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Core-satellite structured Z−scheme catalyst $Cd_{0.5}Zn_{0.5}S/BiVO_4$ for highly efficiency and stable photocatalytic water splitting

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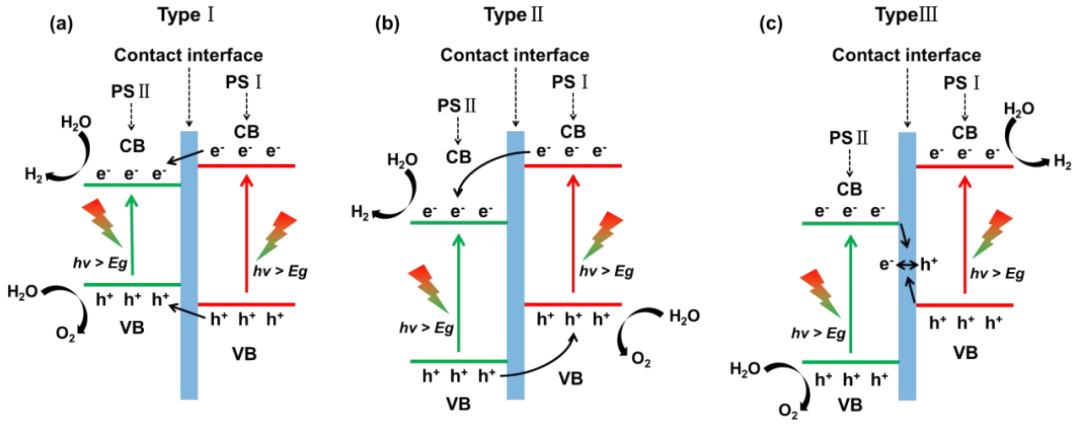
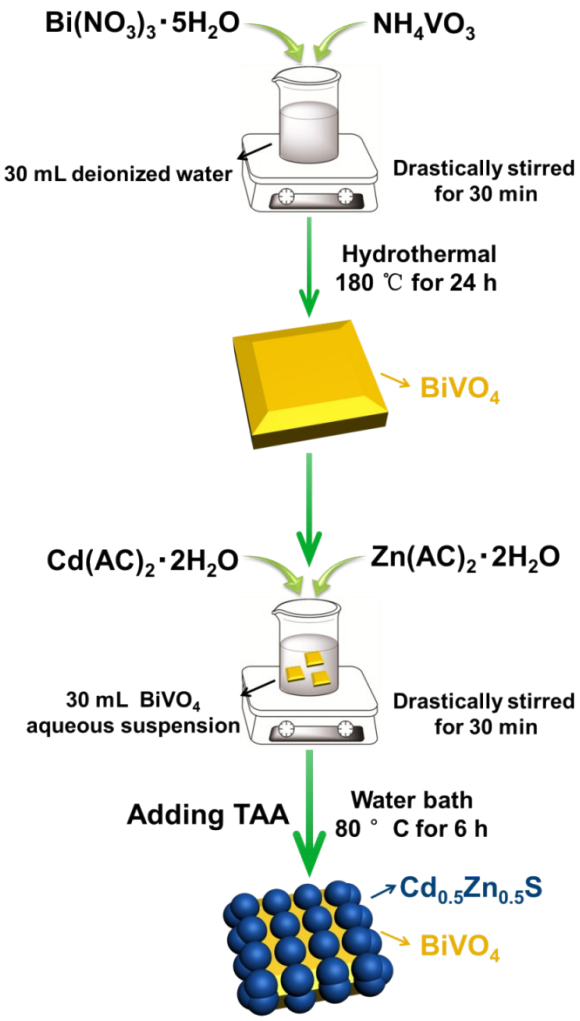
Fabrication of $Cd_{0.5}Zn_{0.5}S$-CoO_x(0.5 %)/$BiVO_4$

CoO_x(0.5 wt%)/$BiVO_4$ was prepared as fallows. $BiVO_4$ was dispersed in a corundum crucible containing 530 ul of $Co(NO_3)_2$ aqueous (80 mmol/L) solution. The crucible was dried at 60 ℃ for 3 h in air. Then it was calcined at 400 ℃ for 2 h in air. After cooling to room temperature, the sample was ground into powder.

