Electronic Supplementary Information (ESI)

Phosphorus-doping In_2S_3 with rich sulfur vacancy toward efficient photocatalytic hydrogen production from formaldehyde solution

*Jing Sui,[a] Zhengxin Peng,[a] Nan Lu,[a,b] KaiCheng Qian,[b] Xiaofan Zhang,[a] Tong Wei,[b] Renhong Li [b]and Xiaoqing Yan**[a]

[a] Department of Chemistry, School of Chemistry and Chemical Engineering, Zhejiang Sci-Tech University, Hangzhou, 310018, PR China.

[b] National Engineering Lab for Textile Fiber Materials and Processing Technology, School of Materials Science & Engineering, Zhejiang Sci-Tech University, Hangzhou, 310018, PR China.

***Corresponding Authors**

E-mail: yanxiaoqing927@126.com *(X.Q. Yan)*

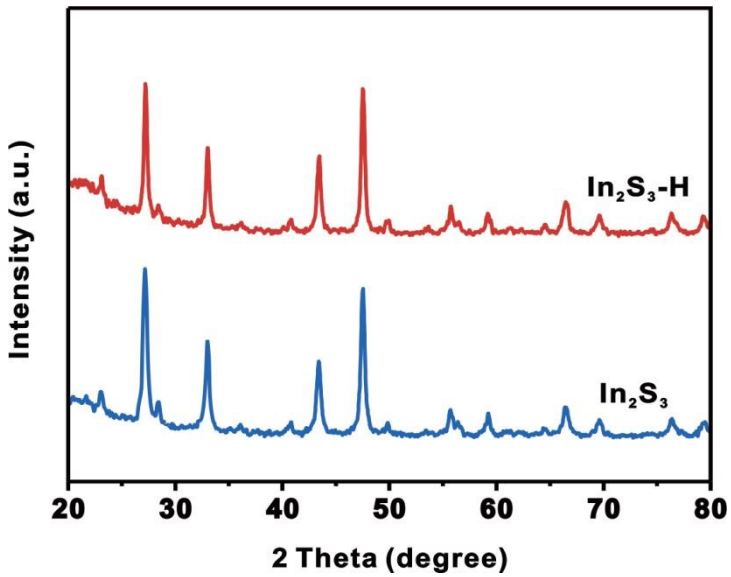

Figure S1. XRD patterns of In_2S_3 and In_2S_3-H.

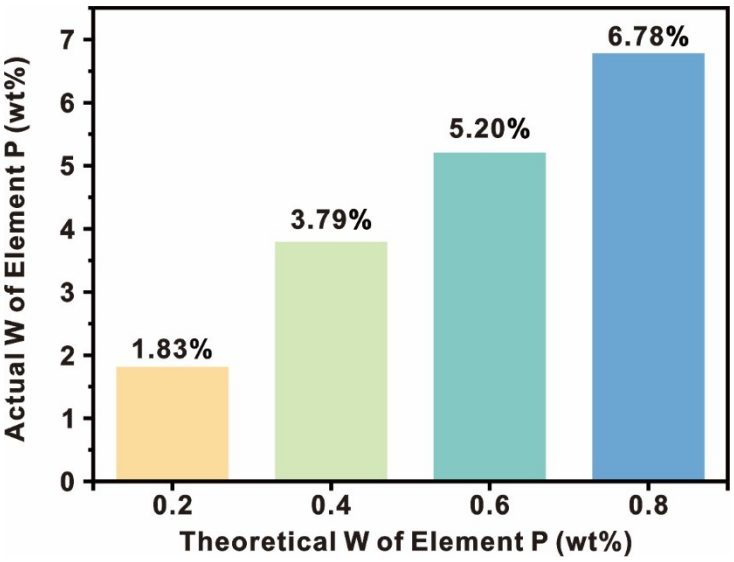

Figure S2. Mass fraction of phosphorus in P-In_2S_3.

