Electronic Supporting Information for

High-efficiency visible-light-driven oxidation of primary C−H bonds in toluene over $CsPbBr_3$ perovskite supported by hierarchical TiO_2 nanoflakes

Jiayu Yi,[a] Sunzai Ke,[a] Suwei Lu,[a] Bo Weng,[b] Lijuan Shen,[a] Xuhui Yang,[a] Hun Xue,[a] Min-Quan Yang*[a] and Qingrong Qian*[a]

[a] College of Environmental and Resource Sciences, College of Carbon Neutral Modern Industry, Fujian Key Laboratory of Pollution Control & Resource Reuse, Fujian Normal University, Fuzhou 350117, P. R. China

[b] cMACS, Department of Microbial and Molecular Systems, KU Leuven, Celestijnenlaan 200F, 3001 Leuven, Belgium

To whom correspondence should be addressed

E-mail: yangmq@fjnu.edu.cn; qrqian@fjnu.edu.cn

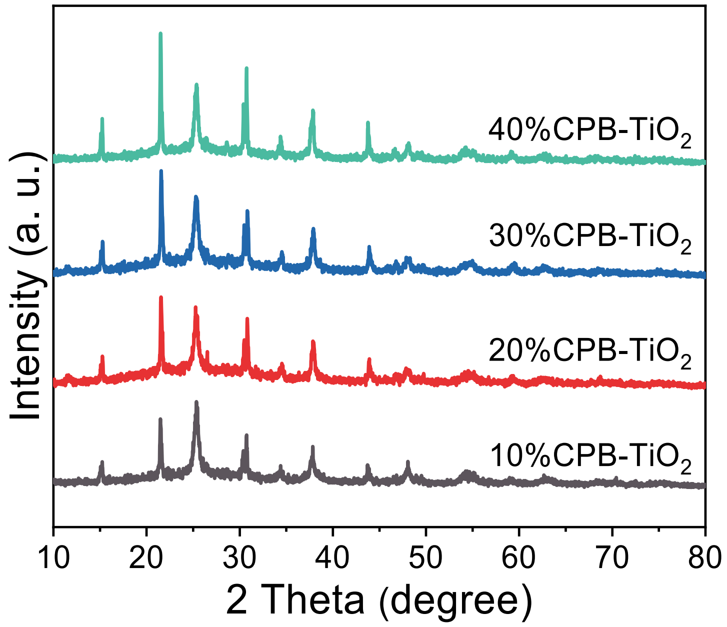

Figure S1. XRD patterns of CPB/TiO_2 composites with different weight contents of $CsPbBr_3$.

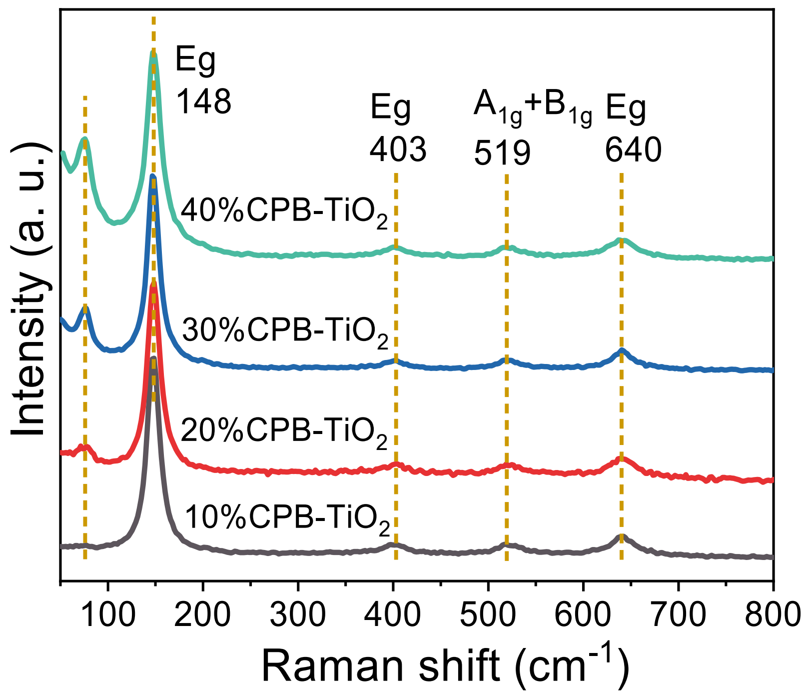

Figure S2. Raman spectra of CPB/TiO_2 composites with different weight contents of $CsPbBr_3$.