$Cd_{0.5}Zn_{0.5}S$-CoO_x(0.5%)/$BiVO_4$ was obtained via the following route. CoO_x(0.5%)/$BiVO_4$ was dispersed in a beaker containing 30 ml of deionized water with ultrasonic and then certain amount of $Cd(AC)_2 \cdot 2H_2O$ and $Zn(AC)_2 \cdot 2H_2O$ were added into the above suspension liquid. Whereafter, quantitive thioacetamide was added into the above suspension. Then the beaker (sealed with plastic wrap) was put into an 80 °C water bath for 6 h with magnetic stirring. After natural cooling, the product was collected by centrifugation and rinsed repeatedly with distilled water and ethanol, and then dried at 60 ℃ for 10 h in air.



Scheme. S1 Three types of charge transfer mechanism for heterojunction photocatalysts.



Scheme. S2 The schematic illustration of the preparation process for CZS-$BiVO_4$ composite photocatalysts.

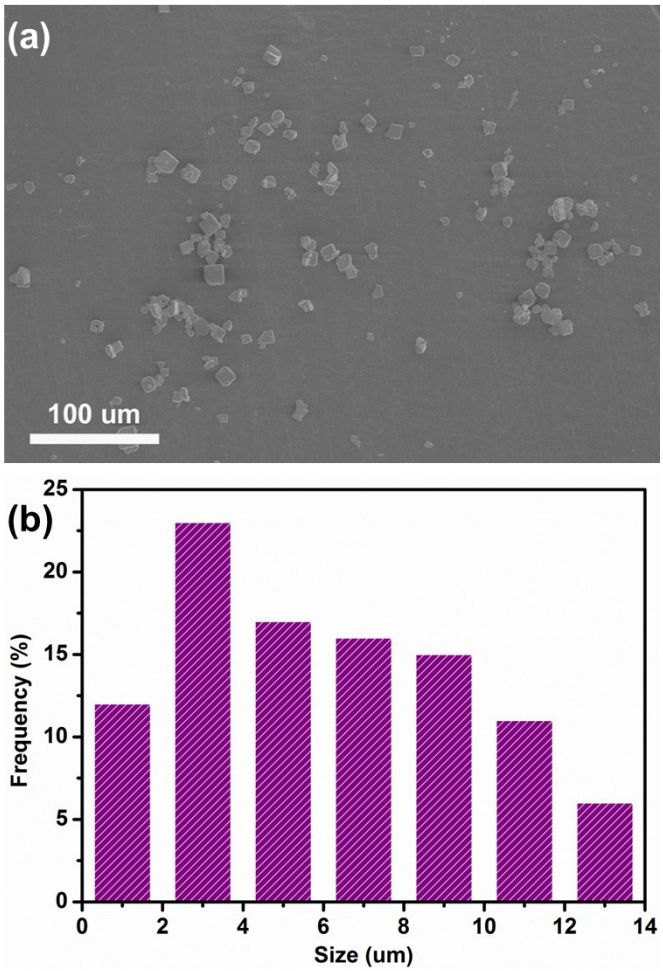


Fig. S1 SEM image and size distribution histogram (calculated by the software of Image J) of $BiVO_4$ sample.

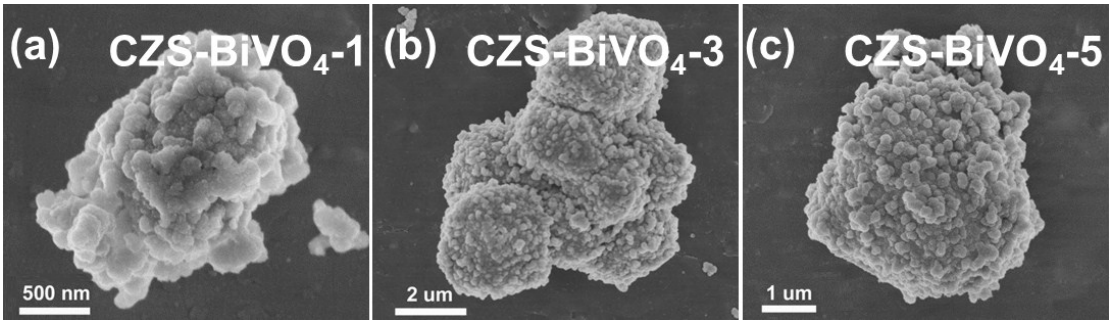


Fig. S2 SEM images of CZS-$BiVO_4$-1, CZS-$BiVO_4$-3, and CZS-$BiVO_4$-5 samples.

