Supplementary Information

Atomically dispersed copper catalysts with dual reaction sites and high mass transfer efficiency for highly-efficient Fenton-like degradation

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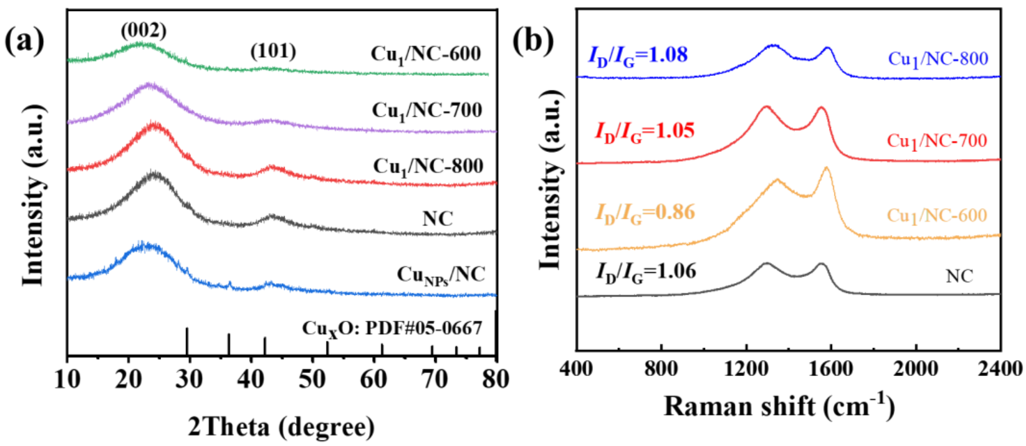

Fig. S1. (a) XRD patterns of Cu_{NPs}/NC, NC, Cu_1/NC-800, Cu_1/NC-600, and Cu_1/NC-700. (b) Raman spectra of Cu_1/NC-600, Cu_1/NC-700, Cu_1/NC-800, and NC.

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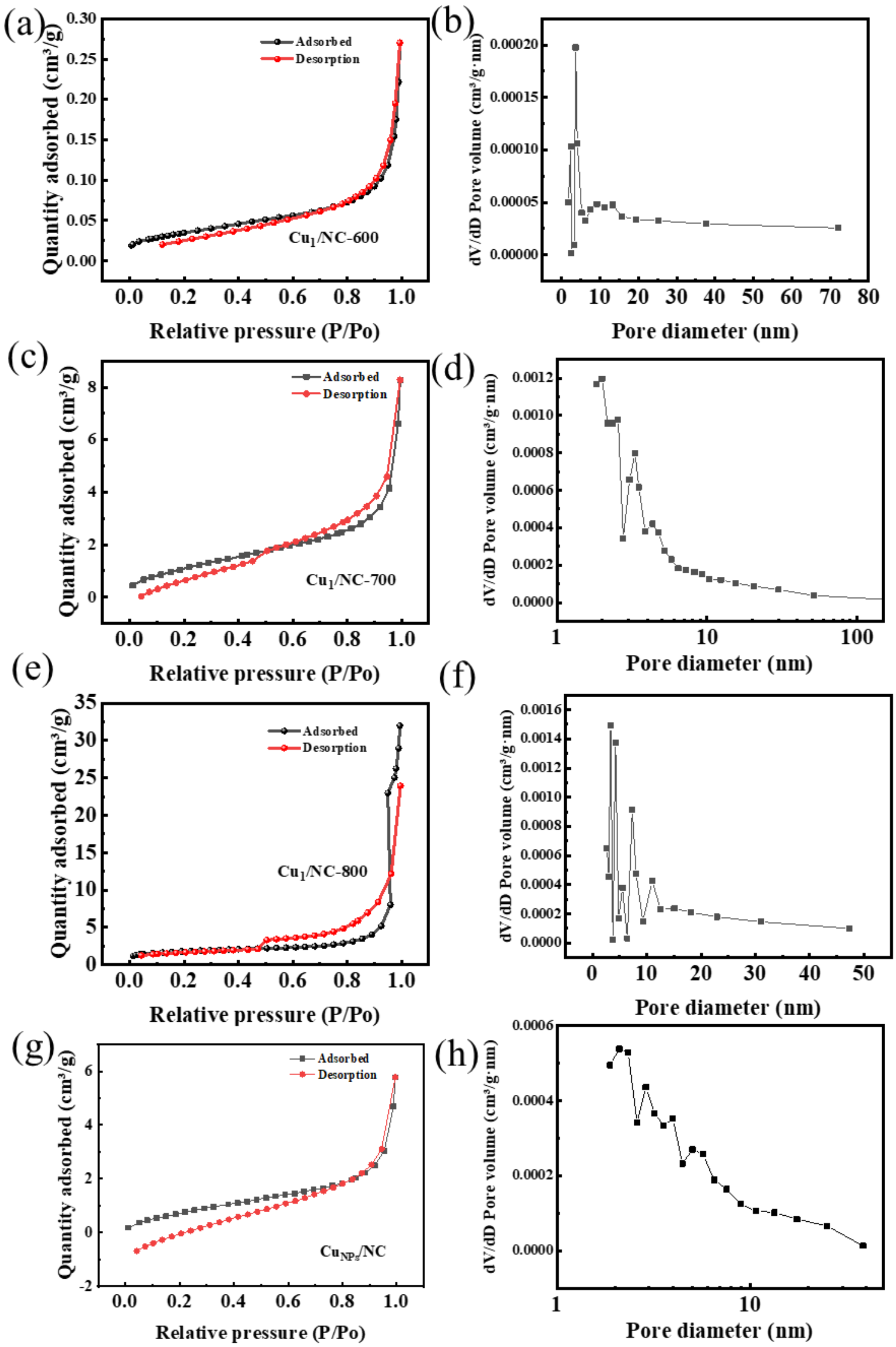

