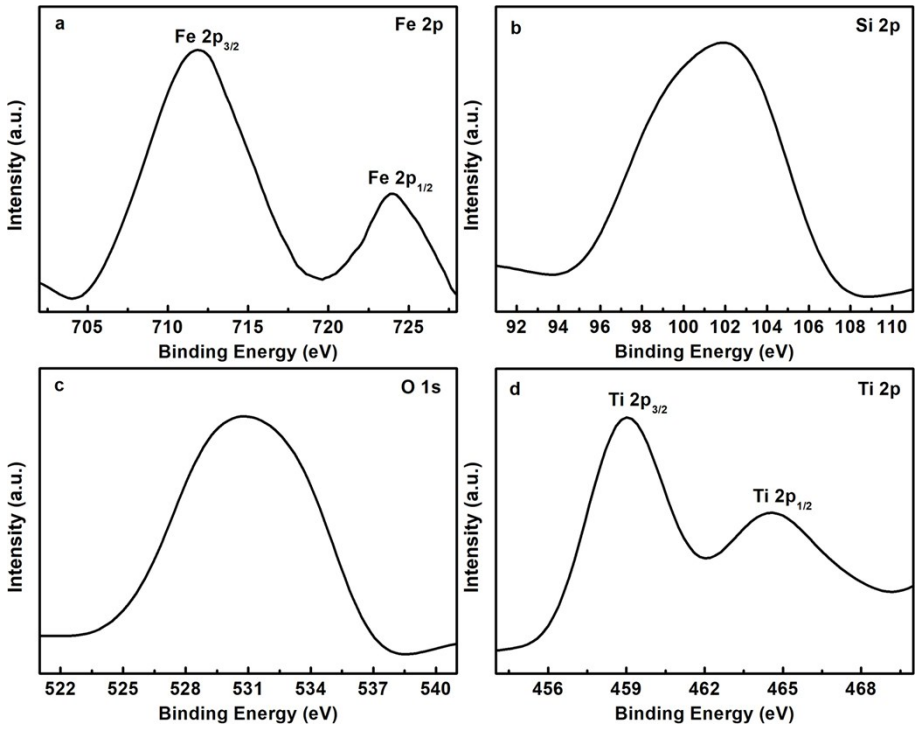

Fig. S3. XPS spectra of TiO_2/SiO_2@Fe_3O_4/FAC (Fe 2p, Si 2p, O 1s and Ti 2p).

Table S1. Specific surface area, total pore volume and average pore diameter of different samples.

Samples	Specific surface area (m^2 g^{-1})	Total pore volume (cm^3 g^{-1})	Average pore diameter (nm)
Magnetic functional heterojunction reactor	184.15	0.12	2.71
Magnetic non-functional heterojunction composite	4.57	0.01	7.37
Magnetic heterojunction without elution	5.92	0.01	7.23
$TiO_2/SiO_2@Fe_3O_4$/FAC	5.87	0.01	8.45
$SiO_2@Fe_3O_4$/FAC	24.61	0.03	5.14
FAC	8.75	0.01	5.46
Magnetic functional heterojunction reactor without FAC	199.09	0.13	2.68
Functional heterojunction reactor without $SiO_2@Fe_3O_4$/FAC	208.37	0.14	2.72