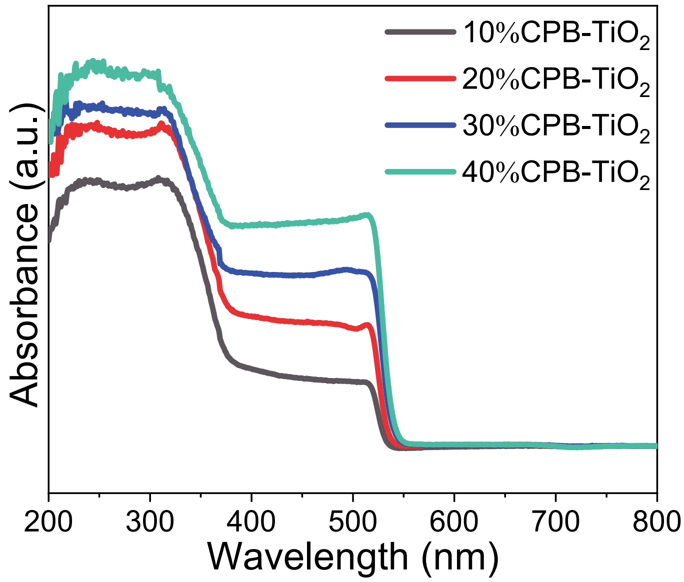

Figure S3. UV-vis diffused reflectance spectra of CPB/TiO_2 composites with different weight contents of $CsPbBr_3$.

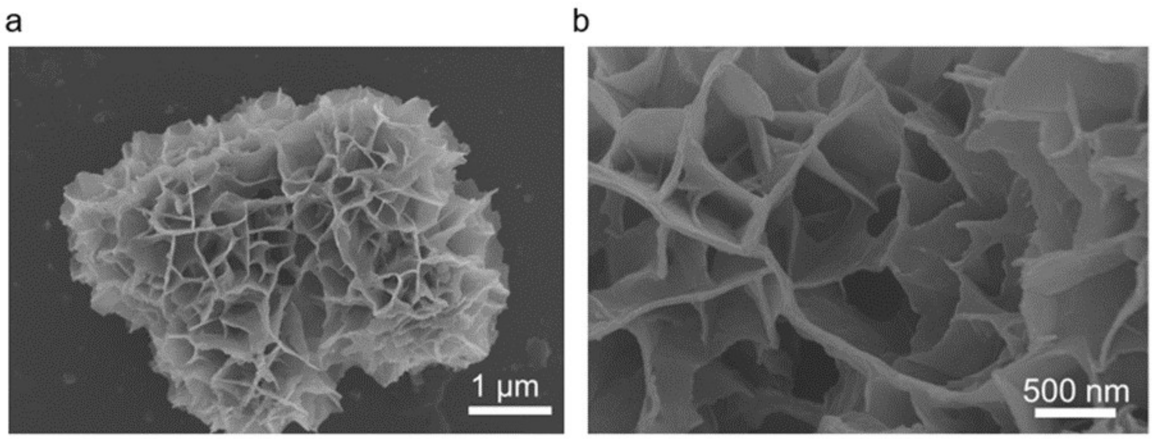

Figure S4. SEM images of blank TiO_2.

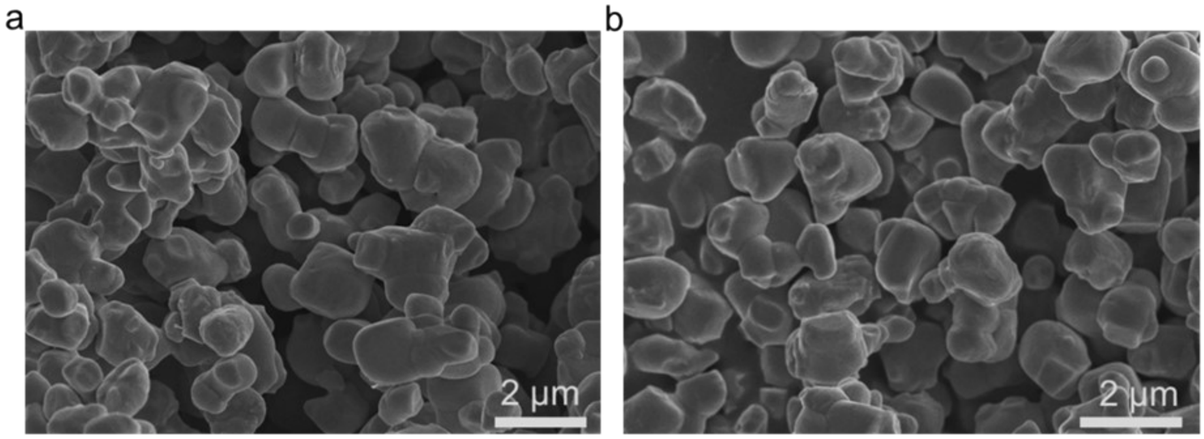

Figure S5. SEM images of blank $CsPbBr_3$.

