Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supporting Information

Preparation of $ZnIn_2S_4$-AlOOH composite for the photocatalytic reduction of CO_2 to CO

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Experimental Section

Quantitative analysis

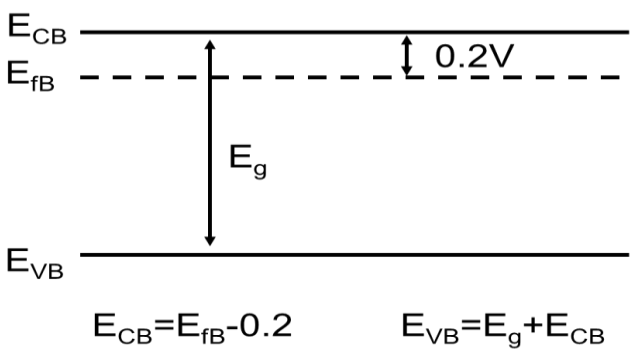
Gas product calculation formula:

$$Y_i\ (\mu\text{mol}) = f_i \times \frac{A_i \times V_{He}}{A_{He} \times V_m} \times 10^3 \qquad F_i(\mu\text{mol/g/h}) = \frac{Y_i}{t \times m_{cat}}$$

Where Y_i is the yield of product, F_i is the rate of product formation, A_i and A_{He} are the peak areas of the product and the internal standard He gas respectively, and V_{He} is the volume of the internal standard He gas (0.1 mL), f_i is the relative correction factor, 6.2974 for CO and 0.5018 for H_2, V_m is the molar volume of the gas (24.5 L mol^{-1}, 25°C, 1.01×10^5 pa), m_{cat} is the mass of the catalyst, t is the reaction time (12 h).

Calculation method of band structure

The flat band potential of the sample can be obtained from the Mott-Schottky plot. The positive slope of the curve indicates that the prepared material is an n-type semiconductor. Generally, the flat-band potential of n-type semiconductors is 0.1-0.3 eV higher than the conduction band (CB) potential, and in this paper, 0.2 eV is chosen. The conduction band potential of the sample can be estimated using the measured flat-band potential. The valence band potential is then calculated using the formula $E_{VB} = E_g+E_{CB}$. [1-3]



