

Supporting Information

Charge separation manipulation in lead-free Cs₃Sb₂Br₉/WO₃ heterojunction for efficient green-light-driven oxidation of benzyl alcohol and mechanistic insights

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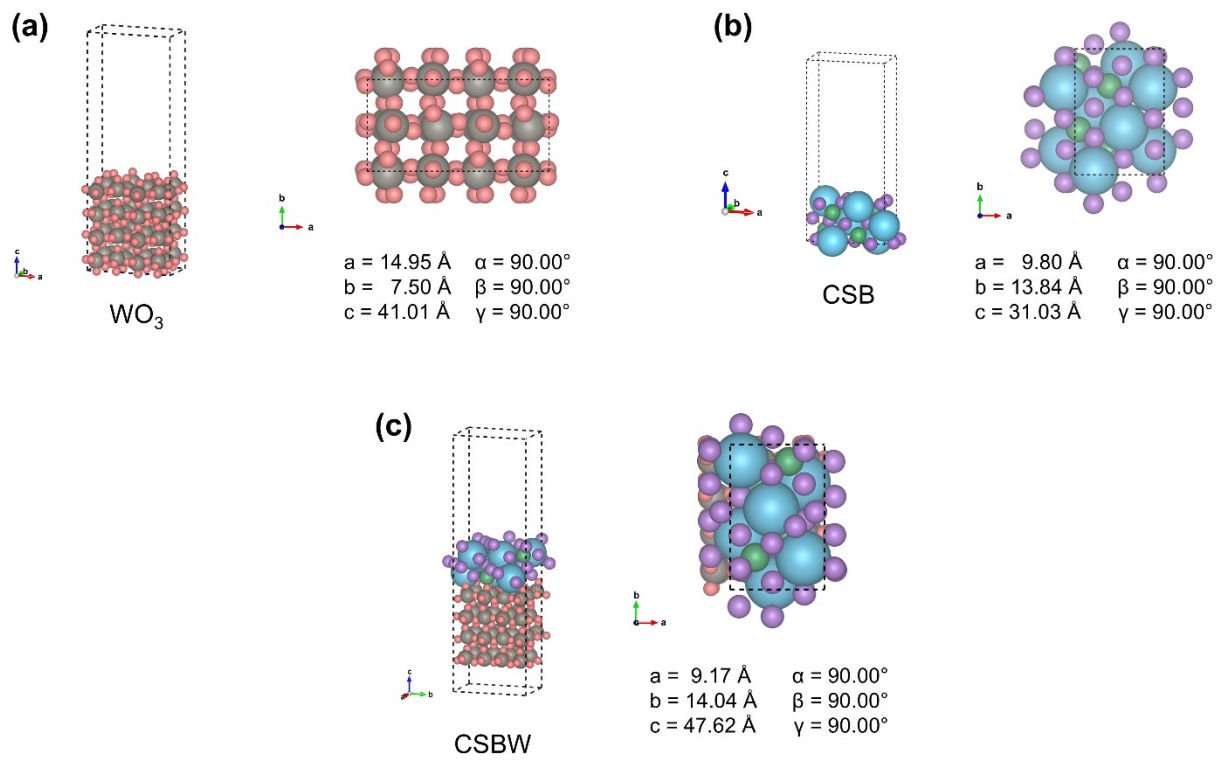


Figure S1 Models and lattice parameters of a) WO₃, b) CSB, and c) CSBW.