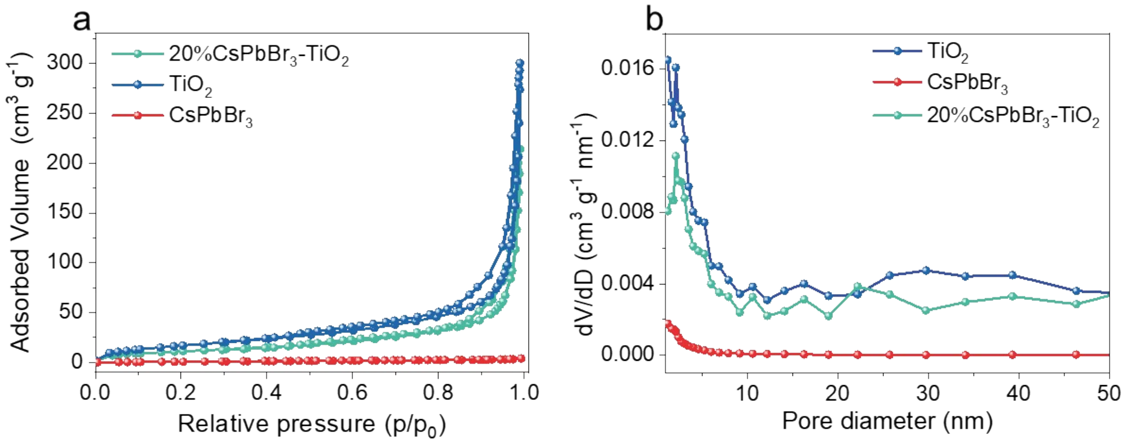

Figure S6. N_2 adsorption-desorption isotherms and the corresponding pore size distributions of blank TiO_2, $CsPbBr_3$ and 20% CPB/TiO_2 composite.

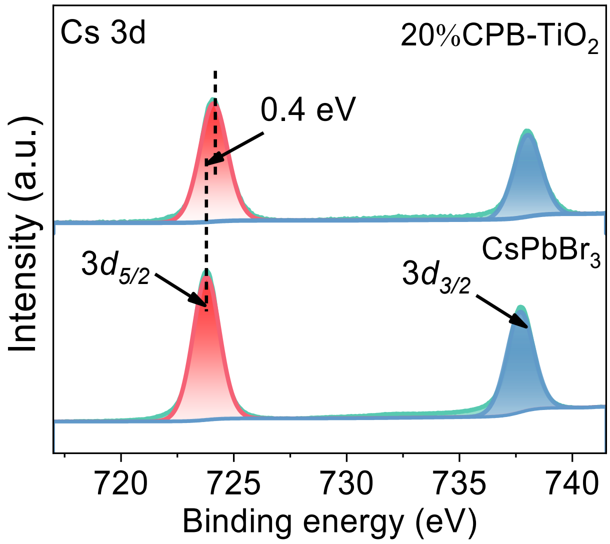

Figure S7. Cs 3d XPS spectra of $CsPbBr_3$ and 20%CPB/TiO_2.

