

Electronic supplementary information (ESI)

Construction of direct Z-scheme CeO₂/UiO-66-NH₂ heterojunction with boosting photocatalytic organic pollutants degradation and H₂ evolution performance

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Characterization

The powder X-ray diffraction (PXRD) pattern was recorded on the Bruker D8 Advance X-ray diffractometer (Cu K α , $\lambda = 1.54056$ nm), in the range between 10° and 80° with a scanning rate of 5° min⁻¹ at 40 kV accelerating voltage and 40 mA current. Fourier transformed infrared spectroscopy (FT-IR) in the wavelength range of 4000 ~ 400 cm⁻¹ (KBr tablet) was performed by Nicolet 6700 spectrometer. The morphology and structure of CeO₂ monomer, UiO-66-NH₂ and CU_{0.50} were observed with a scanning electron microscope (Zeiss GeminiSEM 300) under the acceleration voltage of 15 kV. The transmission electron microscope (TEM) images were measured using JEOL JEM-2100F microscope at 200 kV. X-ray photoelectron spectroscopy (XPS) measurements were performed on a Thermo Fisher ESCALAB XI+ spectrometer and using Mg K α radiation as the nonmonochromatized source ($h\nu=1253.6$ eV). The electronic binding energy (BE) of the elements was corrected based on C1s (284.6 eV). Optical properties were analyzed by using UV–vis diffuse reflectance spectra (DRS, Shimadzu UV 2600) and wavelengths ranging from 200 nm to 800 nm. The photoelectrochemical properties of all prepared materials were tested using a CHI 660E electrochemical workstation (Chenhua Company). The electron spin resonance (ESR) spectrum was measured by using a Bruker EPR A 300-10/12 spectrometer to tracing the activated species. The total organic carbon (TOC) removal of TC was determined on a total organic carbon analyzer (Shimadu TOC-L CPN).

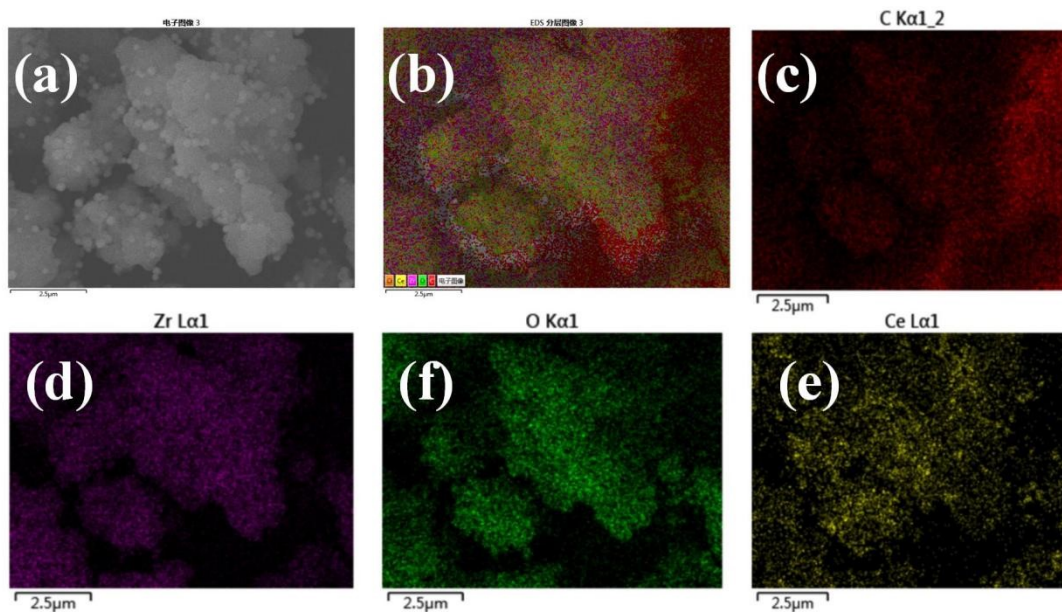


Figure S1 C, O, Zr, and Ce EDX mapping of CU_{0.50}.

