Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.

# The Z-Scheme $ZnIn_2S_4/Nb_2O_5$ nanocomposite: Constructed and used as efficient bifunctional photocatalyst for $H_2$ evolution and oxidation of 5-hydroxymethylfurfural

Yuwei Wang, Xianggui Kong,* Meihong Jiang, Fazhi Zhang, Xiaodong Lei*

State Key Laboratory of Chemical Resource Engineering, Beijing University of Chemical Technology, PO Box 98, Beijing 100029, China.
E-mail address: leixd@mail.buct.edu.cn (X. Lei); kongxg@mail.buct.edu.cn (X. Kong)

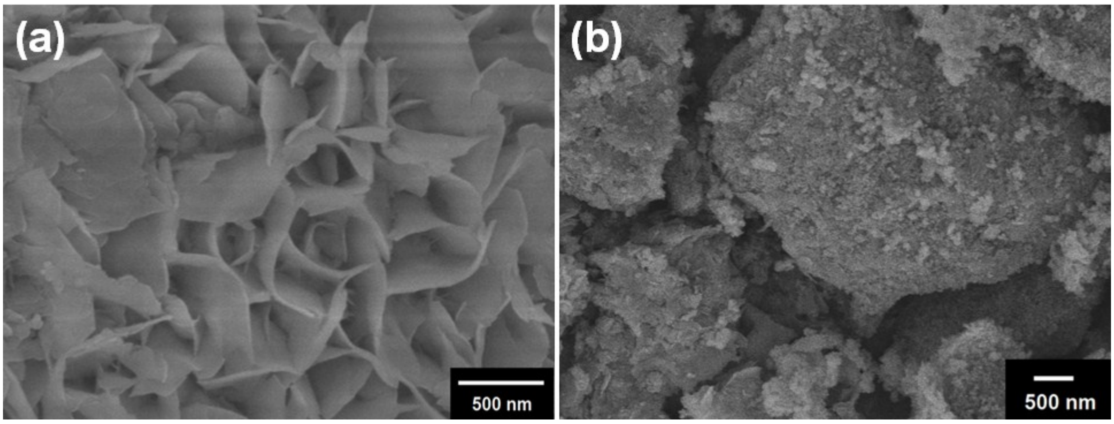

**Fig. S1** SEM images of ZIS/NbO-2 (a) and ZIS/NbO-20 (b).

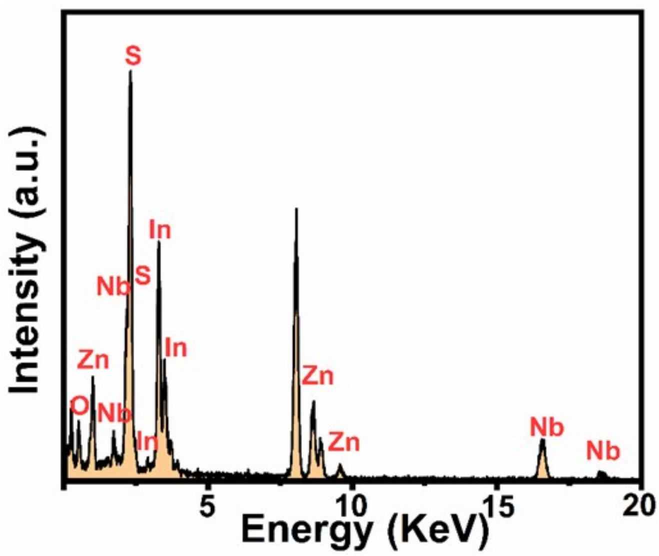