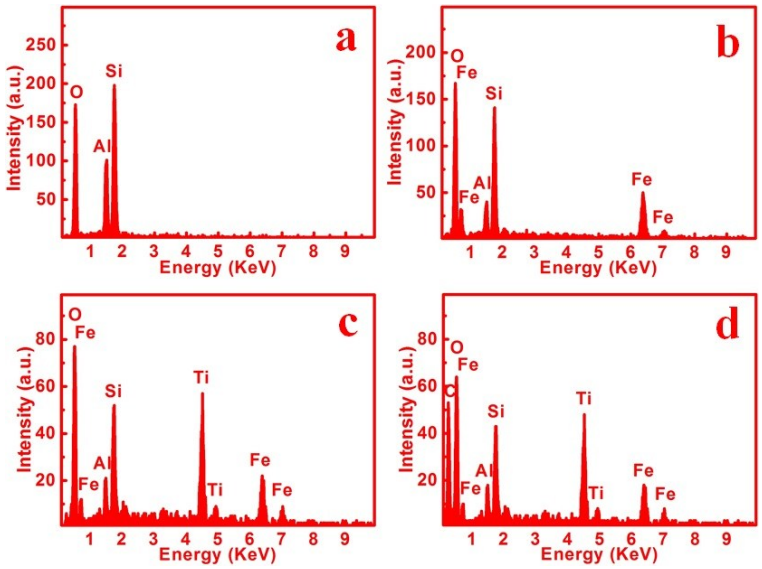

Fig. S4. EDS spectra of FAC (a), $SiO_2@Fe_3O_4$/FAC (b), $TiO_2/SiO_2@Fe_3O_4$/FAC (c) and magnetic functional heterojunction reactor (d).

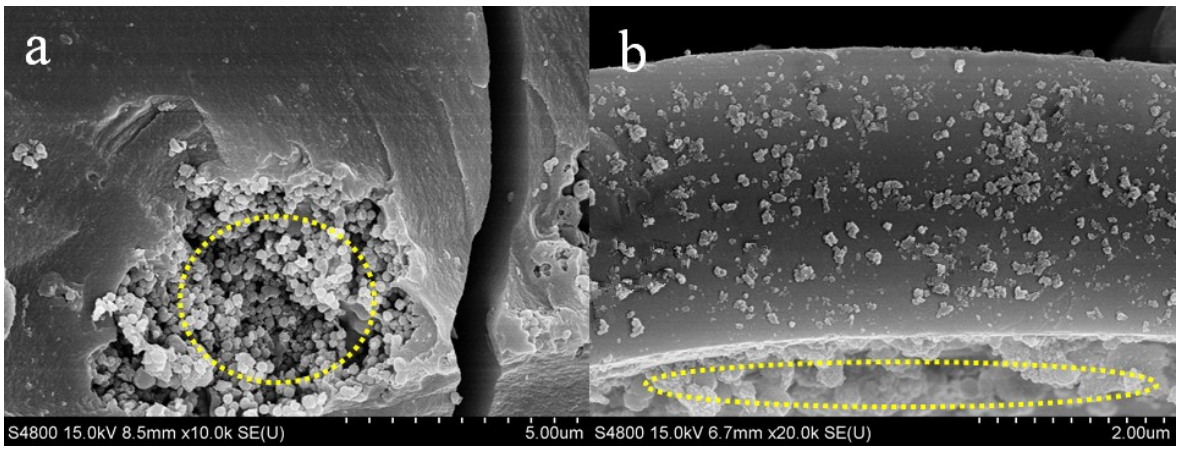

Fig. S5. SEM images of the exposed surface of magnetic functional heterojunction reactor.