Fig. S2. N_2 adsorption/desorption isotherm curves of (a) Cu_1/NC-600, (c) Cu_1/NC-700, (e) Cu_1/NC-800, and (g) Cu_{NPs}/NC, along with pore sizes distributions of (b) Cu_1/NC-600, (d) Cu_1/NC-700, (f) Cu_1/NC-800, and (h) Cu_{NPs}/NC.

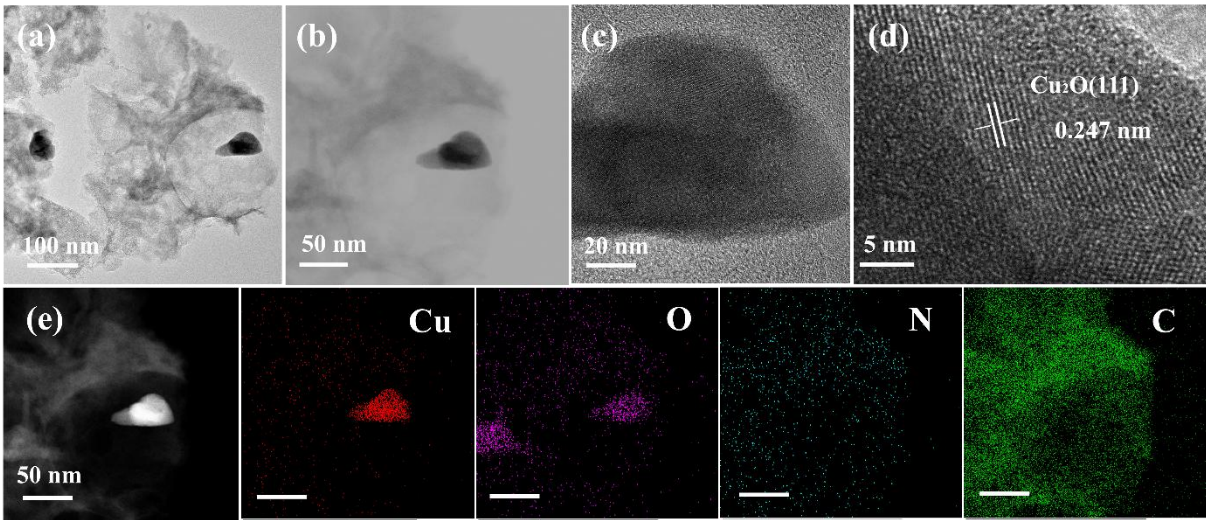

Fig. S3. (a-d) TEM/HRTEM and (e) STEM and elemental mapping images of Cu_{NPs}/NC.