**Fig. S2** The EDS image of ZIS/NbO-8.

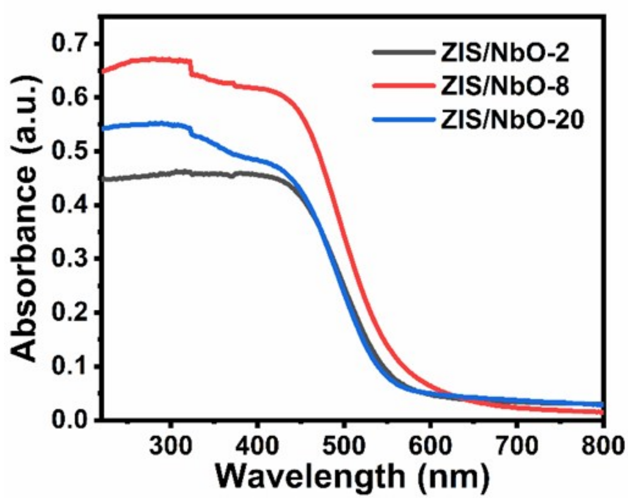


**Fig. S3** UV-vis DRS spectra for ZIS/NbO-2, ZIS/NbO-8 and ZIS/NbO-20.

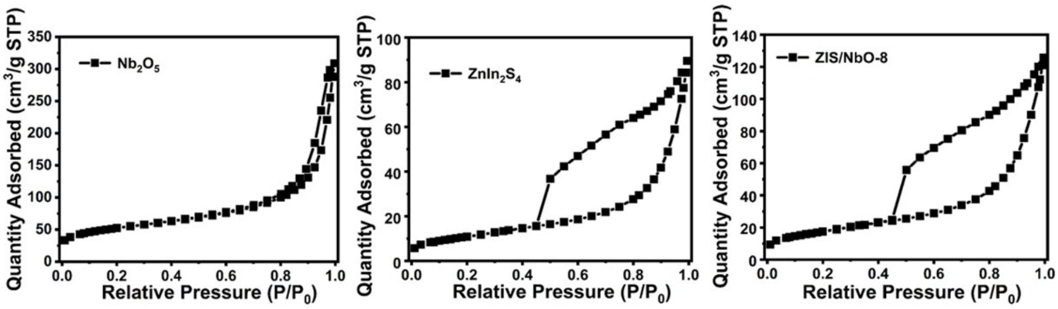


**Fig. S4** $N_2$ adsorption–desorption isotherms of $Nb_2O_5$, $ZnIn_2S_4$ and ZIS/NbO-8.

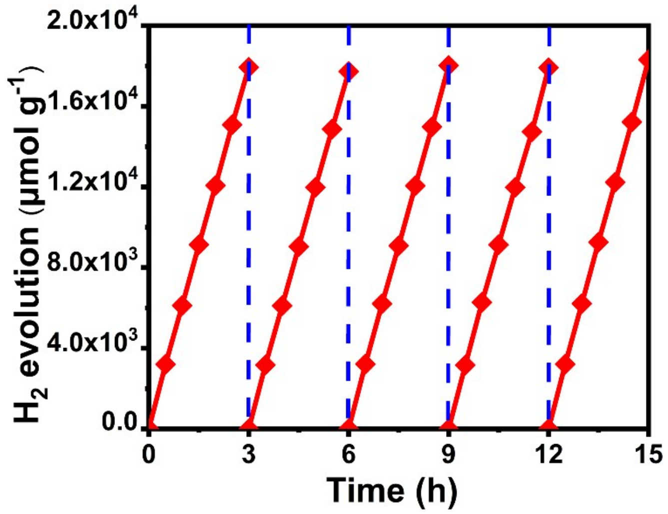


**Fig. S5** The stability of ZIS/NbO-8 composite under simulated solar light.

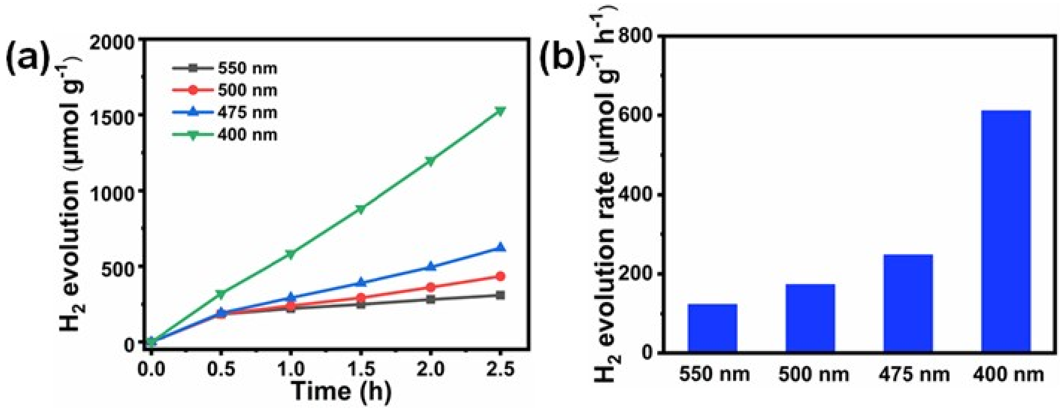


**Fig. S6** (a) Time-yield plots of $H_2$ of ZIS/NbO-8 and (b) photocatalytic $H_2$ evolution rate (μmol $g^{-1}$ $h^{-1}$) of ZIS/NbO-8 under photoirradiation with different wavelengths.
(light intensity: 200 mW $cm^{-2}$)