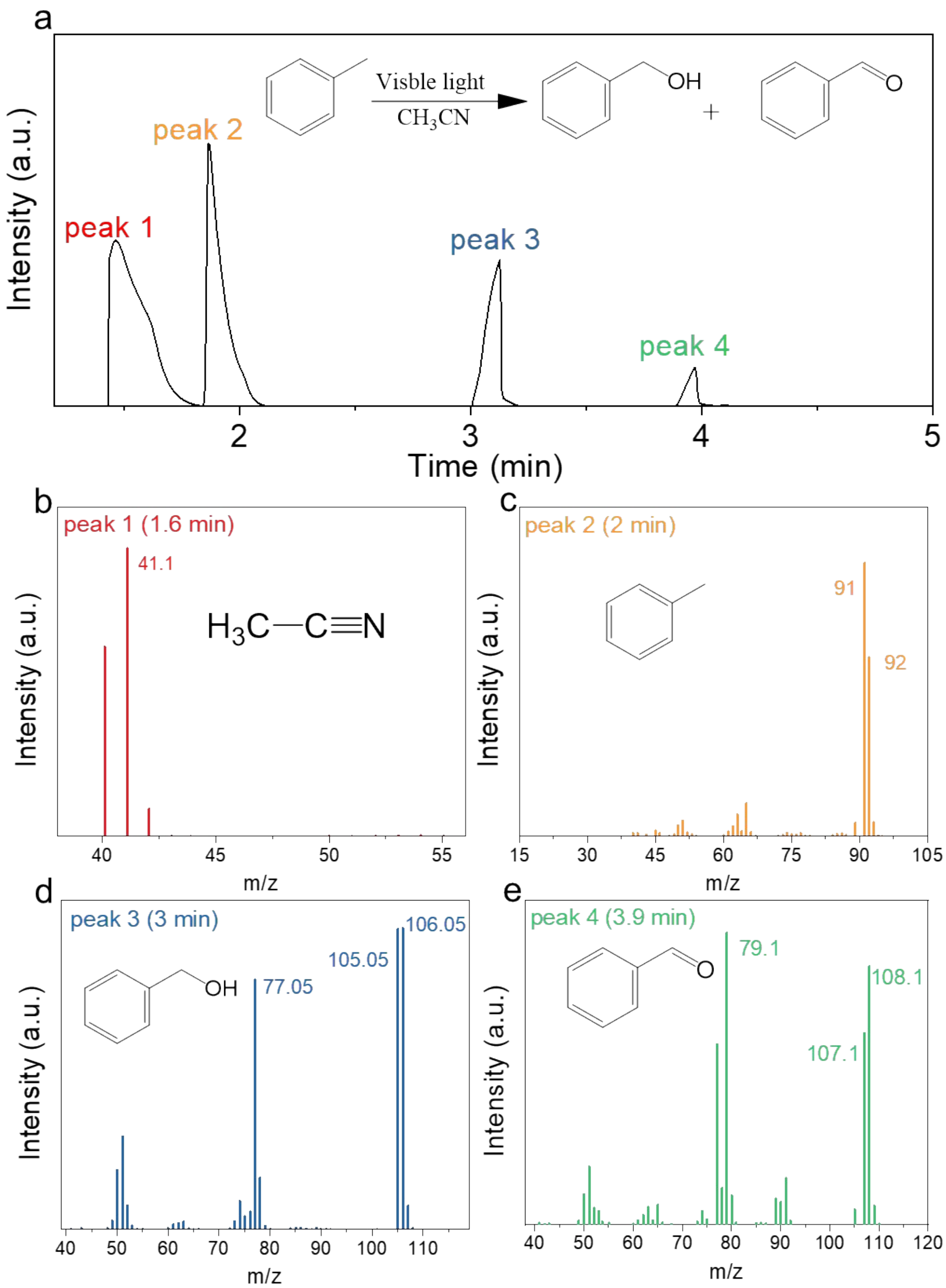

Figure S8. GC-MS spectra of the reaction solution after photocatalytic experiment. Conditions: 1 ml toluene, 10 mg 20%CPB/TiO_2, 2 mL CH_3CN, $\lambda > 420$ nm.

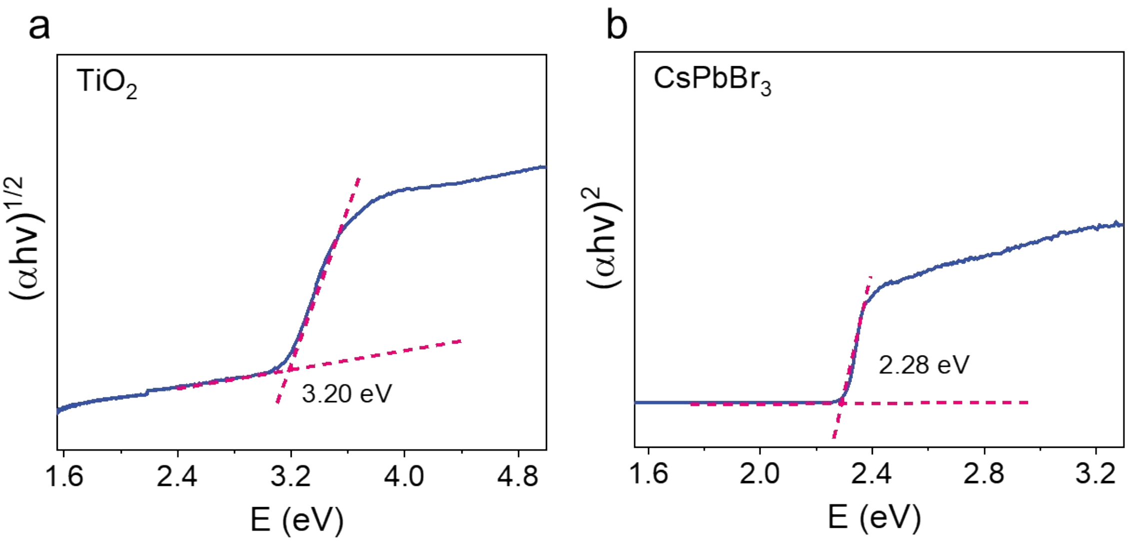

Figure S9. Band-gap values of (a) TiO_2 and (b) $CsPbBr_3$.

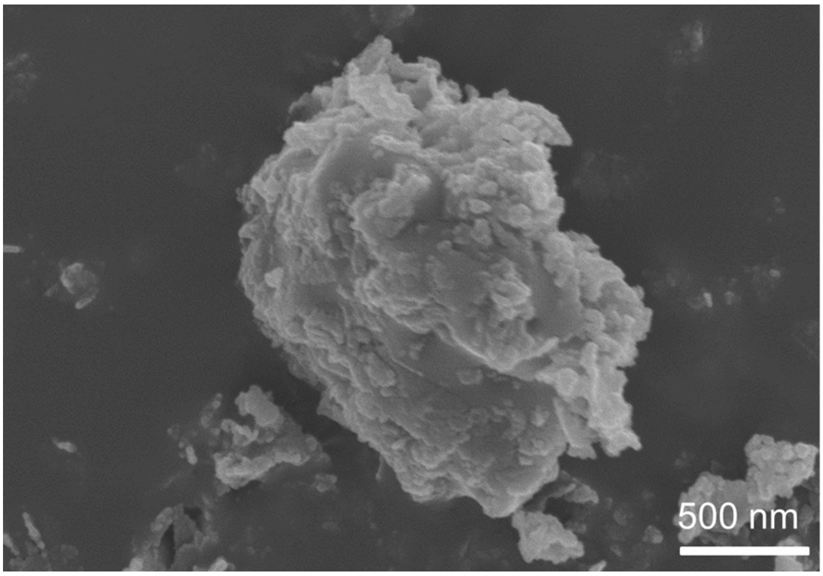

Figure S10. SEM image of collapsed TiO_2 without hierarchical structure.