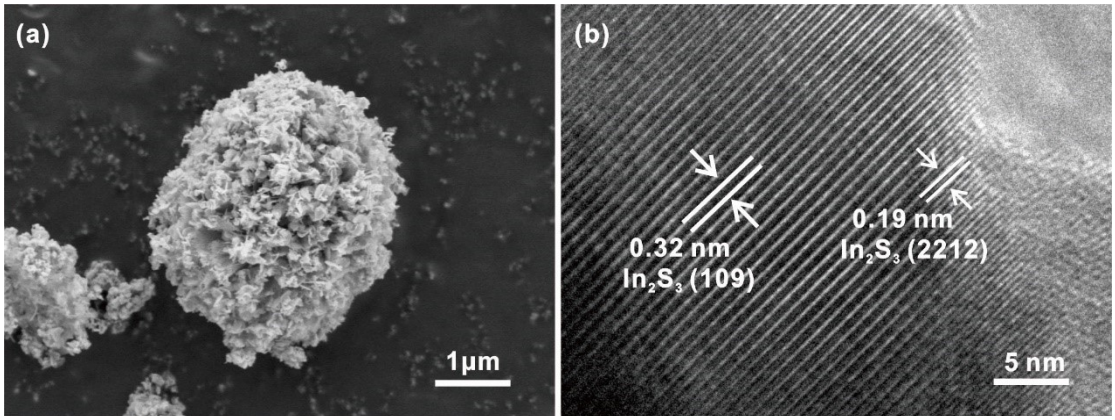

Figure S3. (a) SEM and (b) HRTEM of In_2S_3.

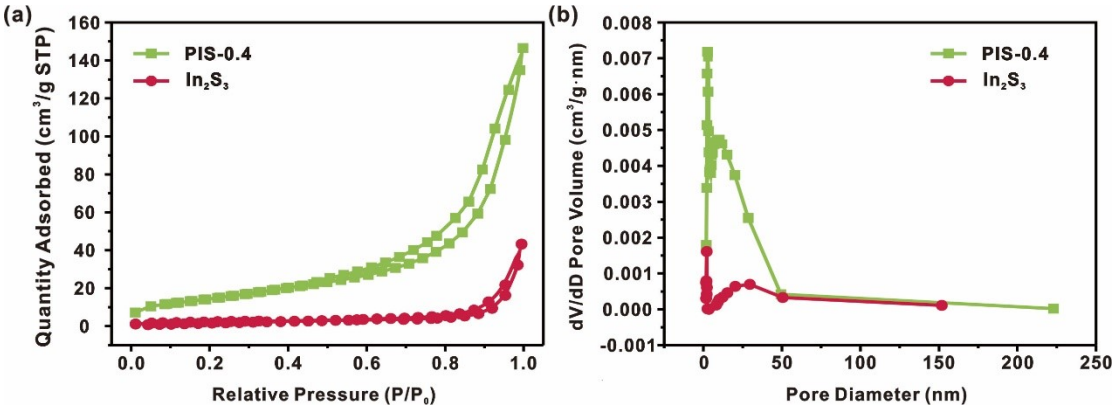

Figure S4. (a) N_2 adsorption-desorption isotherms and (b) the pore size distribution plots of PIS-0.4 and In_2S_3.