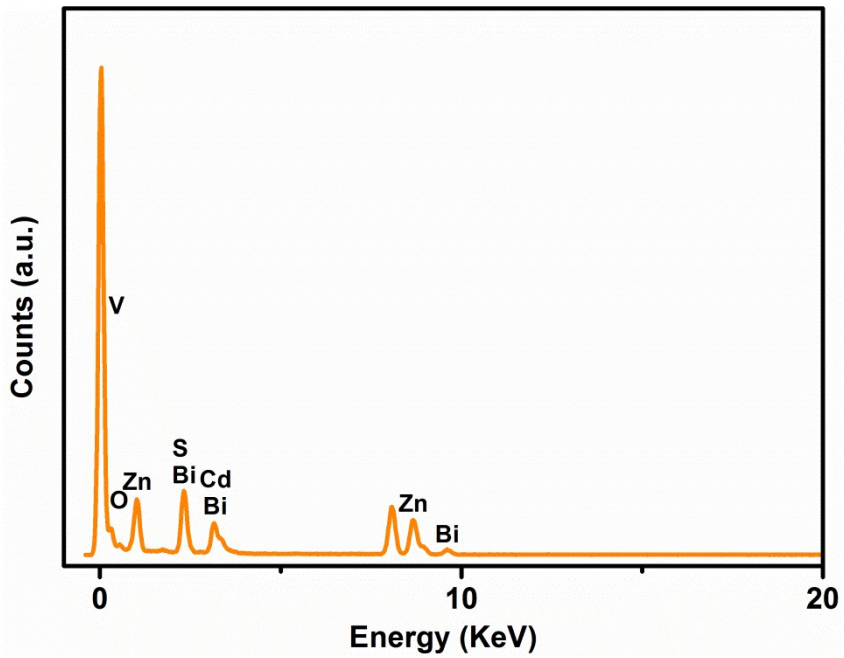


Fig. S3 EDX spectrum for CZS-$BiVO_4$-3 sample.

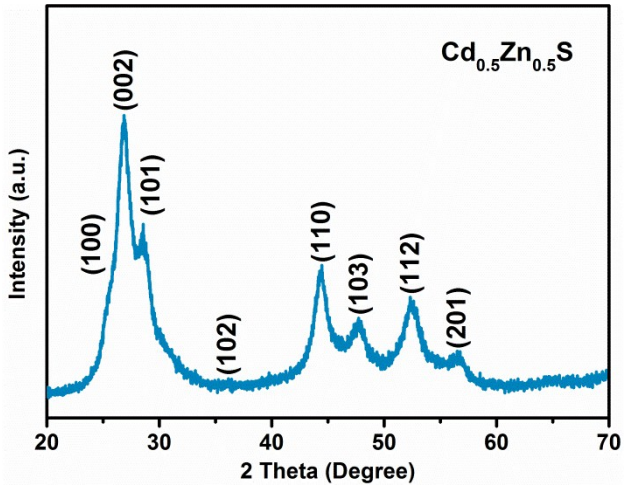


Fig. S4 XRD pattern of $Cd_{0.5}Zn_{0.5}S$.