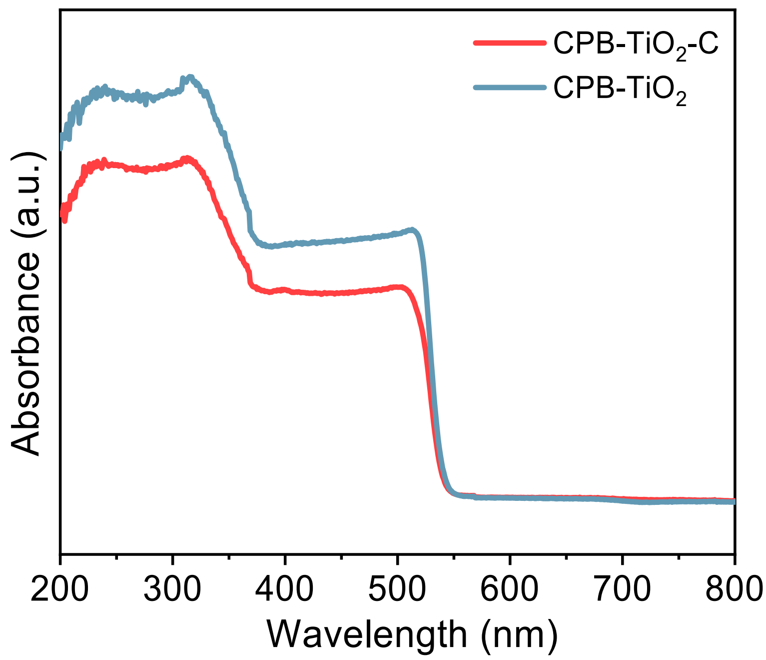

Figure S11. UV-vis diffused reflectance spectra of CPB/TiO_2 and CPB/TiO_2-C.

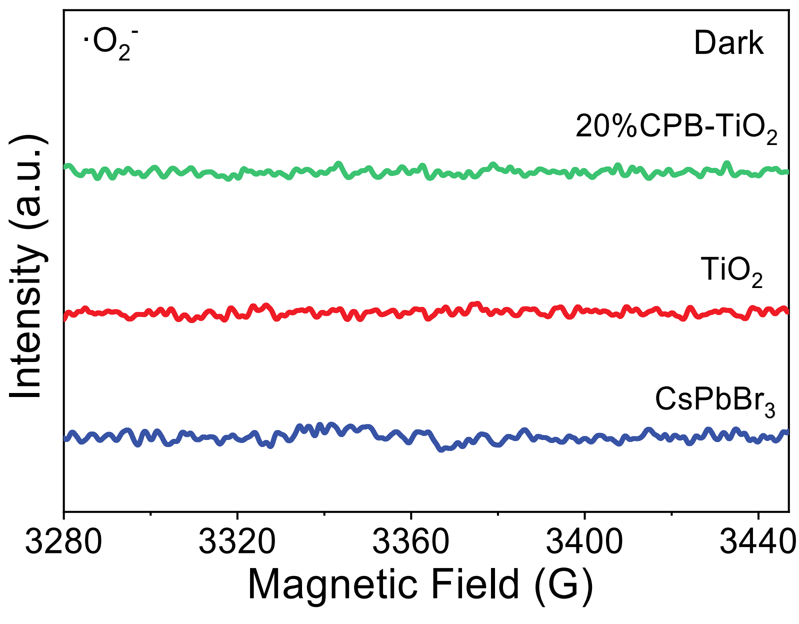

Figure S12. EPR spectra of DMPO-•O_2^-without light.

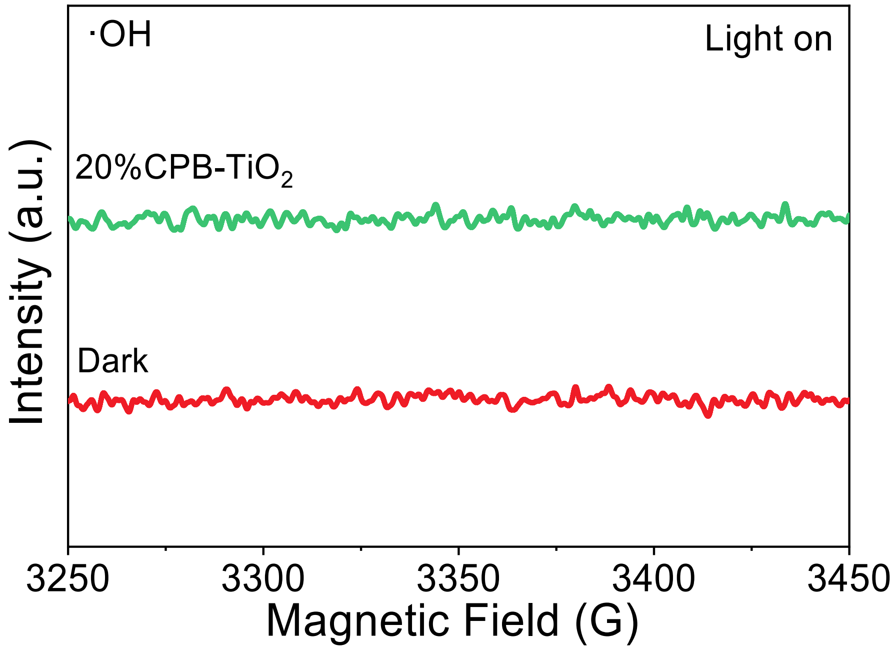

Figure S13. EPR spectra of DMPO-•OH for 20%CPB/TiO_2 in the presence of light and without light.