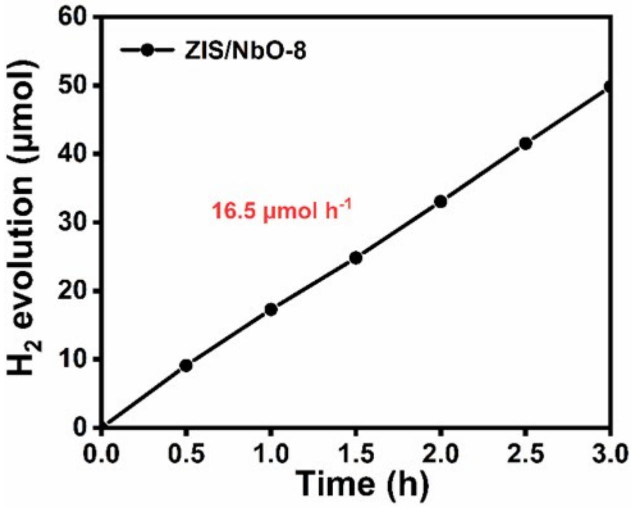


**Fig. S7** The $H_2$ production of ZIS/NbO-8 under 365 nm light irradiation.

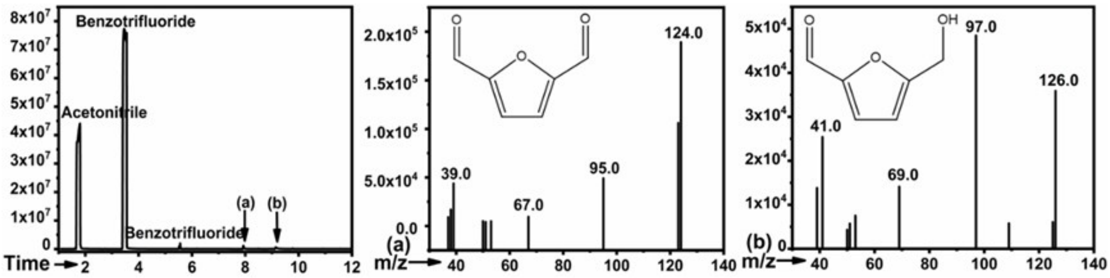


**Fig. S8** Total ion chromatogram and the mass spectra of peaks (a) and (b) obtained from the ZIS/NbO-8 suspended benzotrifluoride, and diluted by acetonitrile after 3 h simulated solar light irradiation.

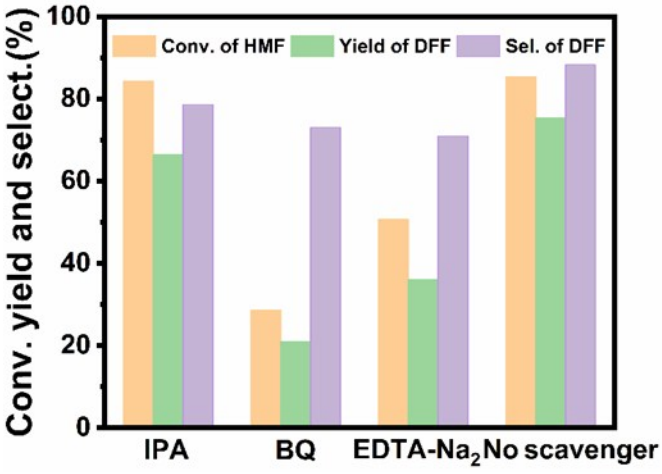


**Fig. S9** The effect of various scavengers on the photocatalytic reaction performance. (Reaction Conditions: simulated solar light; Irradiation time, 3 h; Solvent, benzotrifluoride, 5 mL)