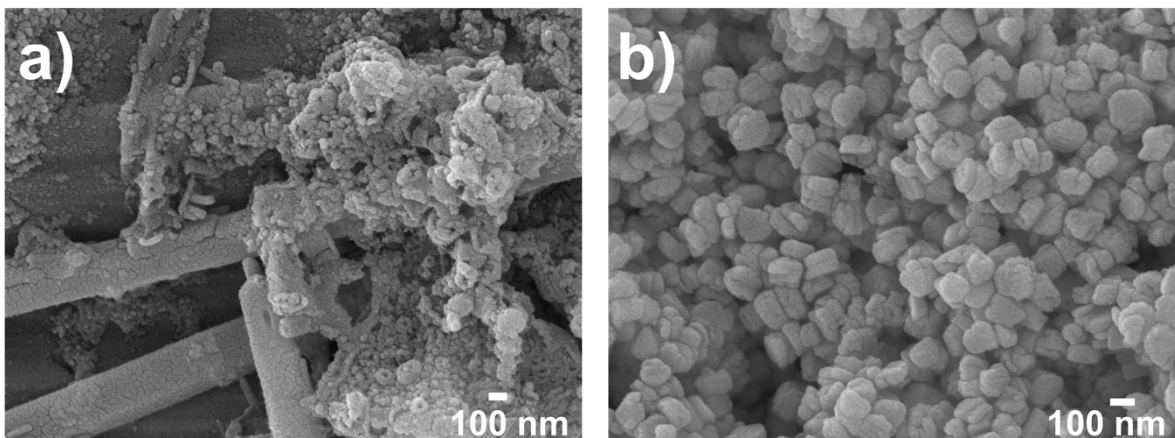


Figure S2 FESEM images of a) CSB and b) WO_3 .

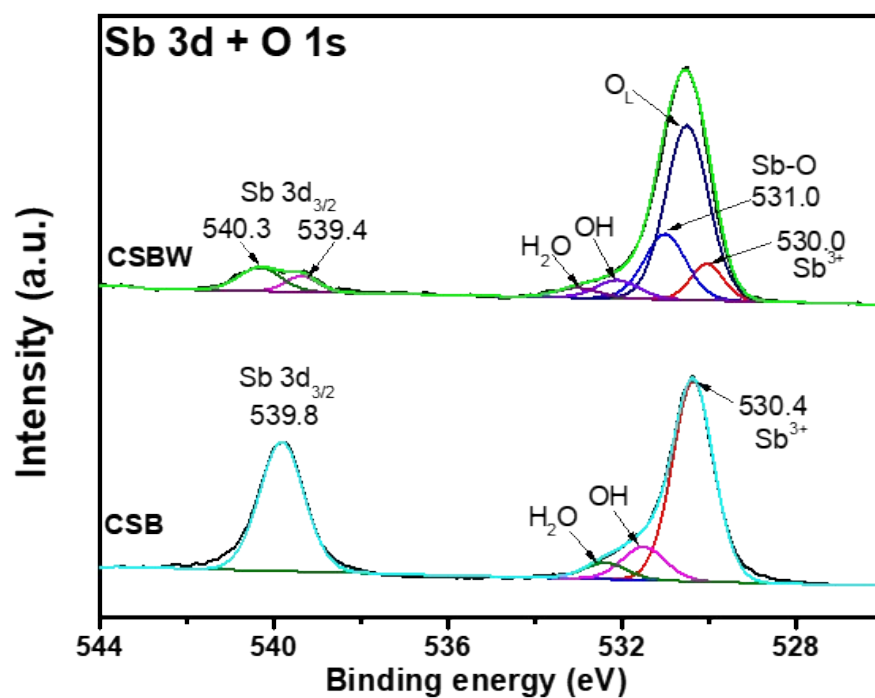


Figure S3 Sb 3d and O 1s core level spectra of pristine CSB and CSBW heterojunction.