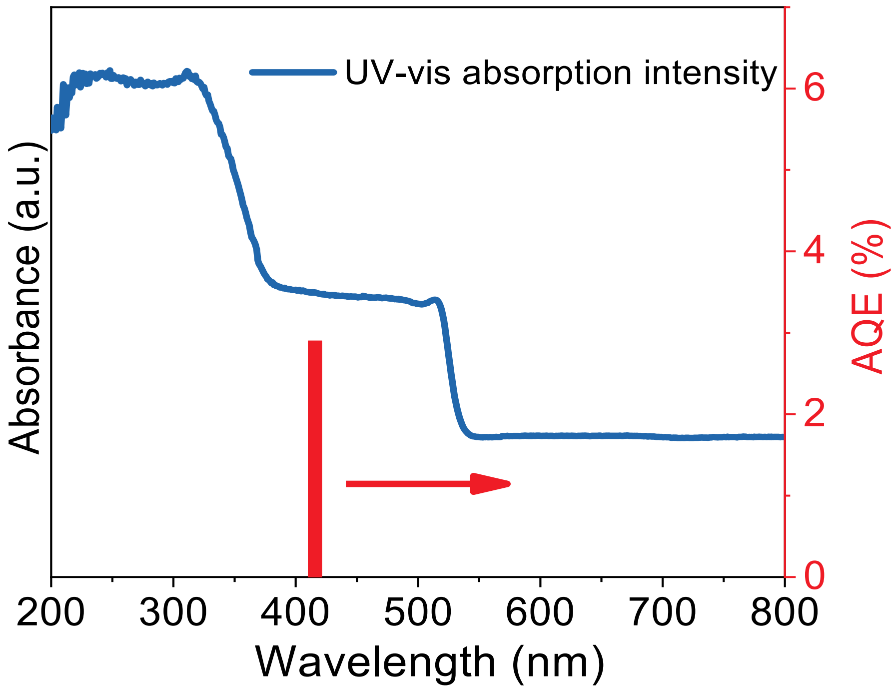

Figure S14. The apparent quantum efficiency measured at 420 ± 5 nm of 20%$CsPbBr_3$/TiO_2 composite.

Note: The number of incident photons (*N*) is calculated by equation 1. The corresponding AQE is calculated to be 2.9% according to equation 2.

$$N = \frac{E\lambda}{hc} = \frac{I \times A \times t \times \lambda}{h \times c} \qquad \text{(Equation 1)}$$

$$AQE = \frac{Number\ of\ transformed\ toluene}{Number\ of\ incident\ photos} = \frac{M \times N_A}{N} \qquad \text{(Equation 2)}$$

Where I is the light intensity (420.38 W m^{-2}), A is the irradiation area of catalyst solution (1.77 × 10^{-4} m^2.), t is light incident time (2 h), λ is the wavenumber of indecent light, h is Planck constant, c is lightspeed, M represents the amount of transformed toluene (54.4 μmol), N_A represents Avogadro's constant.

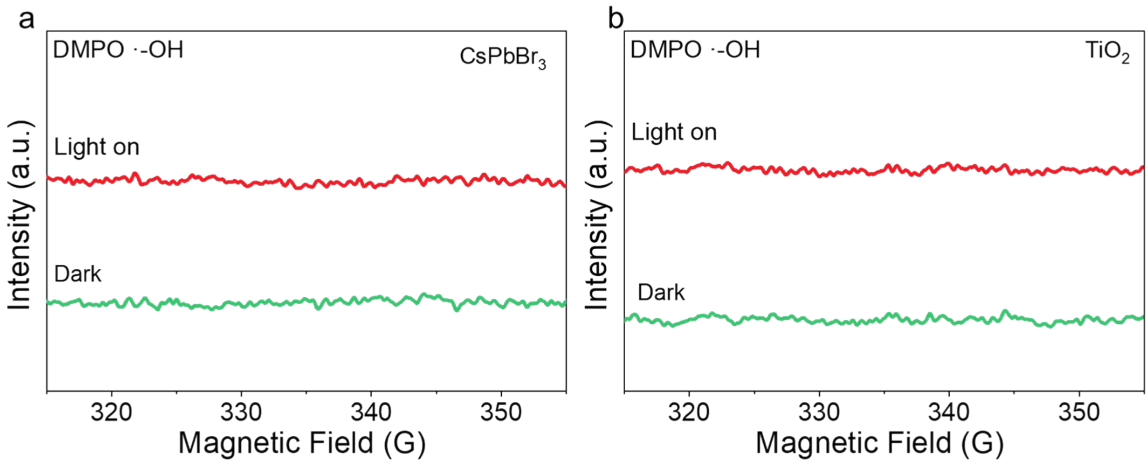

Figure S15. EPR spectra of DMPO-•OH for (a) $CsPbBr_3$ and (b) TiO_2 in the presence of light and without light.