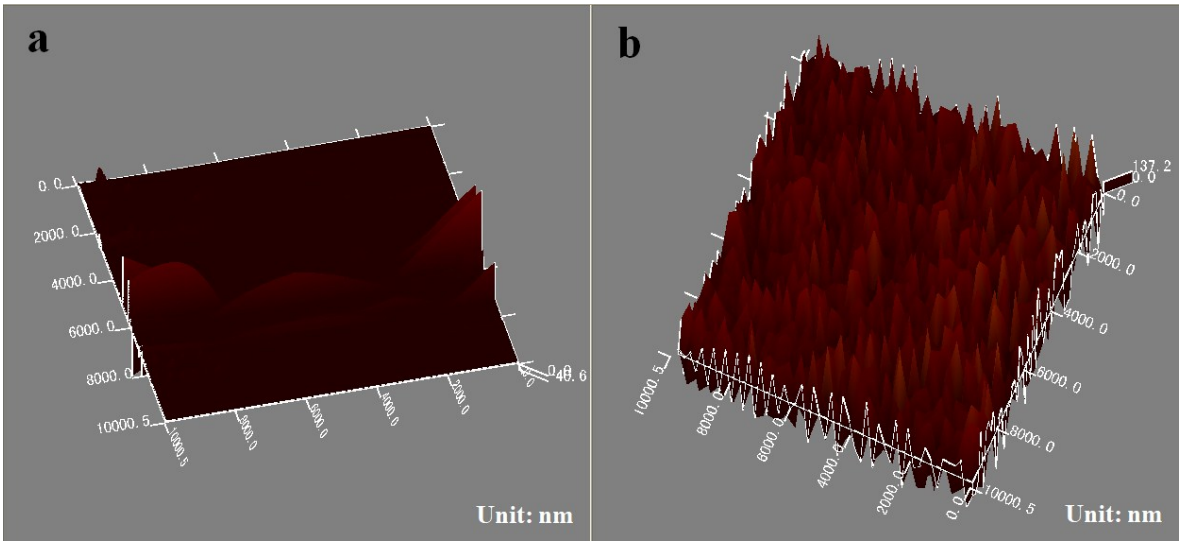

Fig. S6. AFM images of magnetic heterojunction without elution (a) and magnetic functional heterojunction reactor (b).

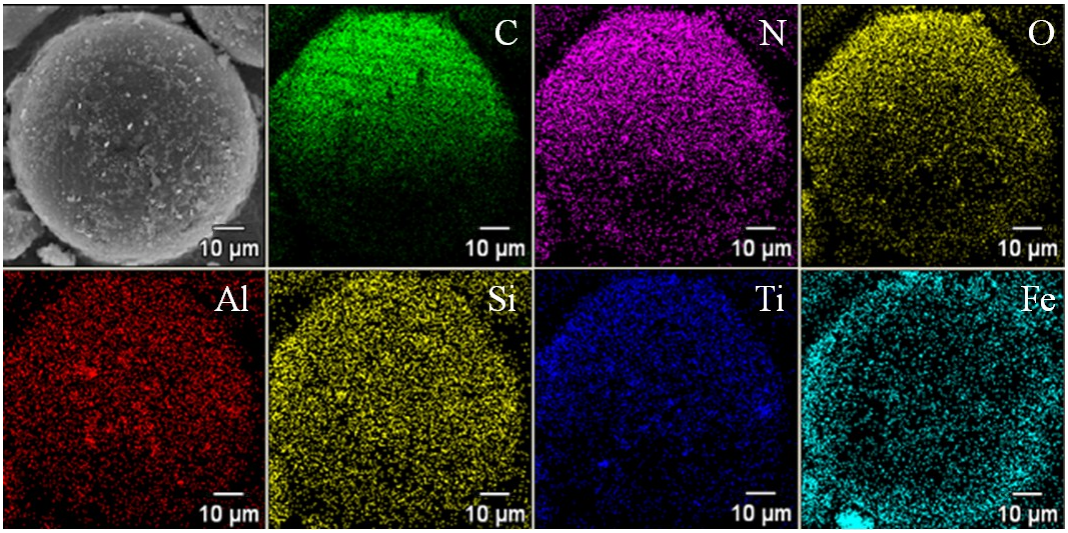

Fig. S7. Element mapping images of magnetic functional heterojunction reactor.

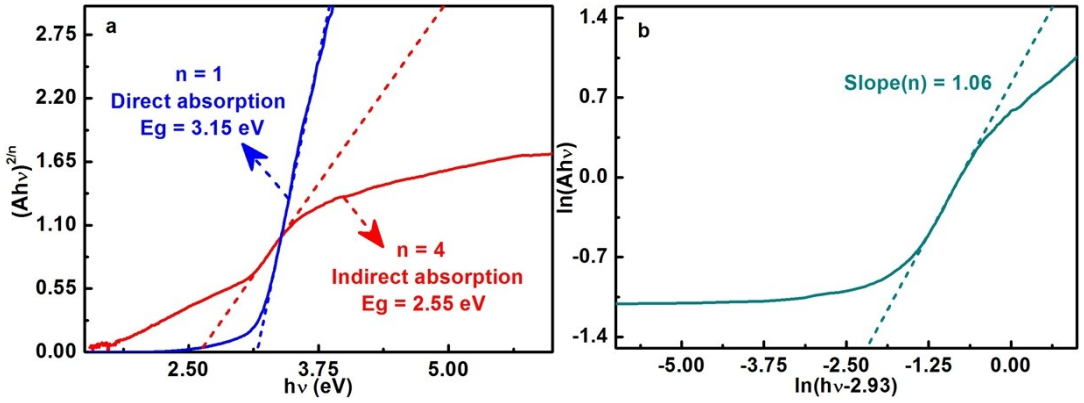

Fig. S8. The plots of $(Ahν)^{2/n}$ versus hν (a) and ln(Ahν) versus ln(hν-2.93) (b) of TiO_2.