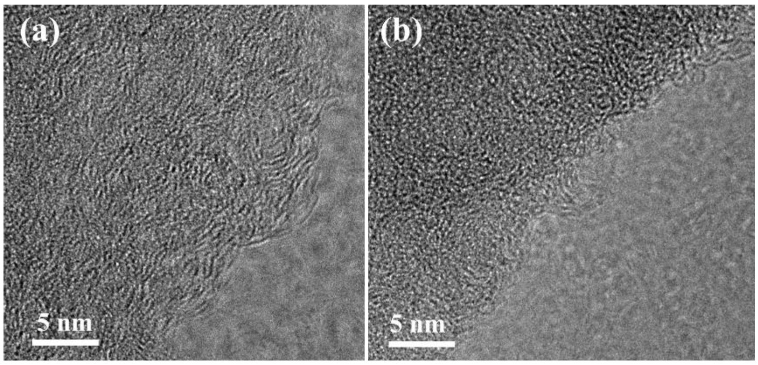

Fig. S4. TEM images of (a) Cu_1/NC-800 and (b) Cu_1/NC-600.

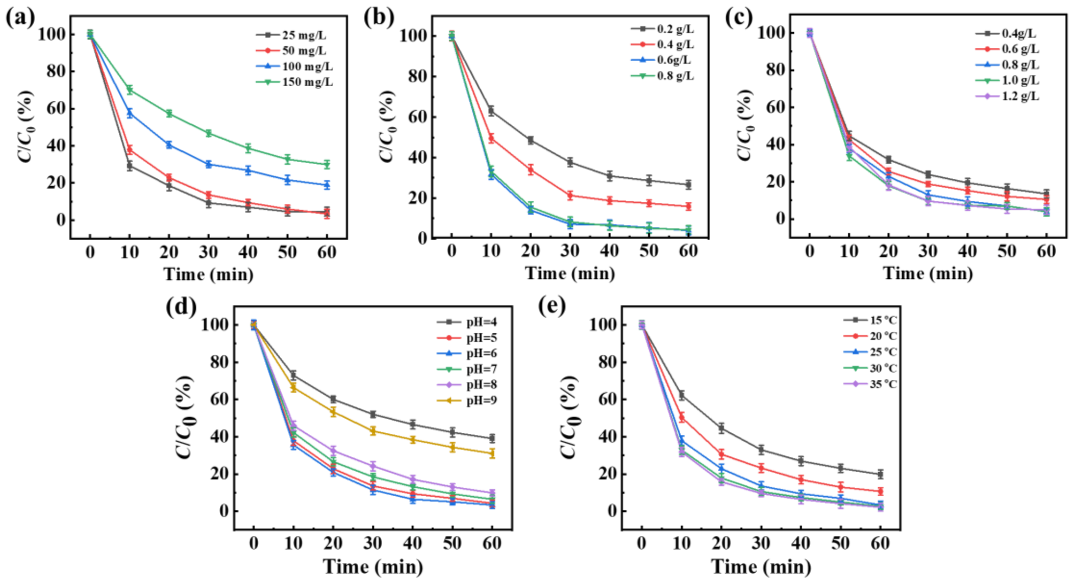

Fig. S5. Influence of different factors (a) substrate concentration, (b) catalyst dosages, (c) PMS concentrations, (d) pH, and (e) temperature on the degradation effect.