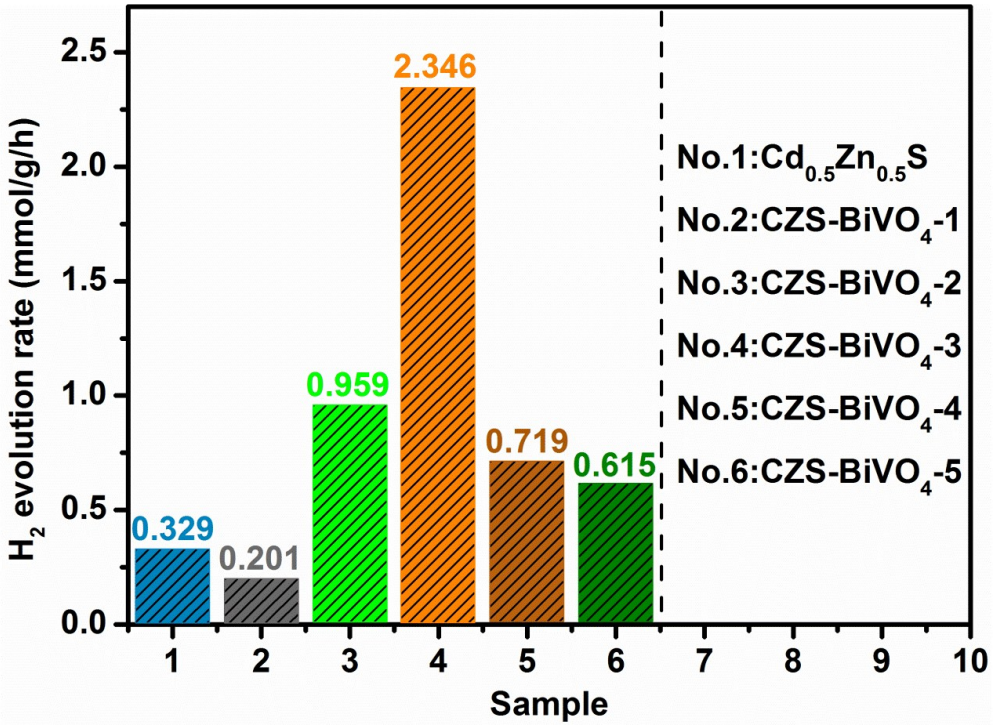


Fig. S5 Apparent rate constants of H_2 evolution for $Cd_{0.5}Zn_{0.5}S$, and CZS-$BiVO_4$ composite samples under visible light illumination.

The TOF of Pt atoms for CZS-$BiVO_4$-3 sample under visible light irradiation for 4 h is calculated as following:

[TON] = [9.01165 * 10^{-3} *0.05 * 4] / [0.05 * 3% / 195.084] = 234.4

[TOF] = [TON] / t = 234.4 / 4 = 58.6 h^{-1}

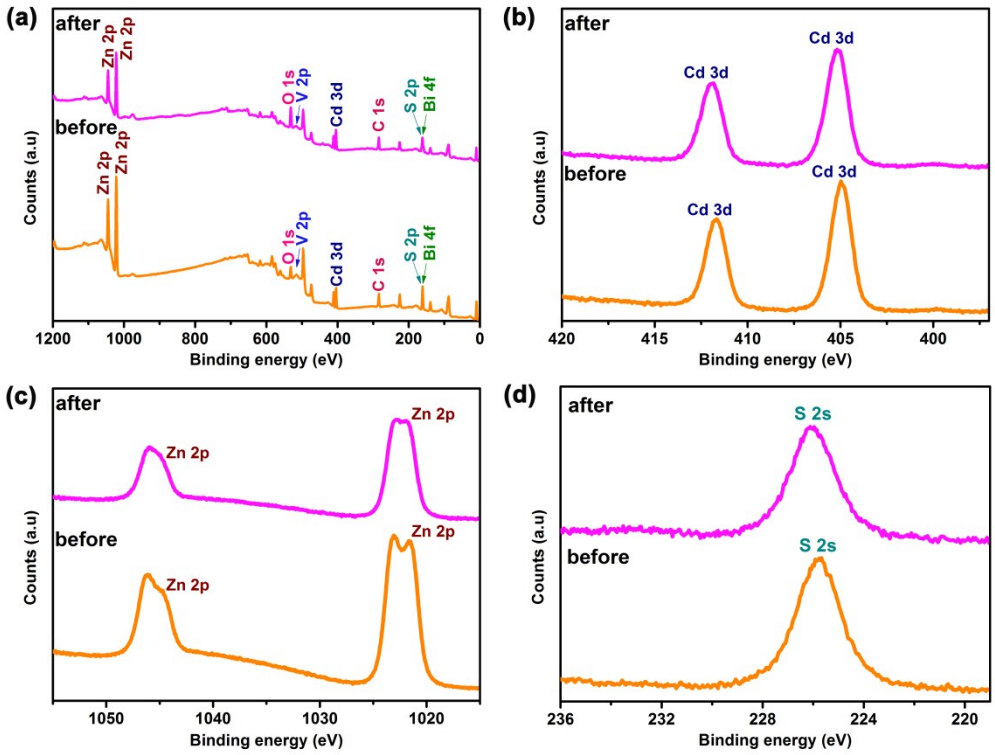


Fig. S6 Typical XPS survey spectra **(a)**, high-resolution XPS spectra of Cd **(b)**, Zn **(c)**, and S **(d)**, for CZS-$BiVO_4$-3 sample before and after photocatalytic reaction.