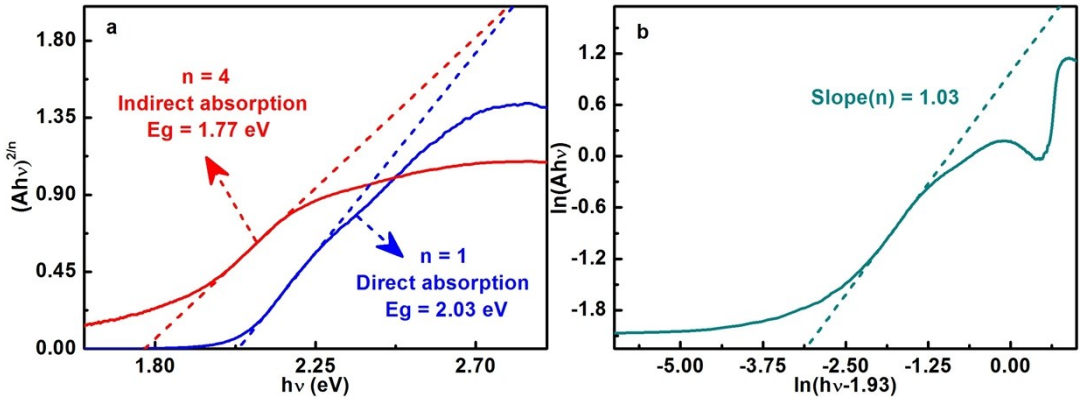

Fig. S9. The plots of $(Ahν)^{2/n}$ versus hν (a) and ln(Ahν) versus ln(hν-1.93) (b) of POPD.

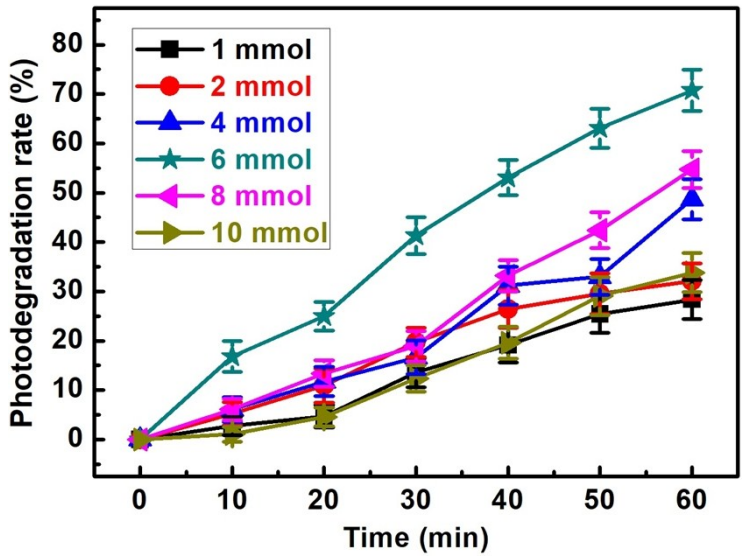

Fig. S10. Influence of different molar mass of OPD on photocatalytic activity.