Supporting Figures

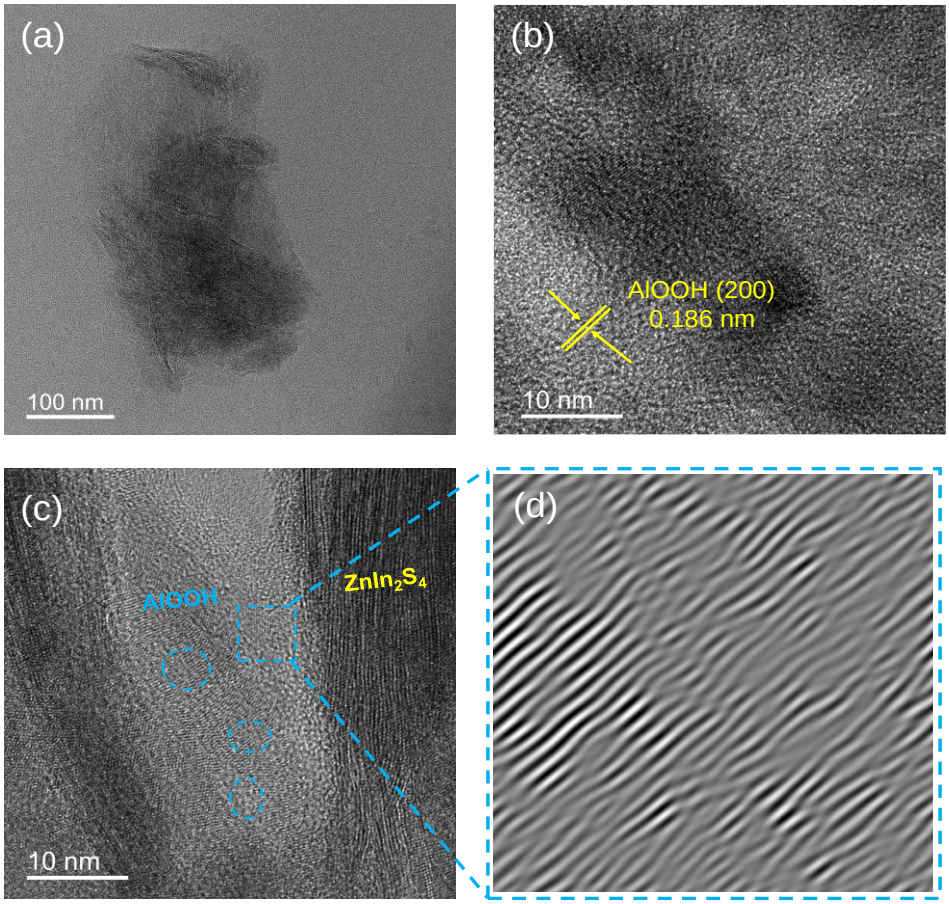


Fig. S1 (a) TEM images, (b) HRTEM images of AlOOH, (c-d) HRTEM images of ZIS-AlOOH.

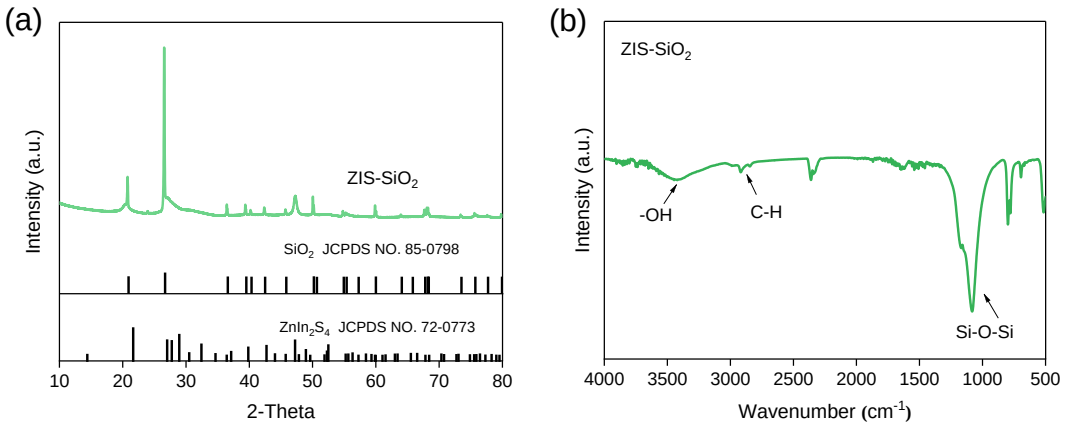


Fig. S2 (a) X-ray diffraction patterns and (b) FT-IR spectra of ZIS-SiO_2 catalyst.

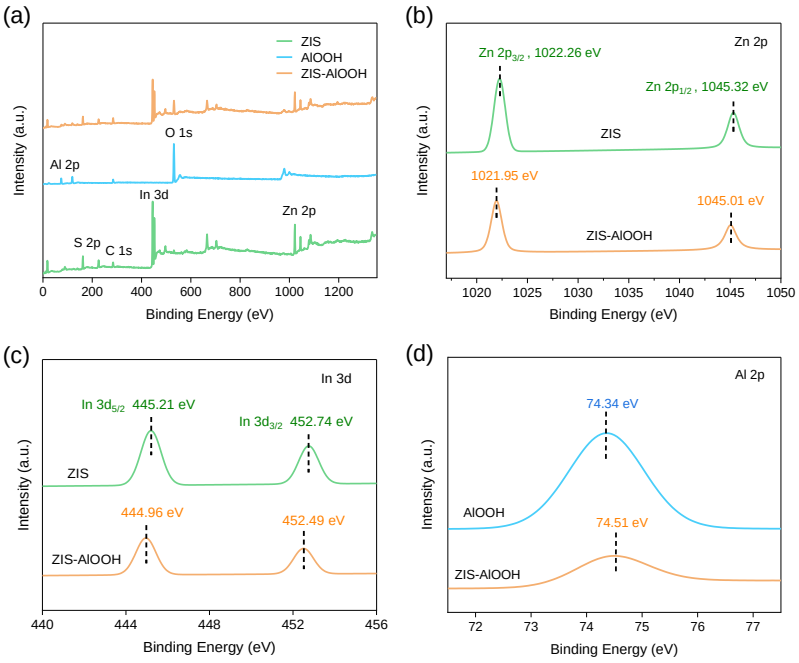


Fig. S3 (a) XPS survey spectra and corresponding high-resolution XPS spectra of (b) Zn 2p, (c) In 3d, and (d) Al 2p of the ZIS, AlOOH, and ZIS-AlOOH.