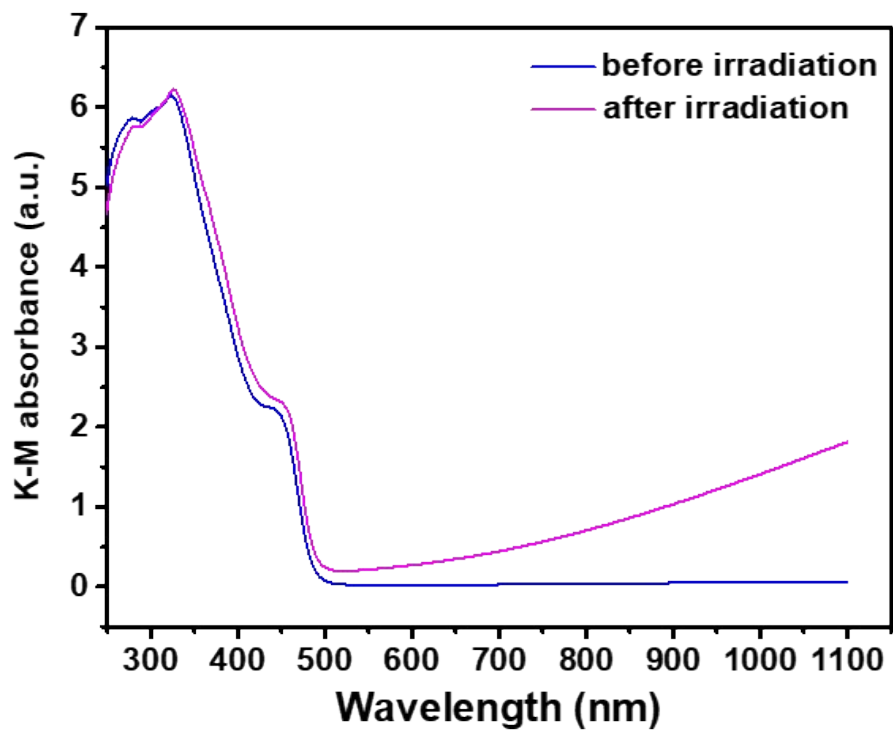


Figure S4 UV-Vis DRS spectra of CSBW before and after green LED illumination.

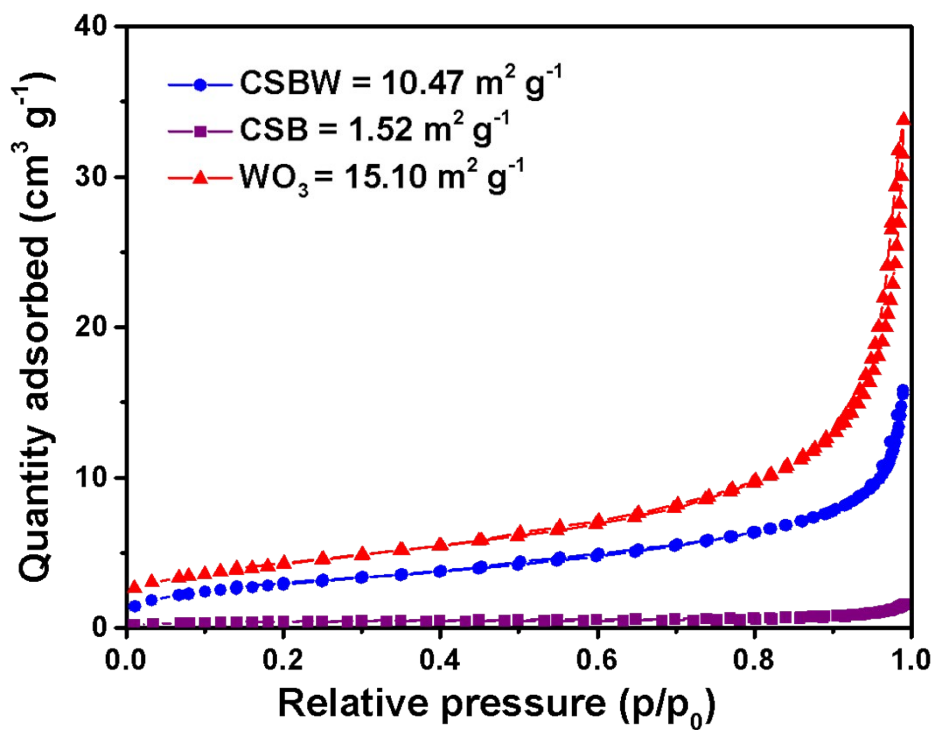


Figure S5 BET adsorption-desorption isotherms of CSB, WO_3 and CSBW composite.

