

Supplementary Information

All-solid-state Z-scheme $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr}$ heterostructures for efficient visible-light photocatalysis and photocatalytic

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To further confirm the existence of Ag in the used $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr-4}$ hybrid sample, the used $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr-4}$ sample after 5 recycling runs was examined by XPS analysis. The results are shown in Fig. S. Fig. Sa shows the XPS survey spectrum of the used photocatalyst, which mainly exhibited the peaks of Ag, Br, P, O and C. No other impurities were presented in the sample. A high-resolution XPS spectrum of Ag 3d is shown in Fig. Sb and Fig. Sc.

As shown in Fig. Sb, a pair of symmetric peaks that located at 367.7 and 373.7 eV are ascribed to the binding energy values of the $3d_{5/2}$ and $3d_{3/2}$ of Ag^+ in the fresh $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr-4}$.

As shown in Fig. Sc, the used $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr-4}$ sample could be separated the Ag^0 and Ag^+ peaks. The weak peaks at 368.8 and 374.8 eV are attributed to Ag^0 , while the strong peaks at 367.7 and 373.7 eV are assigned to Ag^+ of AgBr and Ag_3PO_4 . From the XPS peak areas, the molar ratio of Ag^0 to Ag^+ is $n(\text{Ag}^0): n(\text{Ag}^+) = 31.1:68.9$, and the surface Ag^0 and Ag^+ contents are calculated to be 5.8 and 12.9 mol %, respectively.

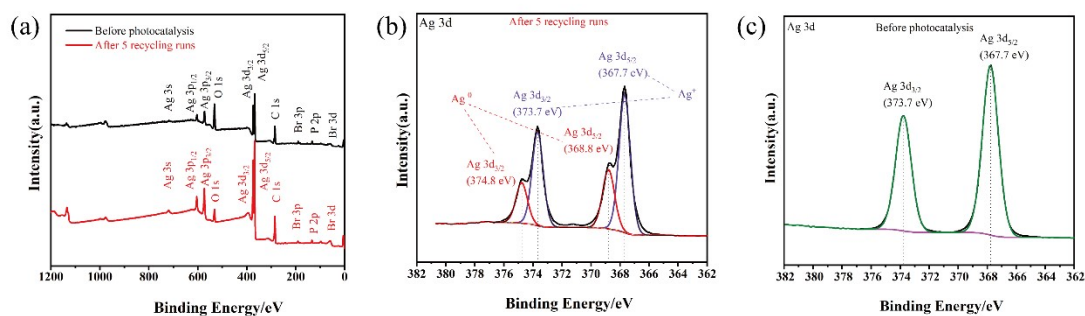


Fig S. XPS survey spectrum of $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr-4}$ (a), Ag 3d XPS spectra of the fresh (b) and the used (c) $\text{Ag}_3\text{PO}_4/\text{CSs}/\text{AgBr-4}$ after 5 recycling runs.

[Table S1](#) lists the results of UPS analysis. Compared with Au and Ag, the ionization potential of CSs is smaller and it shows metallicity, so it can be used as a metal-like material to construct an ideal Z-scheme heterojunction. The atomic contents of all the elements in Ag₃PO₄/CSs/AgBr-4 sample are listed in [Table S2](#).

Table S1 The UPS calculation results of each sample

Photocatalyst	Φ/eV	$E_{\text{HOMO}}-E_f/eV$	E_g/eV	IP/eV	E_a/eV
CSs	4.37	-2.93	7.30	----	----
Ag ₃ PO ₄	4.57	-2.64	7.21	2.24	4.97
Ag ₃ PO ₄ /CSs	4.49	-2.74	7.23	2.13	5.10
Ag ₃ PO ₄ /CSs/AgBr-4	4.560	-2.73	7.32	1.96	5.36

Table S2. XPS results of the fresh and the used Ag₃PO₄/CSs/AgBr-4

	Mole fraction/%				
	Ag	Br	P	O	C
The fresh Ag ₃ PO ₄ /CSs/AgBr-4	10.4	0.2	6.7	29.6	53.1
The used AgBr/Ag ₃ PO ₄ /CSs-4 after 5 recycling runs	18.8	0.1	5.9	13.1	62.1