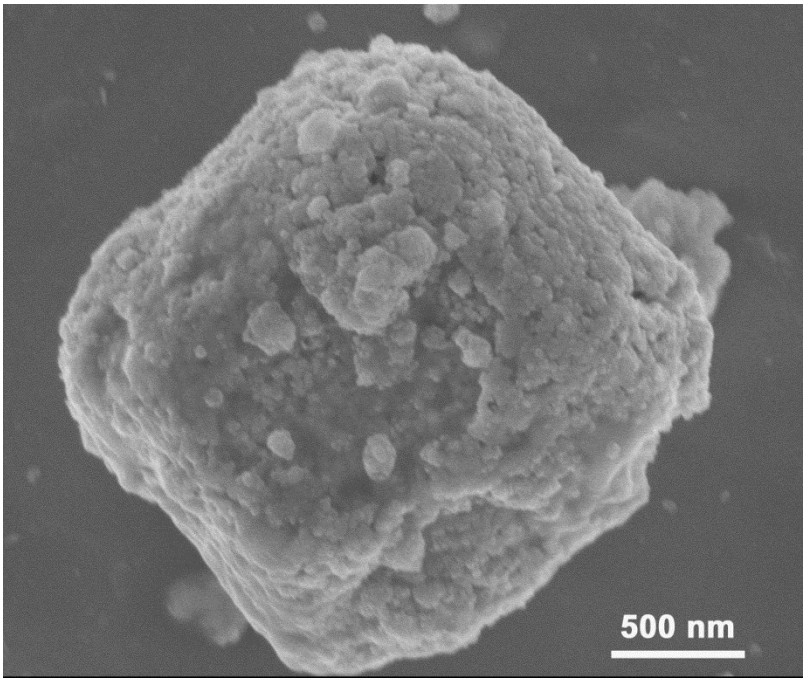


Fig. S7 SEM image of CZS-$BiVO_4$-3 sample after photocatalytic reaction.

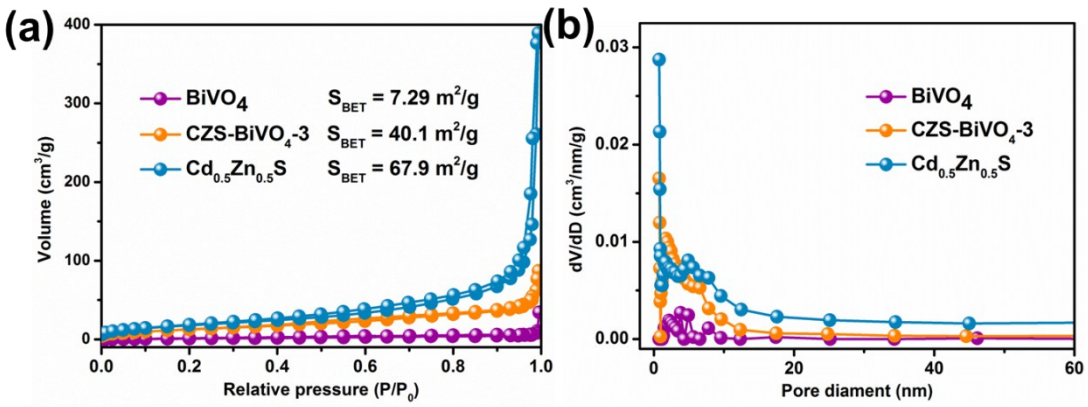


Fig. S8 Nitrogen adsorption/desorption isotherms **(a)** and pore diameter distribution **(b)** of $BiVO_4$, CZS-$BiVO_4$-3, and $Cd_{0.5}Zn_{0.5}S$ samples.

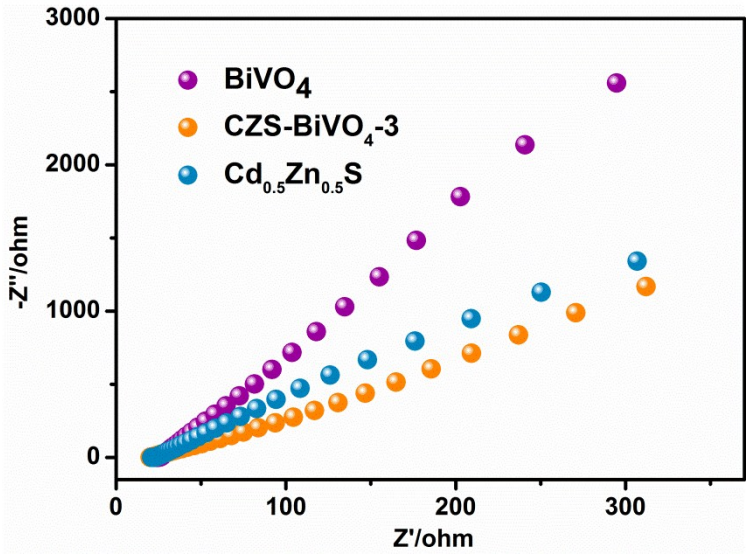


Fig. S9 EIS Nynquist plots for $BiVO_4$, CZS-$BiVO_4$-3, and $Cd_{0.5}Zn_{0.5}S$ samples.