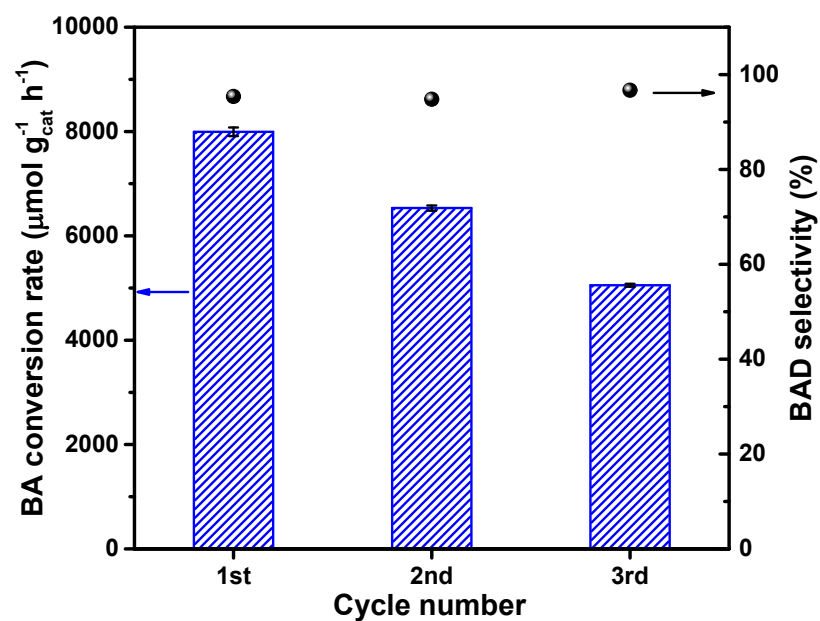


Figure S6 Recyclability of the CSBW photocatalysts.

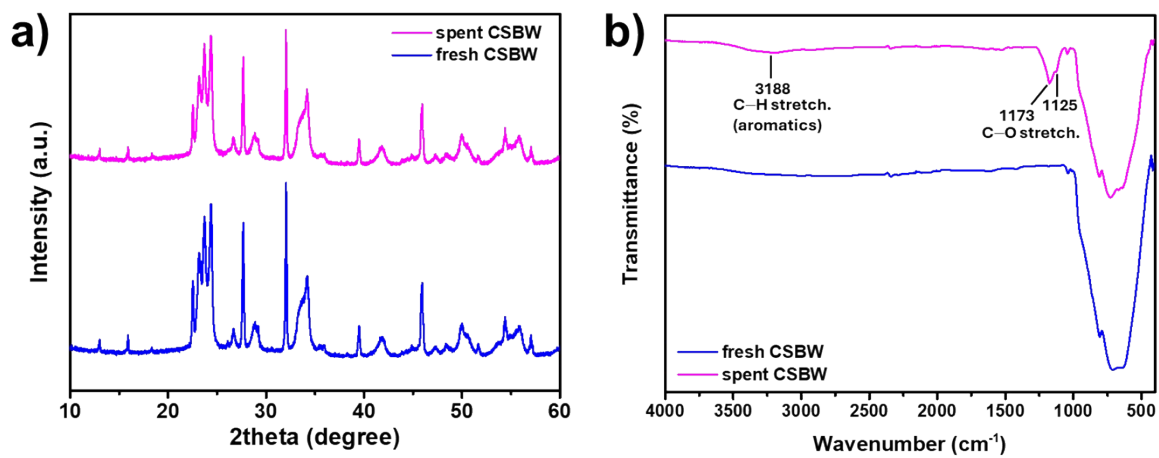


Figure S7 a) XRD patterns and b) ATR-FTIR spectra of fresh and spent CSBW samples.