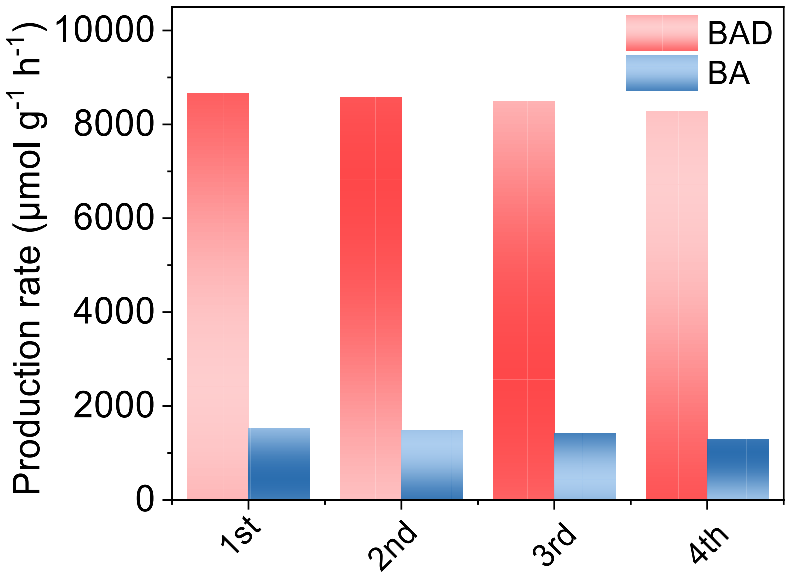

Figure S16. Cycle test of the 20%$CsPbBr_3/TiO_2$ under visible light.

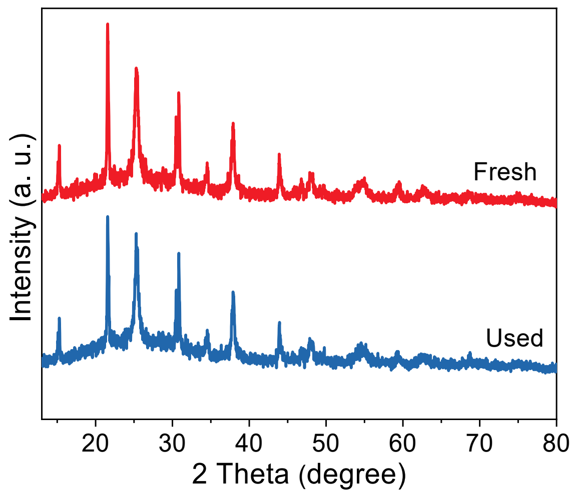

Figure S17. XRD patterns of the used and fresh 20%$CsPbBr_3/TiO_2$ composite..