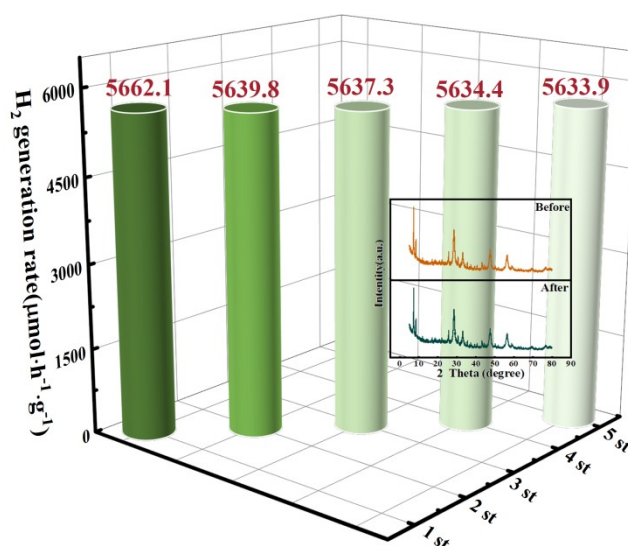


Figure S2 Stability test of CeO₂/Uio-66-NH₂ for photocatalytic degradation activity; the inset shows the XRD contrast image.

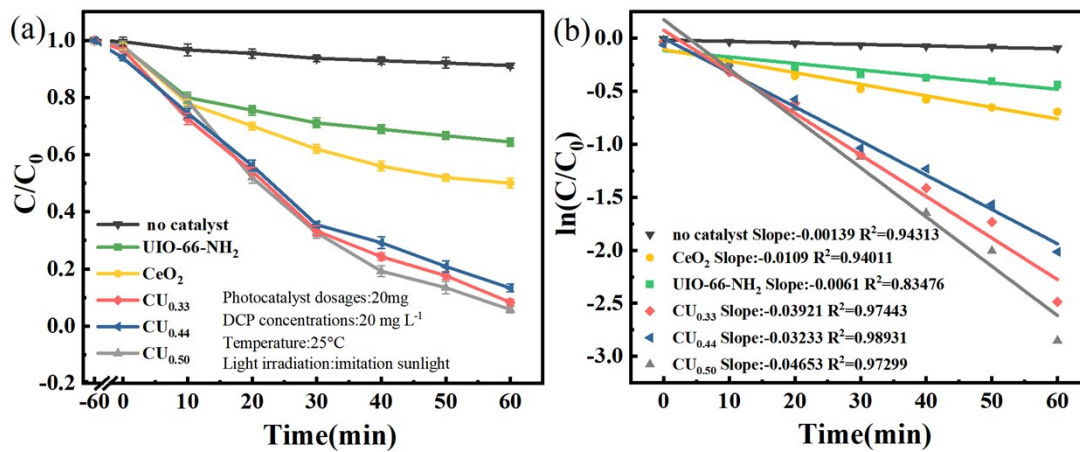


Figure S3 (a) Photocatalytic degradation of DCP over different materials; (b) pseudo-first-order kinetics curves of the photocatalytic degradation over different materials.

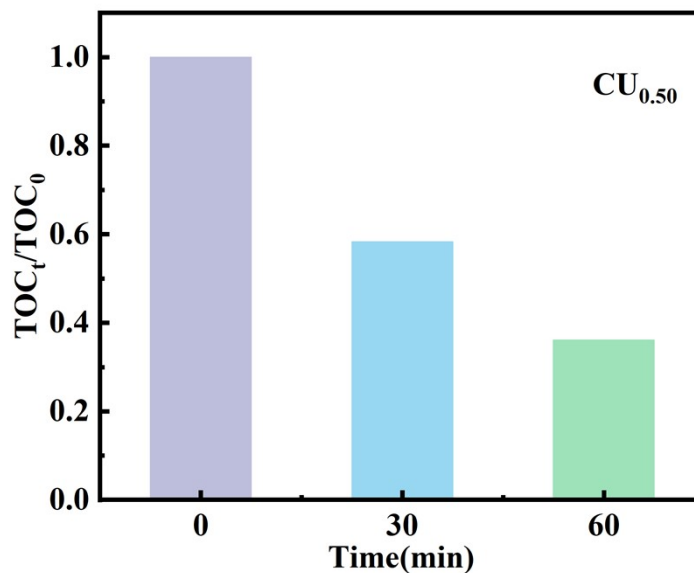


Figure S4 TOC removal of TC over CU_{0.50} under sunlight illumination.