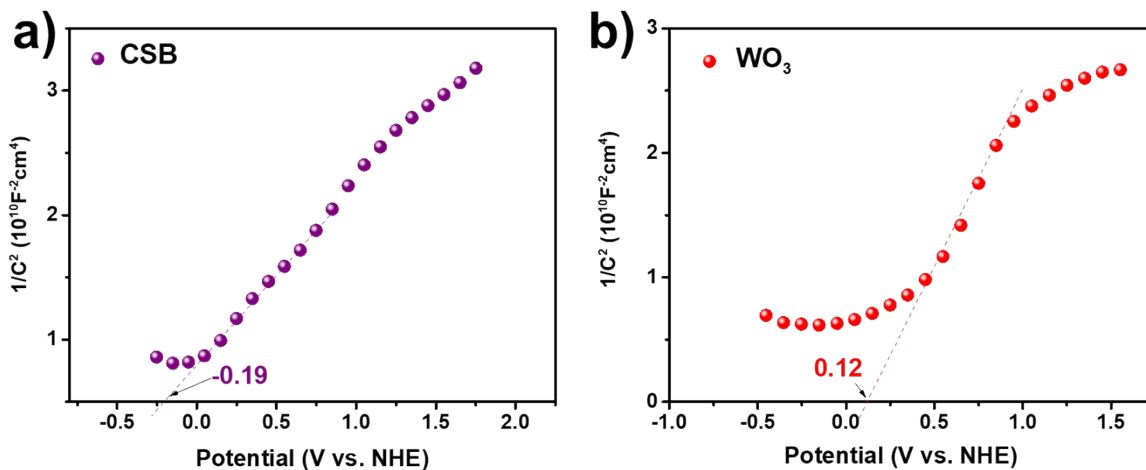
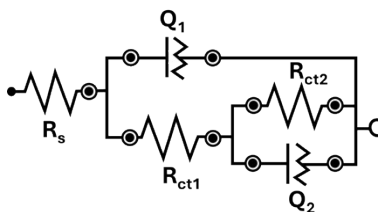


Figure S8 Mott-Schottky plots of a) CSB and b) WO_3 .

Table S1 EIS circuit model and fitting parameters.



Catalyst	R_s (Ω)	R_{ct1} (Ω)	R_{ct2} (Ω)	R_{ct} (Ω)= $R_{ct1} + R_{ct2}$	Q_1 (Ω^{-1} s^N)	N of Q_1	Q_2 (Ω^{-1} s^N)	N of Q_2	χ^2
WO_3	107	20×10^3	119×10^3	139×10^3	17.9×10^{-6}	0.863	925×10^{-9}	0	0.3460
CSB	107	710	66.8×10^3	67.5×10^3	2.87×10^{-6}	0.39	15.6×10^{-6}	0.92	0.0113
CSBW	107	105	22×10^3	22.0×10^3	4.27×10^{-6}	1.03	15.2×10^{-6}	0.837	0.0300

Table S2 The Sb concentration from ICP-OES analysis.

Sample	Sb concentration (mg L^{-1})
Fresh CSBW	0.0209 ± 0.003
Spent CSBW	0.0207 ± 0.004

Apparent quantum yield (AQY) calculation

The AQY in the photocatalytic oxidation of benzyl alcohol (BA) was determined under green LED irradiation. The converted BA concentration was determined by using 20 mg of catalyst at 1 h irradiation, with the light intensity of 840 W m⁻² and an irradiated area of 4.5×10⁻⁴ m². The AQY value was calculated using the following equation:

$$AQY = \frac{N_{BA} \times N_A \times h \times c}{I \times S \times t \times \lambda} \times 100\% \quad \text{Equation S1}$$

Where N_{BA} is the converted amount of BA (mol), N_A is Avogadro's number ($6.02 \times 10^{23} \text{ mol}^{-1}$), h is Plank constant ($6.62 \times 10^{-34} \text{ J s}$), c represents the speed of light ($3 \times 10^8 \text{ m s}^{-1}$), S is the area of irradiation ($4.5 \times 10^{-4} \text{ m}^2$), I is the intensity of irradiation (840 W m^{-2}), t is irradiation time (3600 s), and λ is the wavelength of incident green light ($530 \times 10^{-9} \text{ m}$).