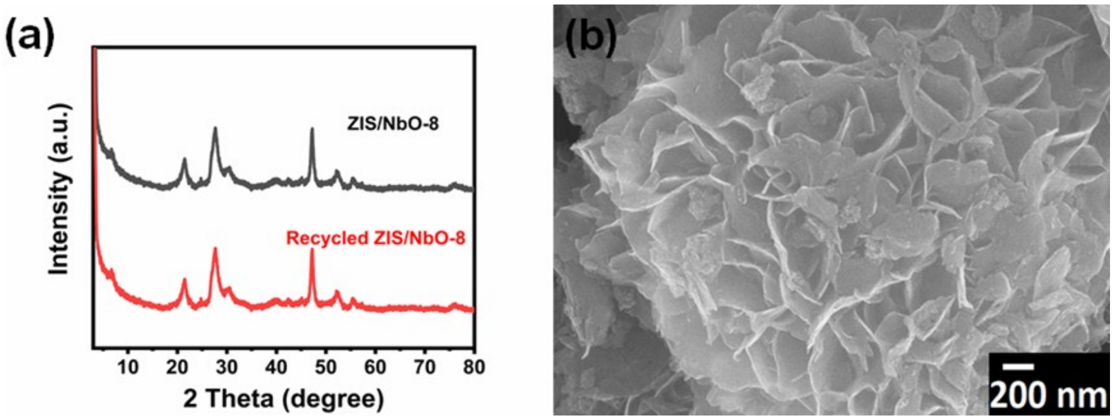


**Fig. S10** (a) XRD patterns of the fresh and long-term photocatalytic test for ZIS/NbO-8. (b) SEM image of the recycled ZIS/NbO-8.