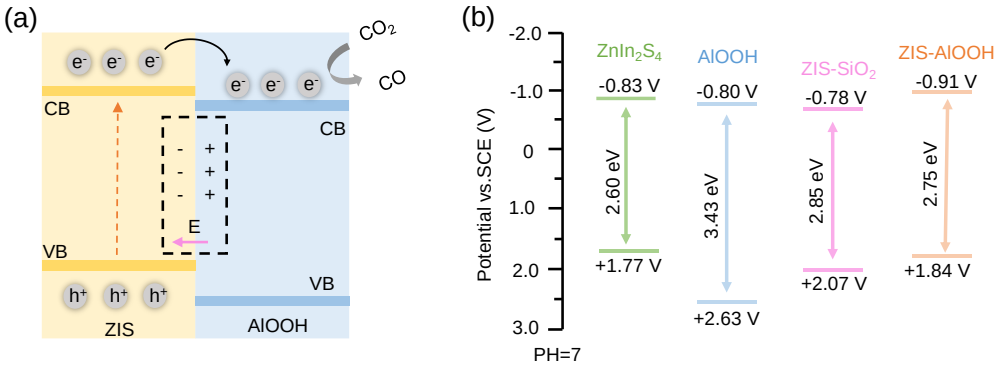


Fig. S4 (a) The schematic illustration of the internal electric field (IEF) induced charge migration of ZIS and AlOOH, (b) the energy band positions of the as-prepared photocatalysts.

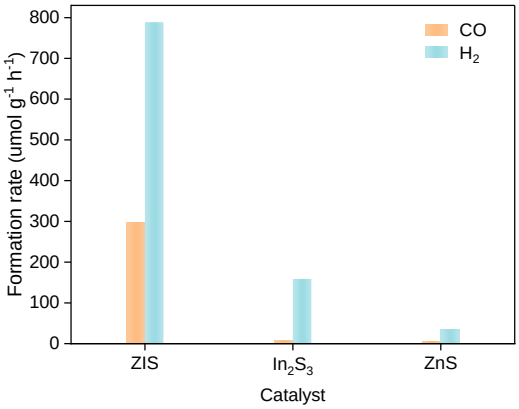


Fig. S5 Photocatalytic activities of ZIS, In_2S_3, and ZnS. Reaction conditions: 5 mg of catalyst, 0.9 mL of MeCN, 0.1 mL of H_2O, 0.1 mL of triethylamine, 1 bar CO_2, blue LEDs (455 nm), 12 h.

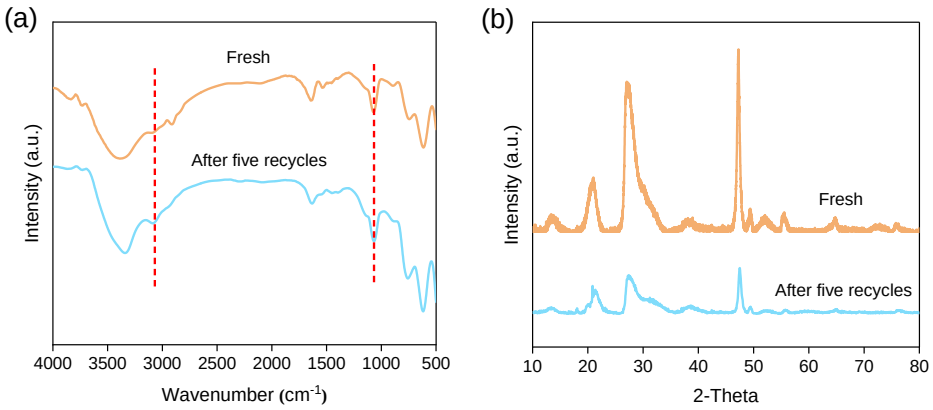


Fig. S6 (a) FT-IR spectra and (b) X-ray diffraction patterns of ZIS-AlOOH catalyst before and after reaction.

References

1 J. Song, Y. Lu, Y. Lin, Q. Liu, X. Wang and W. Su, *Appl. Catal., B*, 2021, **292**, 120185-120193.

2 J. Wang, S. Sun, R. Zhou, Y. Li, Z. He, H. Ding, D. Chen and W. Ao, *J. Mater. Sci. Technol.*, 2021, **78**, 1-19.

3 J. Wang, S. Lin, N. Tian, T. Ma, Y. Zhang and H. Huang, *Adv. Funct. Mater.*, 2021, **31,** 2008008-2008046.