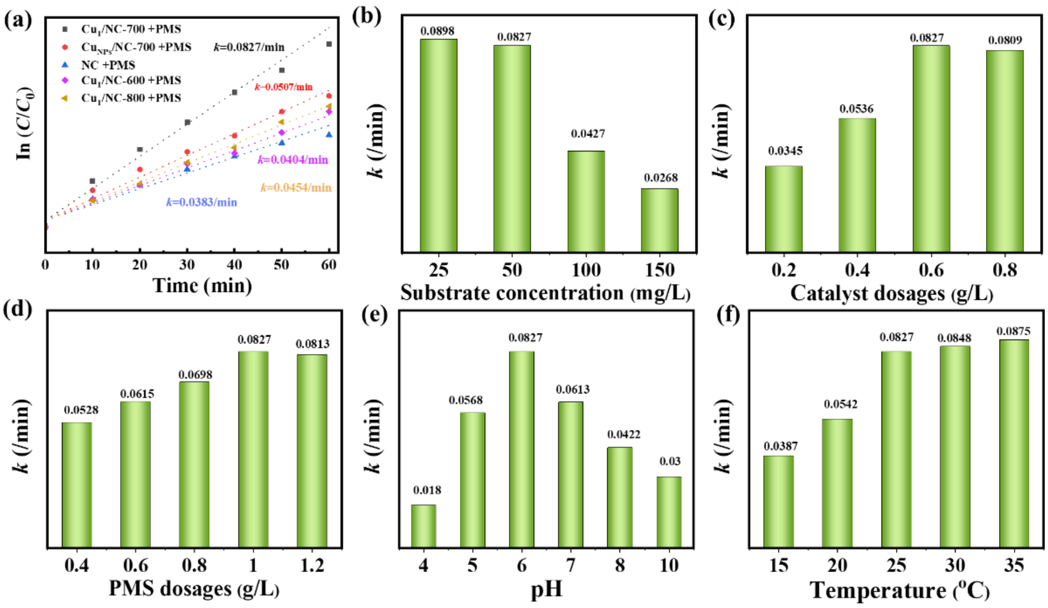

Fig. S6. The k constants corresponding to different factors. (a) Cu_1/NC-600, Cu_1/NC-700, Cu_1/NC-800, and Cu_{NPs}/NC catalyst, (b) substrate concentration, (c) catalyst dosages, (d) PMS concentrations, (e) pH, and (f) temperature.

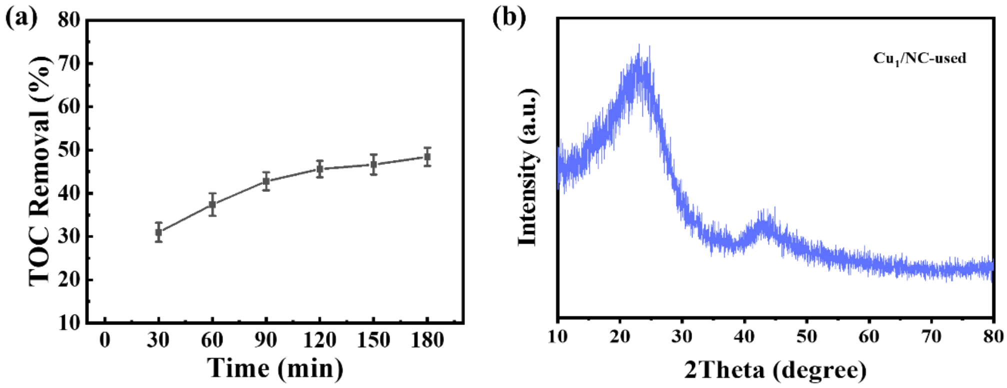

Fig. S7. (a) Removal of TOC for OTC with different reaction times in Cu_1/NC-700+PMS system. (Conditions: 0.6 g/L catalyst, 1.0 g/L PMS, pH=6, 50 mg/L pollutants, and 25℃). (b) XRD pattern of Cu_1/NC-700-used.