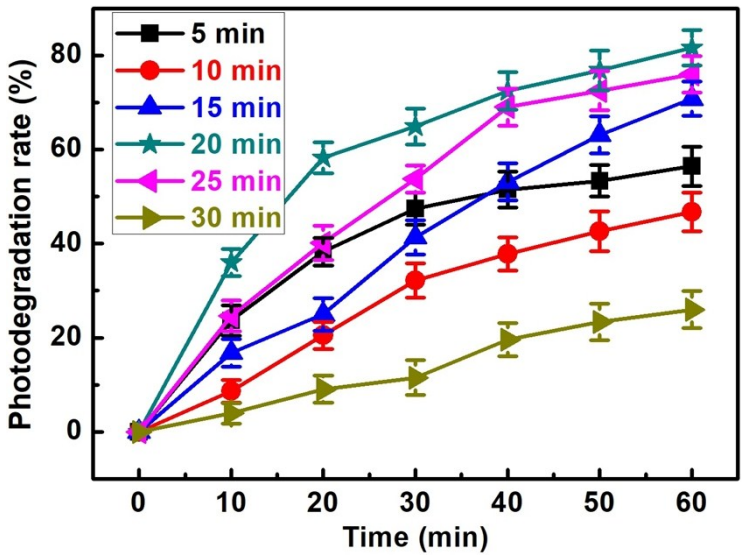

Fig. S11. Influence of different visible light induced polymerization times on photocatalytic activity.

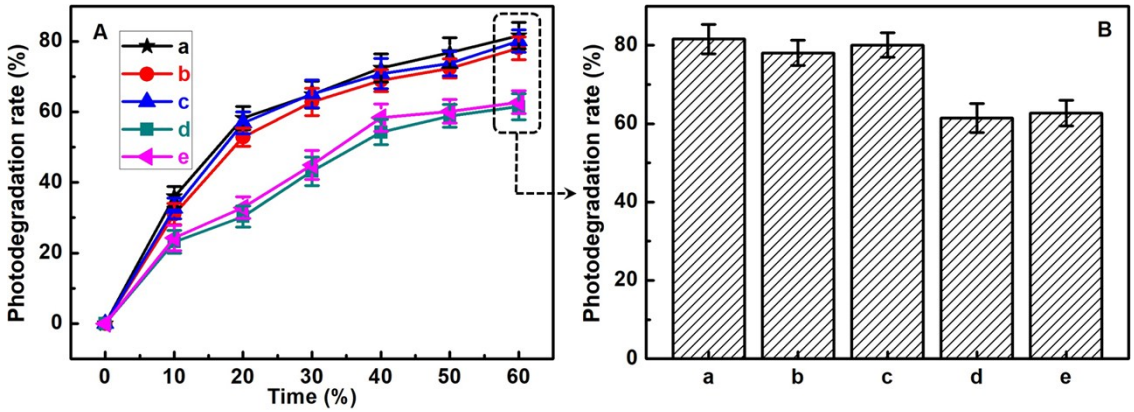

Fig. S12. Photodegradation rates (A) and photodegradation rates at 1 h (B) for danofloxacin mesylate under a 250 W xenon lamp of different photocatalysts (a. magnetic functional heterojunction reactor, b. magnetic functional heterojunction reactor without FAC, c. functional heterojunction reactor without SiO_2@Fe_3O_4/FAC, d. TiO_2/SiO_2 and e. TiO_2).

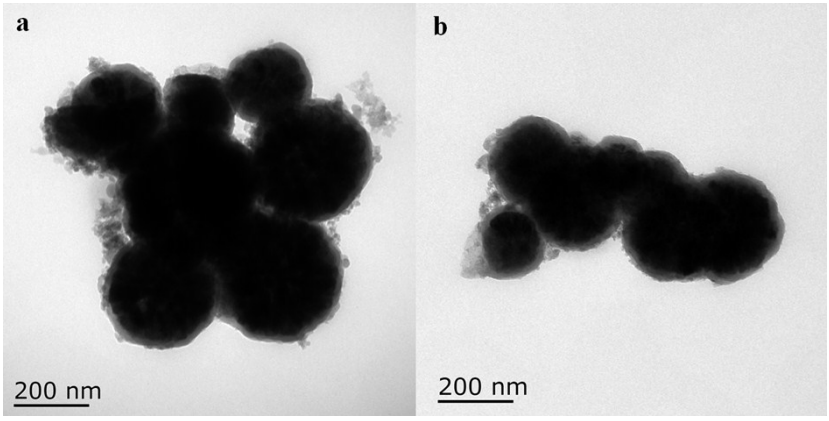

Fig. S13. TEM images of magnetic functional heterojunction reactor without FAC (a) and functional heterojunction reactor without SiO_2@Fe_3O_4/FAC (b).