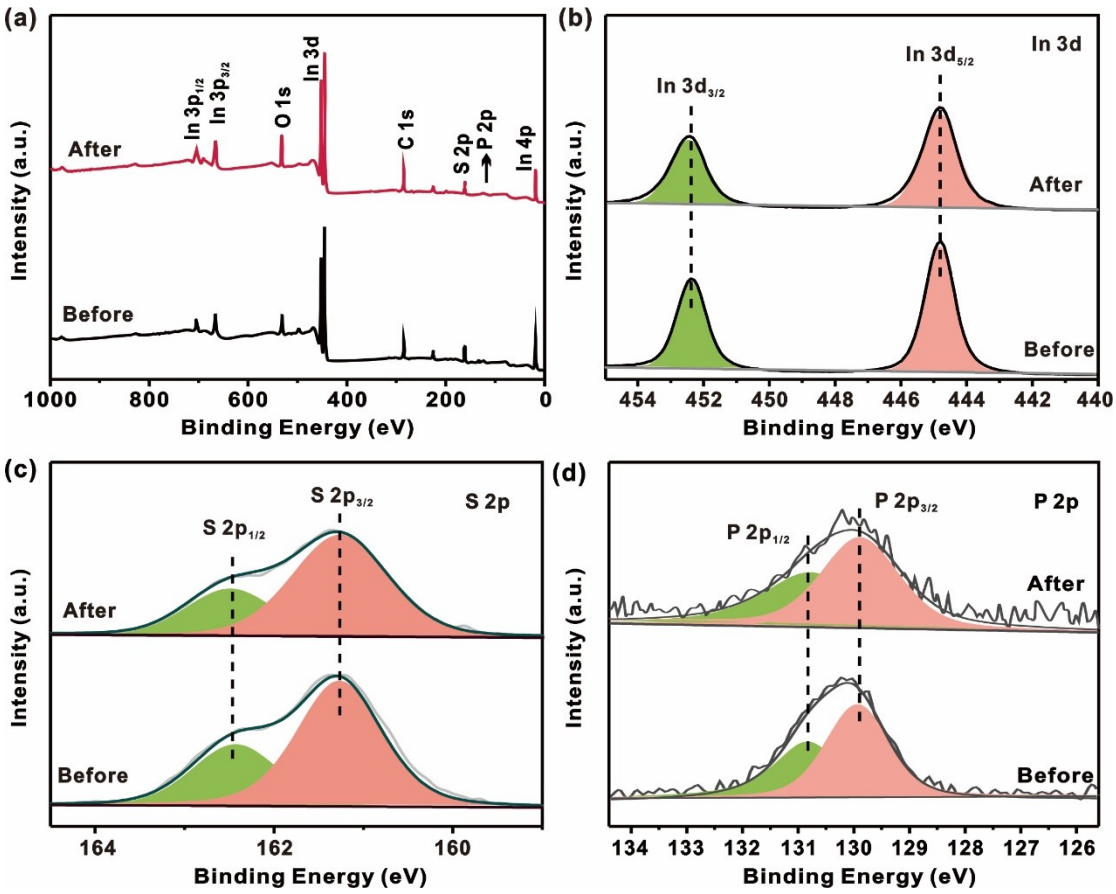

Figure S5. The XPS (a) survey, (b) In 3d, (c) S 2p, and (d) P 2p core levels spectra of PIS-0.4 before and after photocatalytic HCHO oxidation reaction.

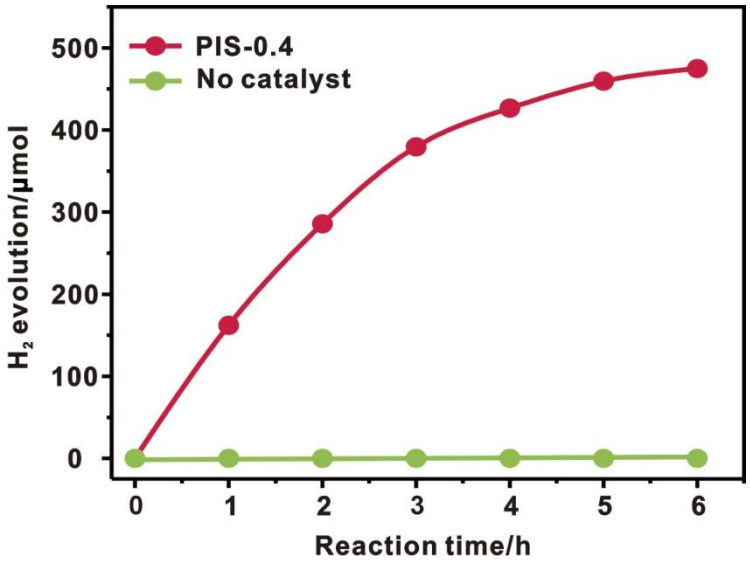

Figure S6. The time profiles of hydrogen production from PIS-0.4 and no catalyst suspending in an aqueous solution containing equimolar amounts (1M) of HCHO and NaOH at 0.21 O_2 atm under light conditions.