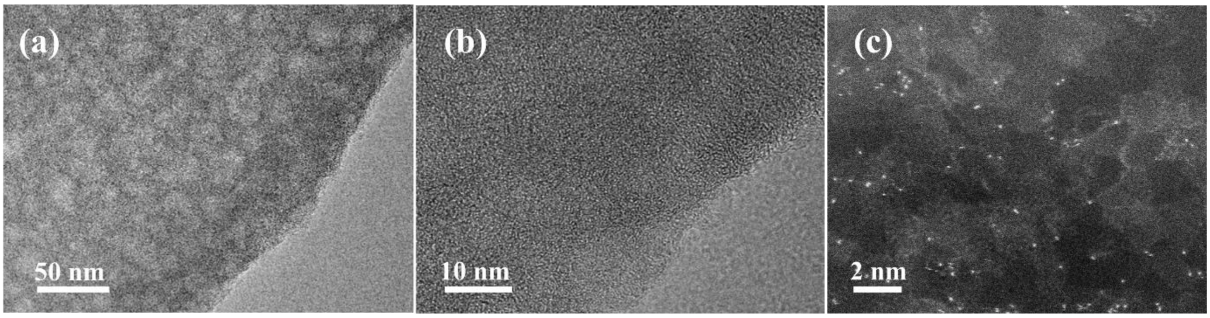

Fig. S8. (a) TEM, (b) STEM, and (c) AC HAADF-STEM images of Cu_1/NC-700-used.

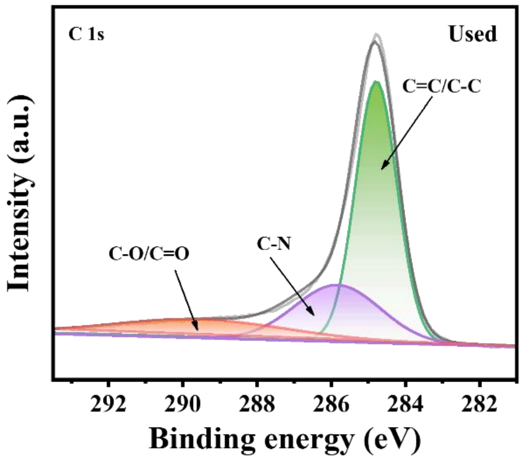

Fig. S9. C 1s XPS spectrum of Cu_1/NC-700-used.

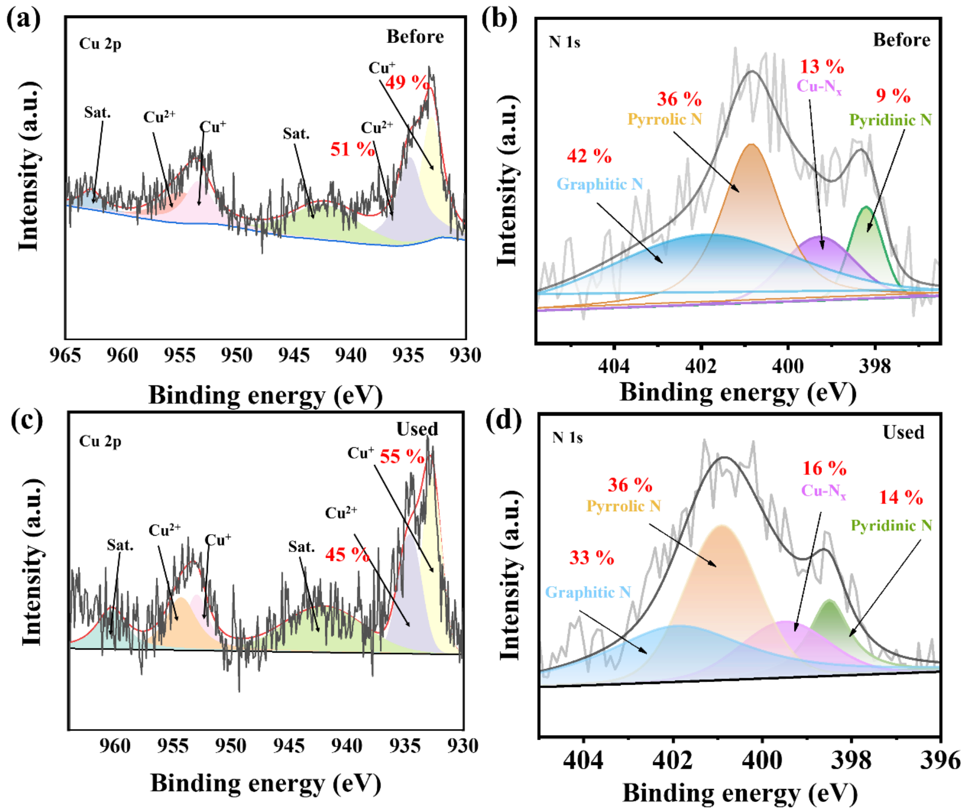

Fig. S10. (a, c) Cu 2p and (b, d) N 1s XPS spectra of Cu_1/NC-700 before and after reaction.