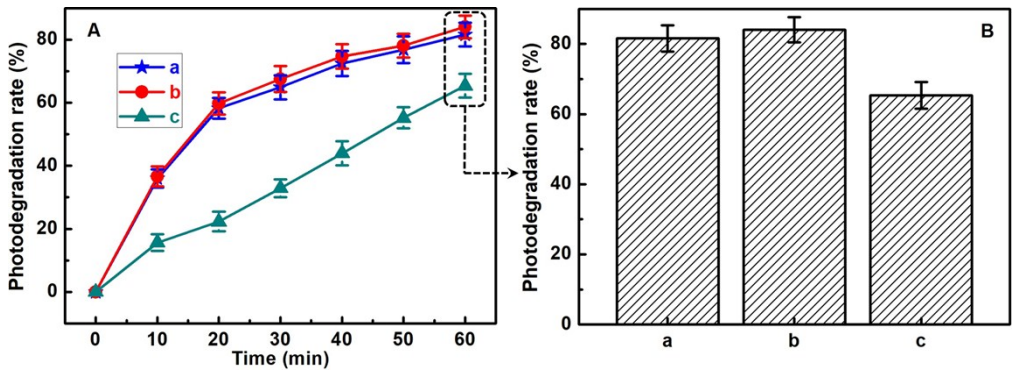

Fig. S14. Photodegradation rates (A) and photodegradation rates at 1 h (B) for danofloxacin mesylate under a 250 W xenon lamp of different photocatalysts (a. magnetic functional heterojunction reactor, b. functional heterojunction reactor without Fe_3O_4 and c. magnetic functional heterojunction reactor without SiO_2).

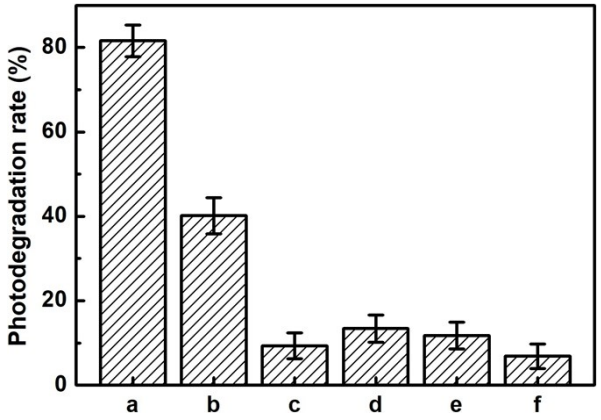

Fig. S15. Photodegradation rates for danofloxacin mesylate at 1 h under a 250 W xenon lamp with different wavelengths (a. full wavelength, b. < 400 nm, c. 400 nm - 500 nm, d. 500 nm - 600 nm, e. 600 nm - 700 nm and f. > 700 nm) of magnetic functional heterojunction reactor.

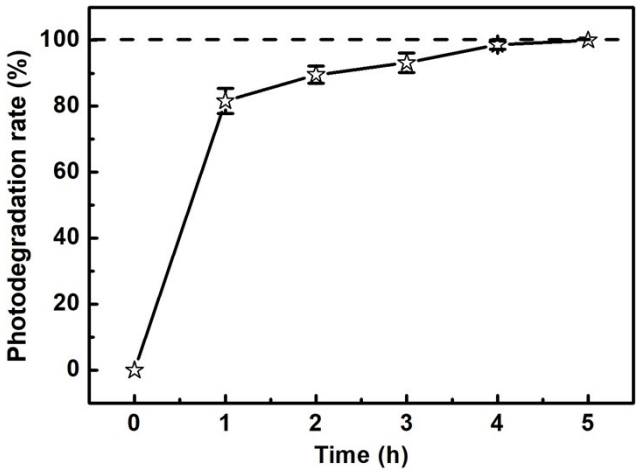

Fig. S16. Photodegradation rates for danofloxacin mesylate under a 250 W xenon lamp of magnetic functional heterojunction reactor.

Table S2. Comparison of photocatalytic activity of different TiO_2 photocatalysts.