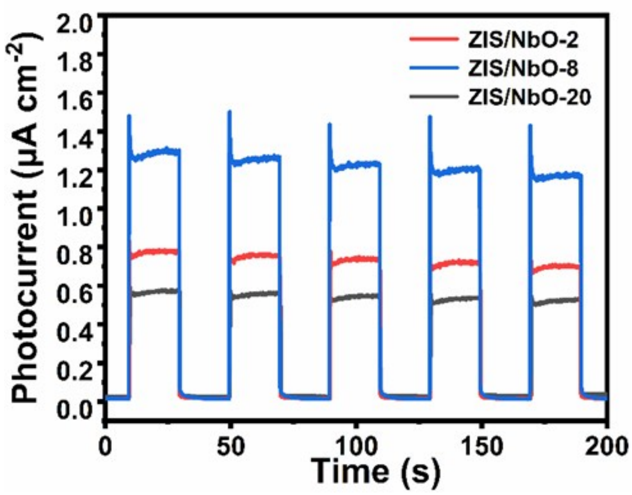


**Fig. S11** Transient photocurrent spectra for ZIS/NbO-2, ZIS/NbO-8 and ZIS/NbO-20.

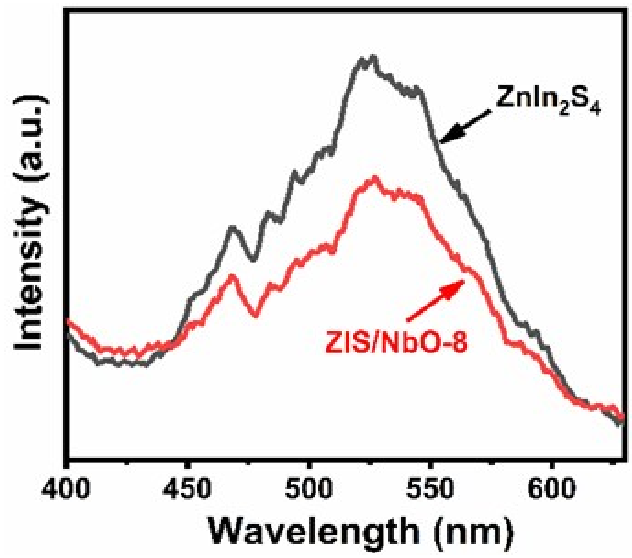


**Fig. S12** Steady-state PL spectra of $ZnIn_2S_4$ and ZIS/NbO-8, respectively.

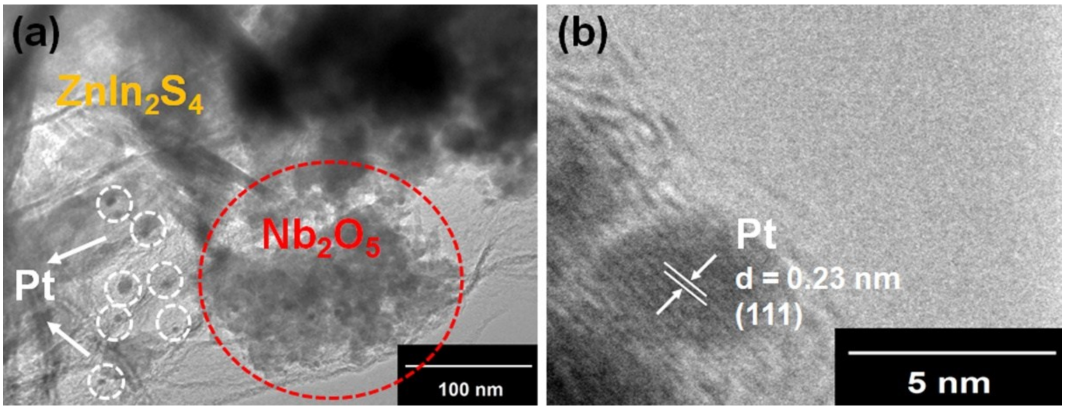


**Fig. S13** TEM (a) and HRTEM images (b) of ZIS/NbO-8 composite loaded with Pt.

**Table S1** Comparison of the photocatalytic activity of the reported $Nb_2O_5$-based composites.

| Catalysts | Light Source | Reaction Conditions | $H_2$ Evolution Rate (μmol $g^{-1}$ $h^{-1}$) | Ref. |
|---|---|---|---|---|
| ZIS/NbO | 300 W Xe lamp, Simulated solar light | 6 wt.% Pt co-catalyst; Aqueous TEOA solution (15 %) | 6026 | This work |
| $CuO/Nb_2O_5$ | 300 W white light source, broadband | 2 wt.% CuO co-catalyst; Aqueous methanol solution (10%) | 1405 | ref. 1 |
| $NiO/Nb_2O_5$ | 300 W white light source, broadband | 2 wt.% NiO co-catalyst; Aqueous methanol solution (10%) | 800 | ref. 1 |
| $Pt/Nb_2O_5$ | 300 W white light source, broadband | 2 wt.% Pt co-catalyst; Aqueous methanol solution (10%) | 510 | ref.1 |
| $Nb_2O_5$ hollow nanospheres | 300W Xe lamp, (λ> 420 nm) | 3 wt.% Pt co-catalyst; Aqueous $Na_2SO_3$ solution (2.5%) | 130 | ref.2 |
| $CdS/Nb_2O_5$/ NGR | 150 W Xe lamp, (λ> 400 nm) | a mixed aqueous solution (0.35 M $Na_2S$ and 0.25 M $Na_2SO_3$) | *ca.* 100 | ref.3 |
| $g-C_3N_4/Nb_2O_5$ | 300 W Xe lamp, (λ> 400 nm) | 1.5wt.% Pt co-catalyst; Aqueous TEOA solution (10 %) | 1710 | ref.4 |
| r- $Nb_2O_5$ | 300 W Xe lamp, Full-sunlight | 0.5wt.% Pt co-catalyst; Aqueous methanol solution (20%) | 274.8 | ref.5 |

**Table S2.** The results of photocatalytic oxidation of HMF in reported literatures.

| Catalysts | Reaction Conditions | Conv. of HMF (%) | Sel. to DFF (%) | Ref. |
|---|---|---|---|---|
| **ZIS/NbO-8** | **Solvent: $PhCF_3$ (5 mL) Time:3 h, 30 °C Simulated solar light** | **85.5%** | **88.3%** | **This Work** |
| **$Nb_2O_5$-800** | **Solvent: $PhCF_3$ (5 mL) Time:6 h, 30 °C λ > 400 nm** | **19.2%** | **90.6%** | **ref.6** |
| **P25** | **Solvent: $PhCF_3$ (5 mL) Time:6 h, 30 °C UV light** | **71.2%** | **17.7%** | **ref.6** |
| **4.7%$WO_3$/g-$C_3N_4$** | **Solvent: ACN (3 mL) + $PhCF_3$ (2 mL) Time: 6 h λ > 400 nm, 30 °C** | **27.4%** | **87.2%** | **ref.7** |
| **1.5% Fe (III)/BMO** | **Solvent: DI water (5 mL) Time: 8 h, RT λ > 400 nm** | **32.62%** | **95.30%** | **ref.8** |
| **g-$C_3N_4$** | **Solvent: ACN + $PhCF_3$ Time: 6 h λ > 400 nm** | **20.2%** | **89.6%** | **ref.9** |
| **$Ru_3$/rGO** | **Solvent: Toluene (10 mL) Time: 8 h, 80 °C λ > 400 nm** | **75.9%** | **96%** | **ref.10** |
| **$Au_3$/rGO** | **Solvent: Toluene (10 mL) Time: 8 h, 80 °C λ > 400 nm** | **83%** | **<1%** | **ref.10** |
| **$Au_{0.5}Ru_{2.5}$/rGO** | **Solvent: Toluene (10 mL) Time: 8 h, 80 °C λ > 400 nm** | **95.7%** | **95%** | **ref.10** |

(ACN: acetonitrile; $PhCF_3$: benzotrifluoride; RT: room temperature)


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