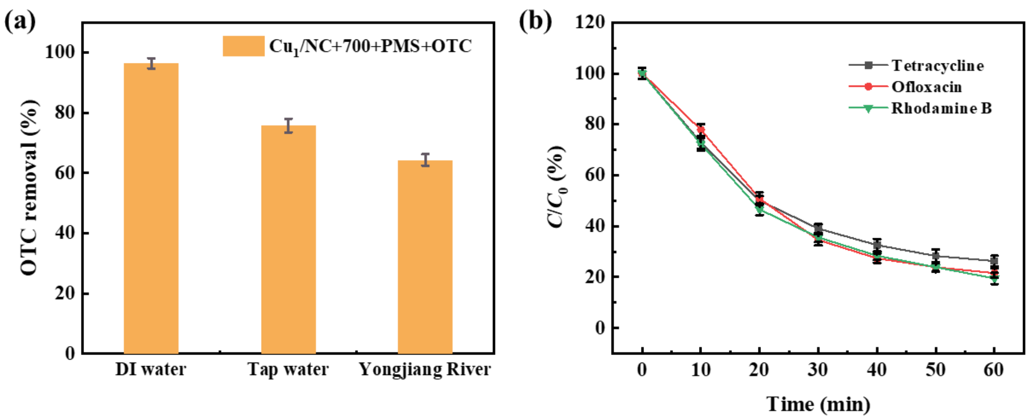

Fig. S11. (a) OTC removal under different water quality. (b) The degradation efficiencies of tetracycline, ofloxacin, and Rhodamine B (initial concentration of 50 mg/L) in the Cu_1/NC-700 + PMS system. (Reaction conditions: 0.6 g/L catalyst, 1.0 g/L PMS, pH=6, 50 mg/L pollutants, and 25℃).