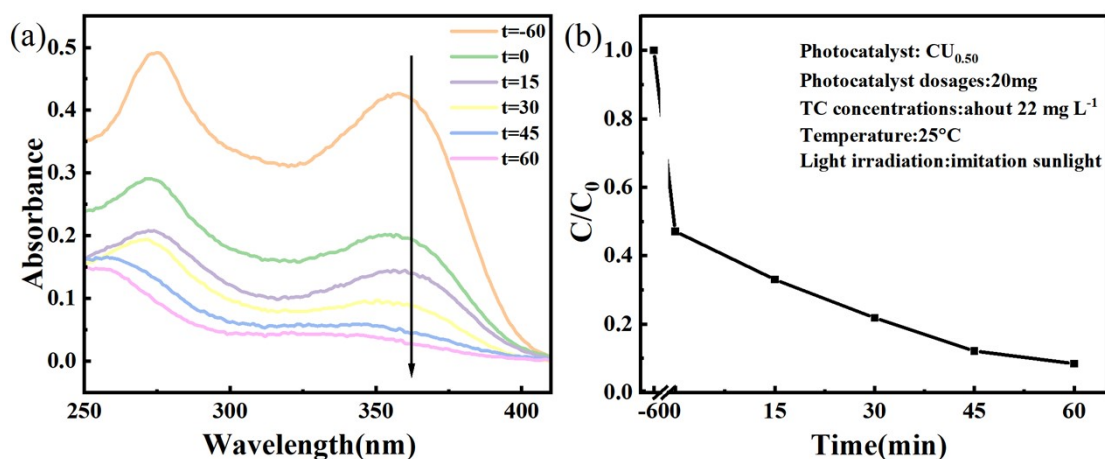


Figure S5 (a) UV-Vis spectra for tetracycline sewage degraded by $\text{CU}_{0.50}$ under sunlight illumination; (b) The actual degradation diagram of $\text{CU}_{0.50}$ in sewage sample containing tetracycline.

Table S1 Comparison of the TC degradation capacity of $\text{CeO}_2/\text{UiO}-66\text{-NH}_2$ with other photocatalysts.

Catalyst/mg	V(mL)/C ₀ (mg·L ⁻¹)	Light source ($\lambda > 420\text{nm}$)	Time (min)	Result (%)	TOF	Ref.
$\text{CeO}_2/\text{UiO}-66\text{-NH}_2/20$	50/20	500 W Xe lamp	60	91.5	0.000765	This work
$\text{BiVO}_4/\text{g}-\text{C}_3\text{N}_4/50$	100/10	250 W Xe lamp	60	72.3	0.000241	[1]
$\text{Ag}_3\text{PO}_4/\text{MMO}/50$	50/40	500 W Xe lamp	90	96.0	0.000427	[2]
$\alpha\text{-Fe}_2\text{O}_3/\text{g}-\text{C}_3\text{N}_4/20$	50/20	500 W Xe lamp	80	99.1	0.000619	[3]

TOF is calculated according to an equation:

$$TOF = \frac{C_{-60} \times V_{TC} \times \text{Degradation rate}}{m_{\text{catalyst}} \times t}$$

Table S3 Comparison of the photocatalytic H_2 evolution rates over different photocatalysts.

Photocatalysts	Irrigation	Sacrificial agents	Activity $\mu\text{mol} \cdot \text{g}^{-1}\text{h}^{-1}$	Ref.
$\text{CeO}_2/\text{UiO}-66\text{-NH}_2$	Visible light	Na_2SO_3 and Na_2S	5662.1	This work
$\text{CeO}_2/\text{g}-\text{C}_3\text{N}_4-6$	Visible light	Na_2SO_3 and Na_2S	1240.9	[4]
$\text{N}-\text{ZnO}/\text{g}-\text{C}_3\text{N}_4$	Visible light	methanol	152.7	[5]
$\text{SnO}_2/\text{g}-\text{C}_3\text{N}_4$	Light ($\lambda \geq 320\text{nm}$)	methanol	1254	[6]
$\text{U6N}-\text{NiO}-2$	Visible light	TEOA	2561.32	[7]

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