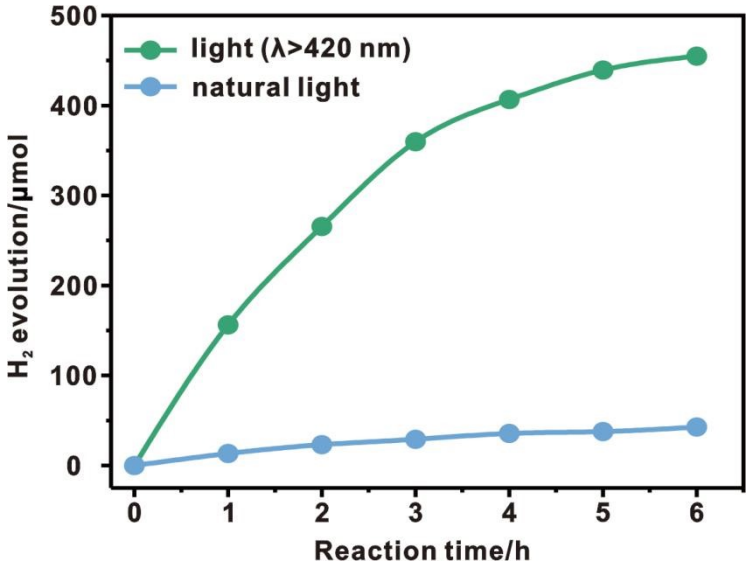

Figure S7. The time profiles of hydrogen production from PIS-0.4 suspending in an aqueous solution containing 1 M HCHO and 1 M NaOH at 0.21 O_2 atm, under natural light and light conditions (λ >420 nm).

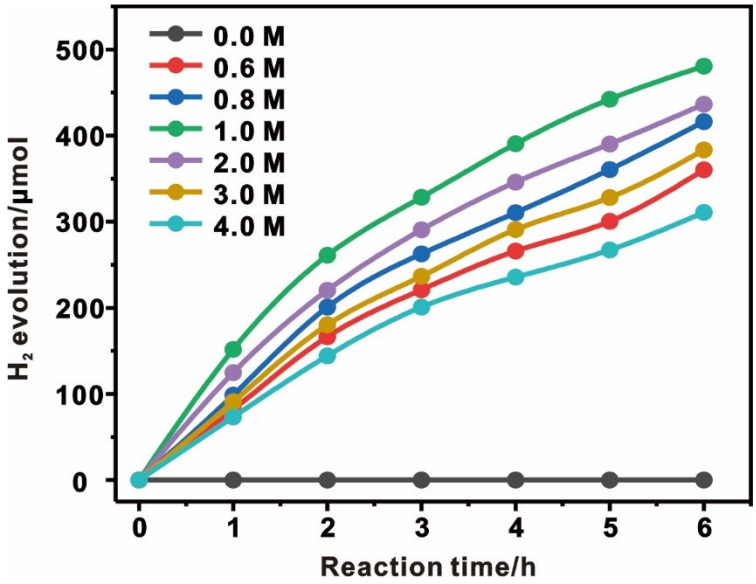

Figure S8. The time profiles of hydrogen production from PIS-0.4 suspending in an aqueous solution containing 1 M of NaOH and different concentrations of HCHO at 0.21 O_2 atm under visible-light irradiation (λ > 420 nm).