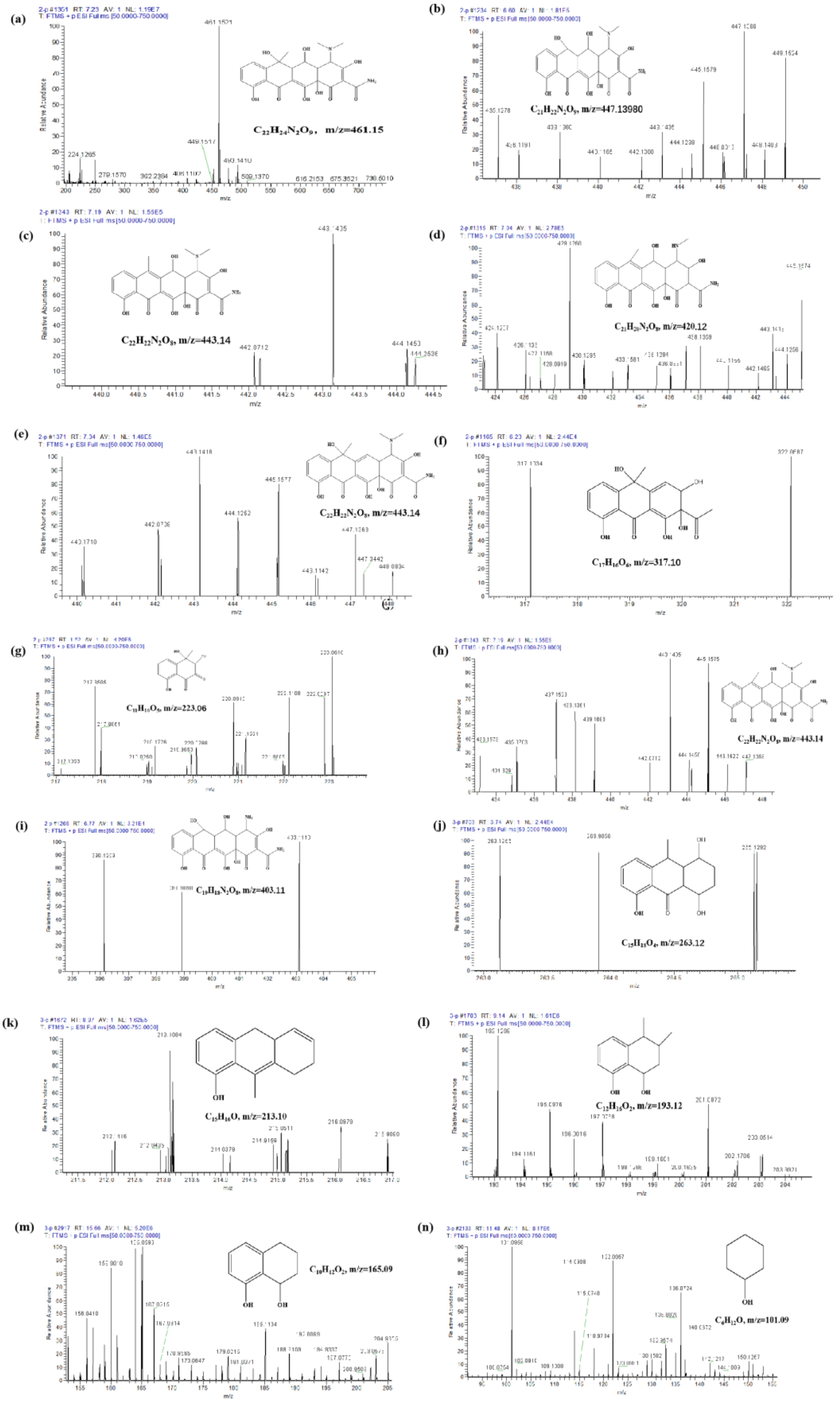

Fig. S12. ESI mass spectra of OTC degradation intermediates detected by HPLC-MS.

Reaction time: (a) 0 min, (b-h) 5 min, and (i-n) 20 min.