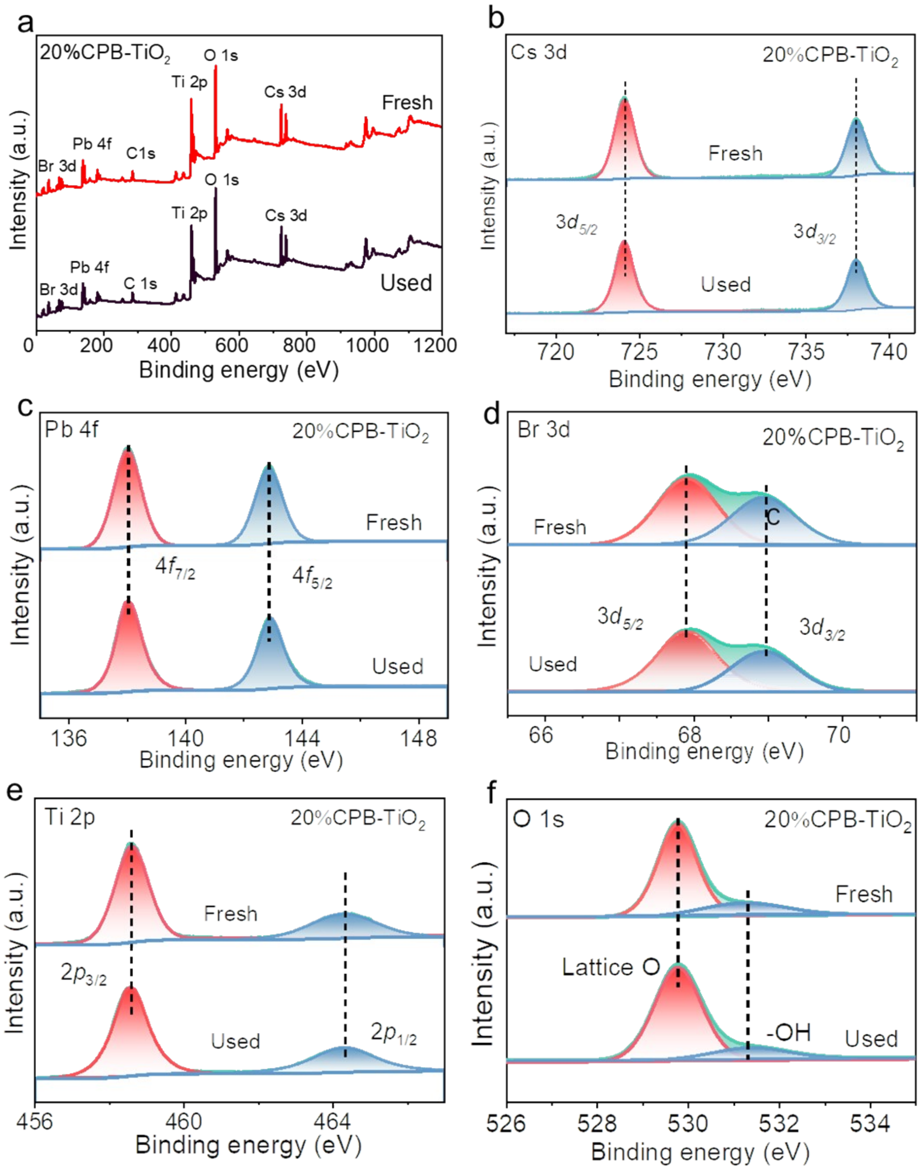

Figure 18. XPS analysis for the used and fresh 20%$CsPbBr_3/TiO_2$ composite.

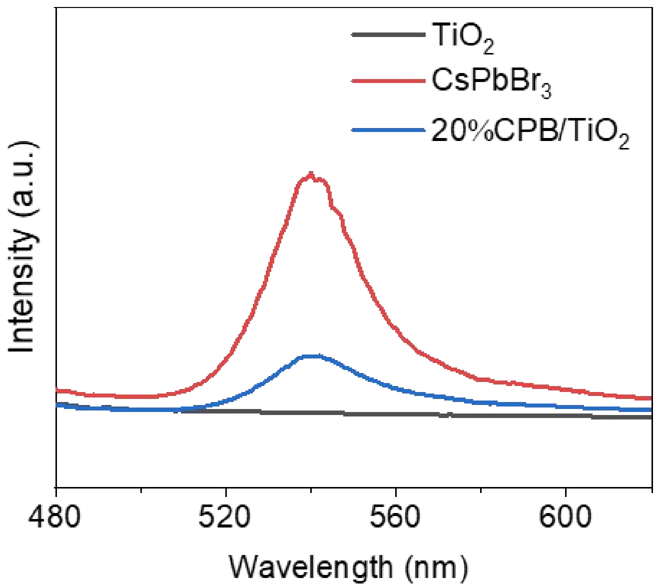

Figure S19. The PL spectra of $CsPbBr_3$, TiO_2 and 20%$CsPbBr_3/TiO_2$.

Table S1. Summary of surface area and pore volume of the TiO_2, $CsPbBr_3$ and CPB/TiO_2 composites.

Samples	Surface area (m^2 g^{-1})	Pore volume (cm^3 g^{-1})
TiO_2	66.467	0.455
$CsPbBr_3$	3.196	0.006
20% CPB/TiO_2	41.882	0.317

Table S2. Comparison on photocatalytic activity for selective toluene oxidation over the photocatalysts prepared in the present work and reported in the literature.

Photocatalyst	Reaction condition	Rate (μmol/(g h))	Ref.
$CsPbBr_3/TiO_2$	$\lambda \geq$ 420 nm, sample (15 mg), toluene (1 mL), O_2 (0.1 MPa), reaction time (5 h)	10200	This work
TiO_2/Bi_2MoO_6	$\lambda \geq$ 400 nm, sample (50 mg), toluene (10 mmol), O_2 (3 mL/min), reaction time (3 h)	1069	[1]
$CdS@C_3N_4$	$\lambda >$ 400 nm, sample (100 mg), toluene (10 mmol), O_2 (3 mL/min), reaction time (3 h)	500	[2]
CdS	$\lambda >$ 420 nm, sample (8 mg), toluene (0.1 mmol), O_2 (0.1 MPa), reaction time (10 h)	413	[3]
$BiOBr/TiO_2$	$\lambda >$ 420 nm, sample (20 mg), toluene (9.4 mmol), O_2 (0.1 MPa), reaction time (4 h)	1169	[4]
$Bi_2WO_{6-x}/BiOCl$	$\lambda >$ 400 nm, sample (50 mg), toluene (10 mmol), O_2 (1 atm), reaction time (2 h)	5162	[5]
$CdIn_2S_4$-CdS	$\lambda >$ 420 nm, sample (10 mg), toluene (47.2 μmol), O_2, reaction time (6 h)	645	[6]
Fe-Bi_2WO_6	$\lambda >$ 420 nm, sample (20 mg), toluene (10 mmol), O_2 (1 mL/min), reaction time (5 h)	1347	[7]
Cl-$BiOBr/TiO_2$	$\lambda >$ 420 nm, sample (20 mg), toluene (1 mL), O_2, reaction time (4 h)	2121	[4]
$Cs_3Bi_2Br_9$/g-C_3N_4	$\lambda >$ 400 nm, sample (10 mg), toluene (5 mL), O_2 (0.1 MPa), reaction time (0.17 h)	8347	[8]
$Cs_3Bi_2Br_9$/P25	Full-spectrum, sample (10 mg), toluene (5 ml), O2, reaction time (4 h)	10651	[9]
$NiO_x/FAPbBr_3/TiO_2$	AM 1.5 G, sample (10 mg), toluene (2.5 ml), O_2, reaction time (4 h)	4419	[10]
$FAPbBr_3/TiO_2$	AM 1.5 G, sample (10 mg), toluene (2.5 ml), O_2, reaction time (4 h)	2859	[10]

Reference

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