Samples (dosage)	Pollutants (concentration)	Reaction time	Photodegradation rate (%)	References
Magnetic functional heterojunction reactor (1 g/L)	Danofloxacin mesylate (20 mg/L)	60 min	81.60	This work
TiO_{2-x}/rGO (1 g/L)	Bisphenol A (20 mg/L)	60 min	64.00	S1
TiO_2/$NiTiO_3$ (1 g/L)	Tetracycline（20 mg/L）	120 min	58.00	S2
Au-TiO_2 (0.75 g/L)	Tetracycline (10 mg/L)	120 min	73.00	S3
TiO_2/zeolite (2 g/L)	Amoxicillin (30 mg/L)	240 min	88.00	S4
RGO-TiO_2 (0.5 g/L)	Carbamazepine (10 mg/L)	90 min	51.00	S5
Fe-N-TiO_2/FAC-chitosan (4 g/L)	Rhodamine B (8 mg/L)	240 min	93.13	S6
TiO_2@g-C_3N_4 (1.33 g/L)	Rhodamine B (16 mg/L)	100 min	93.30	S7
g-C_3N_4/N-TiO_2/FAC (4 g/L)	Methyl orange (20 mg/L)	180 min	71.50	S8
Ag_2O/TiO_2 (1 g/L)	Methyl orange (20 mg/L)	80 min	73.00	S9
TiO_2/chitosan@Fe_3O_4/FAC (1.67 g/L)	Enrofloxacin hydrochloride (20 mg/L)	60 min	75.32	S10
TiO_2/g-C_3N_4 (1.6 g/L)	Methylene blue (10 mg/L)	150 min	84.00	S11
TiO_2/Na-g-C_3N_4 (2 g/L)	Methylene blue（20 mg/L）	60 min	90.00	S12

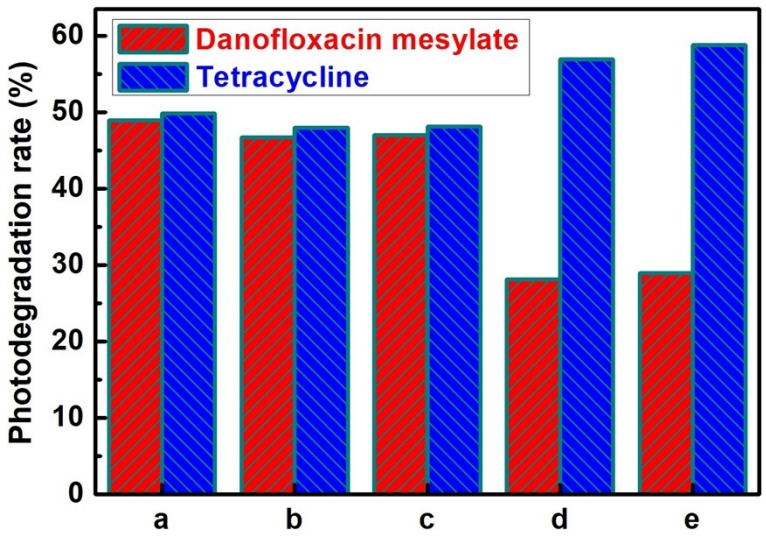

Fig. S17. Photodegradation rates for the binary antibiotic solution under a 250 W xenon lamp at 1 h with different photocatalysts (a. magnetic functional heterojunction reactor, b. magnetic functional heterojunction reactor without FAC, c. functional heterojunction reactor without SiO_2@Fe_3O_4/FAC, d. TiO_2/SiO_2 and e. TiO_2).

Table S3. The pollutant selectivity coefficient ($k_{selectivity}$) and the material selectivity coefficient ($k'_{selectivity}$) of degradation of the binary antibiotic solution with different samples under a 250 W xenon lamp of 1 h.