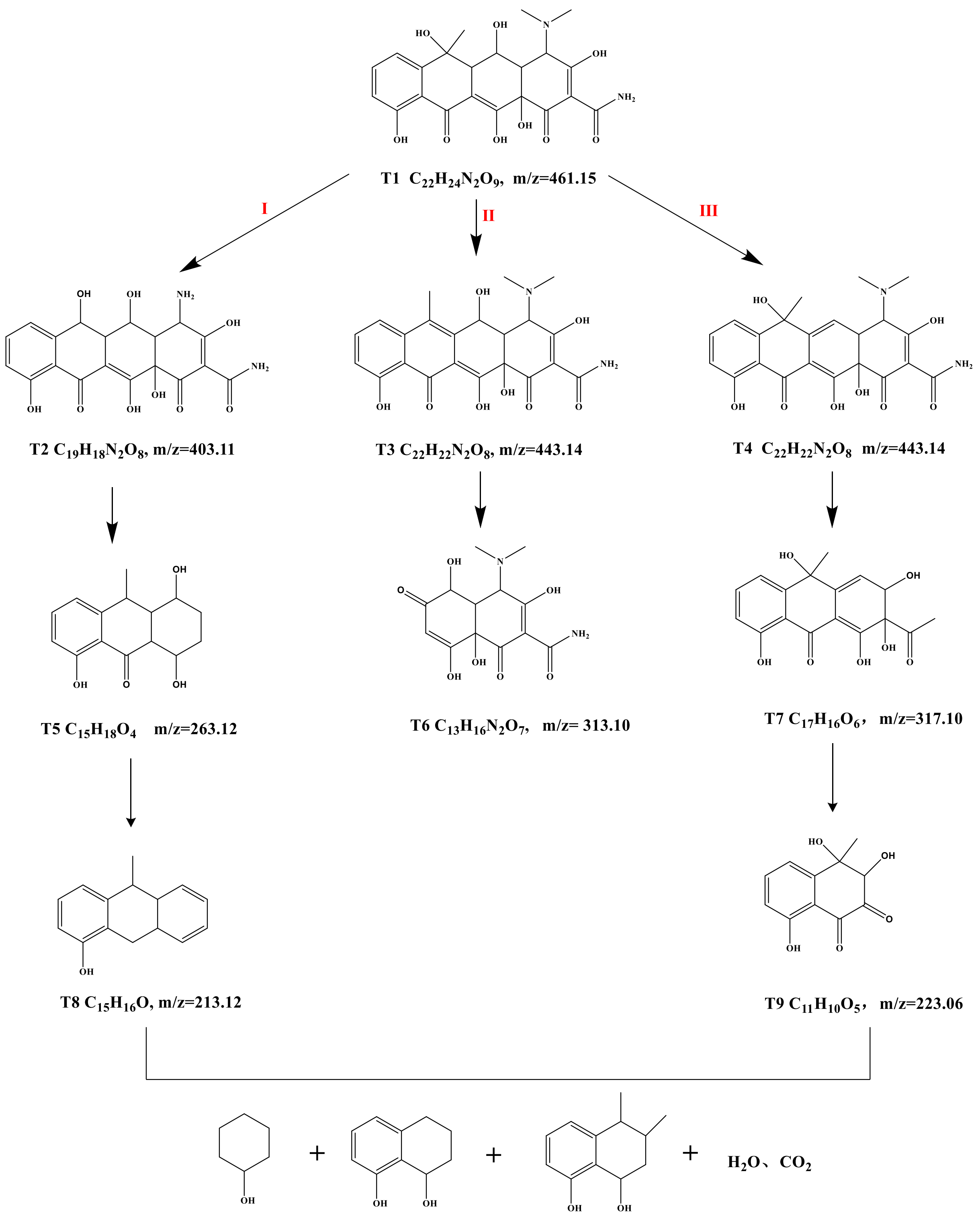

Fig. S13. Possible degradation pathways of OTC over Cu1/NC-700.

Table S1. Cu loadings, specific surface areas, average pore sizes, pore volumes, and compositional information of the Cu_1/NC-600, Cu_1/NC-700, Cu_1/NC-800, Cu_1/NC-700-used, and Cu_{NPs}/NC.

Catalysts	Cu loading[a] (wt%)	C content[b] (%)	N content[b] (%)	S_{BET}[c] (m^2/g)	Average pore size (nm)
Cu_1/NC-700	2.7	85.3	8.7	4	10.7
Cu_1/NC-600	3.1	82.6	10.2	3	2.7
Cu_1/NC-800	2.4	90.4	5.2	7	4.5
Cu_{NPs}/NC	12.0	87.2	7.4	1	9.4
Cu_1/NC-700-used	2.6	85.2	8.4	4	10.8

[a]Obtained from ICP-OES. [b]Obtained from EA. [c]Obtained from BET.

Table S2. Catalytic performance comparison of recently reported catalysts for PMS activation.

Catalyst (g/L)	**Pollutant (mg/L)**	**Oxidant (PMS)**	**Removal efficiency (%)**	**Reaction time (min)**	**Ref.**
Fe-N-C (0.1)	Bisphenol A (10)	0.5 mmol/L	96	60	(Xu et al., 2020)
BC300-MoS_2-1 0.05	Tetracycline (20)	1 mmol/L	79	60	(Su et al., 2022)
FeNC (0.5)	Tetracycline (5)	0.1 mmol/L	100	90	(Hui et al., 2021)
Co-N-S-PC 700 0.066	Phenol (20)	6.5 mmol/L	99	60	(Tian et al., 2018)
SA-Cu/rGO (0.1)	SMX(10)	0.4 g/L	99.9	60	(Chen et al., 2020)
Cu_1/NC-700 (0.6)	OTC(50)	1.0 g/L	96.6	60	This work

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