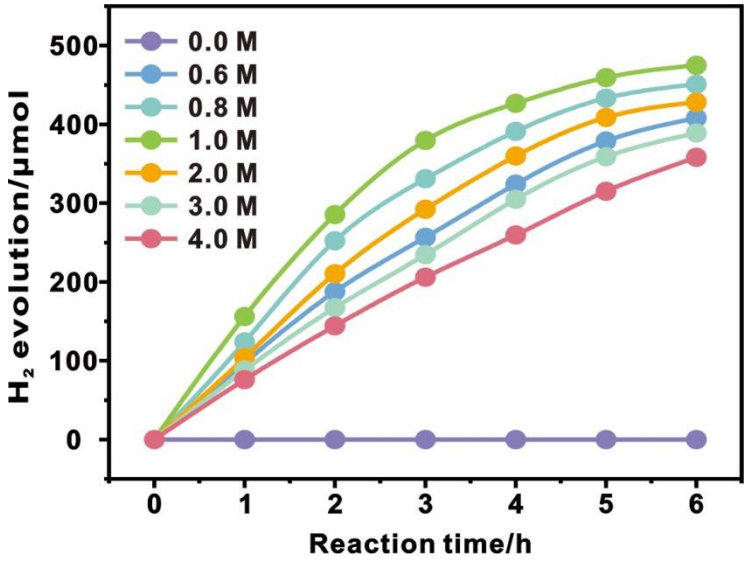

Figure S9. The time profiles of hydrogen production from PIS-0.4 suspending in an aqueous solution containing 1 M of HCHO and different concentrations of NaOH at 0.21 O_2 atm under visible-light irradiation (λ > 420 nm).

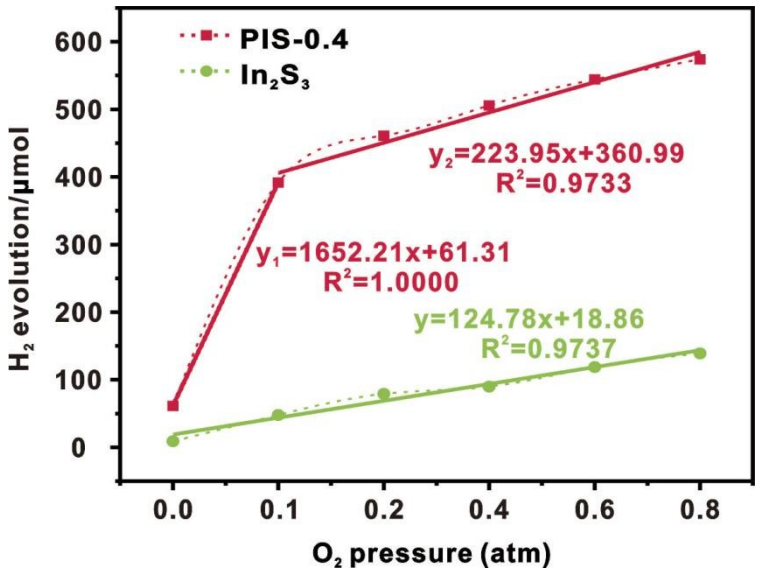

Figure S10. The amount of H_2 evolved after 6 h of photocatalytic reaction of PIS-0.4 and In_2S_3 as a function of pO_2.

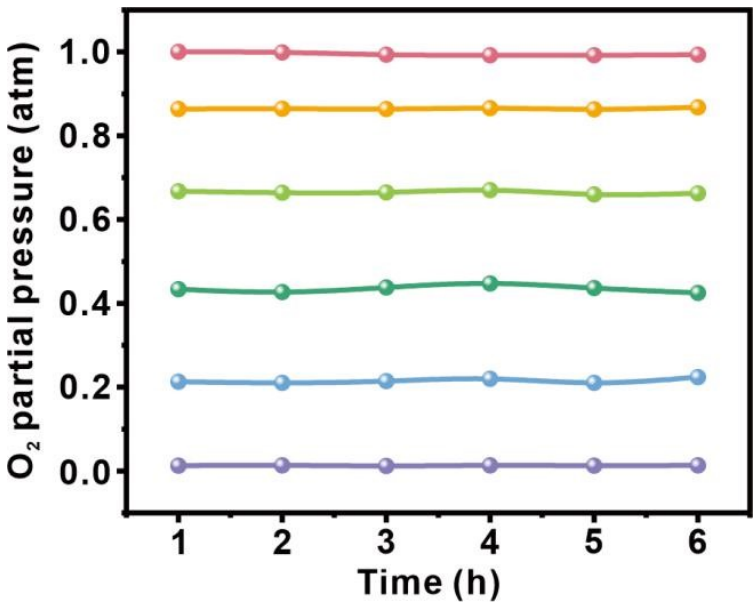

Figure S11. The temporal change of O_2 partial pressure within 6 h of reaction with different initial O_2 partial pressure (pO_2).