Samples	Antibiotics	Photodegradation rate (%)	$k_{selectivity}$ (imprinted)	$k_{selectivity}$ (others)	$k'_{selectivity}$
Magnetic functional heterojunction reactor	Danofloxacin mesylate	48.96	0.98	—	—
	Tetracycline	49.90			
Magnetic functional heterojunction reactor without FAC	Danofloxacin mesylate	46.73	—	0.97	1.01
	Tetracycline	47.99			
Functional heterojunction reactor without SiO_2@Fe_3O_4/FAC	Danofloxacin mesylate	47.05	—	0.98	1.00
	Tetracycline	48.13			
TiO_2/SiO_2	Danofloxacin mesylate	28.19	—	0.50	1.96
	Tetracycline	56.93			
TiO_2	Danofloxacin mesylate	28.97	—	0.49	2.00
	Tetracycline	58.84			

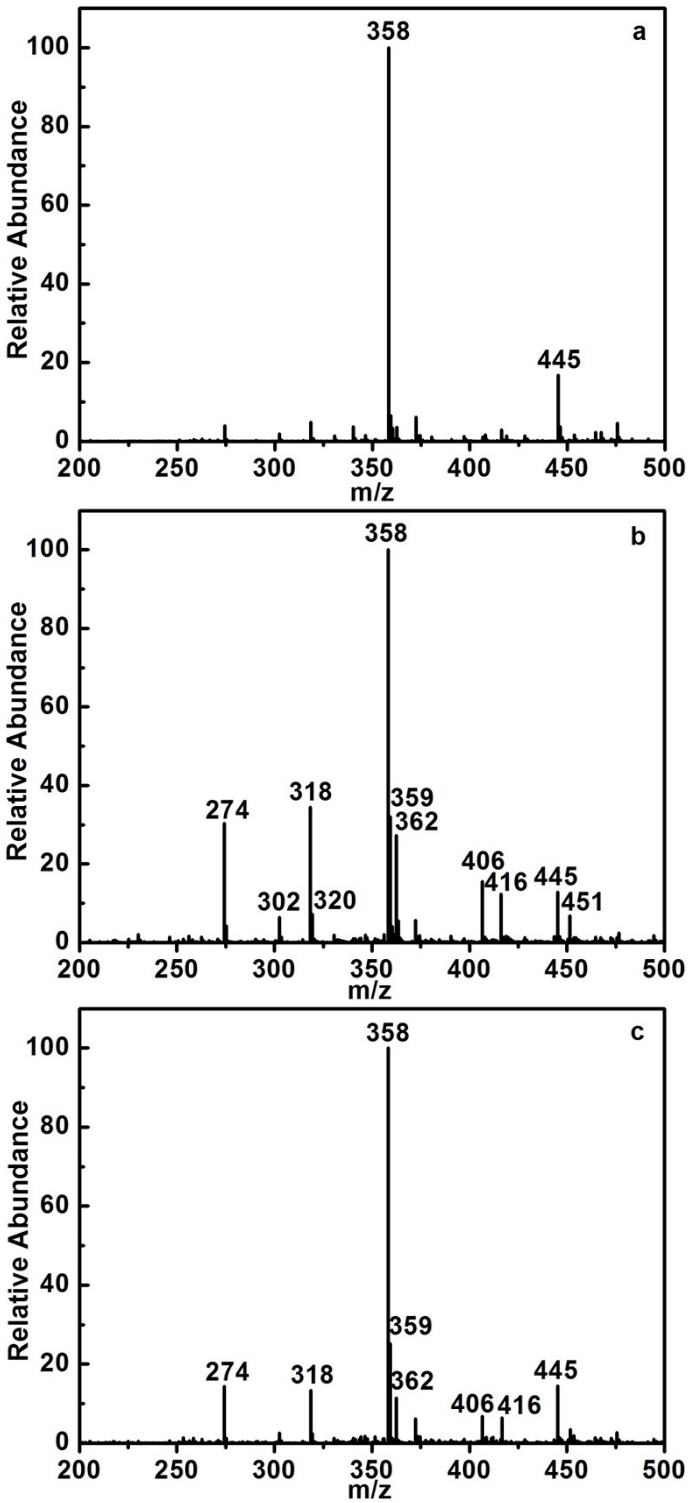

Fig. S18. m/z of degraded the binary antibiotic solution with magnetic functional heterojunction reactor (a. the initial binary antibiotic solution, b. degradation of the binary antibiotic solution in 30 min, c. degradation of the binary antibiotic solution in 60 min).

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