

# **Supporting Information**

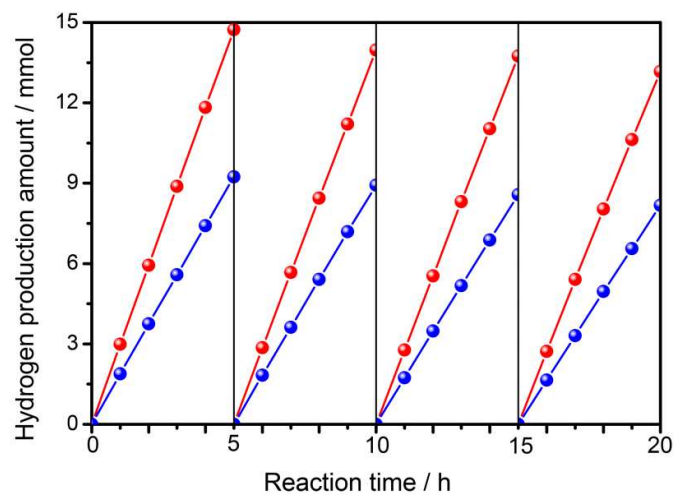
## **Intergrowth of Cocatalysts with Host Photocatalysts for Improved Solar-to-Hydrogen Conversion**

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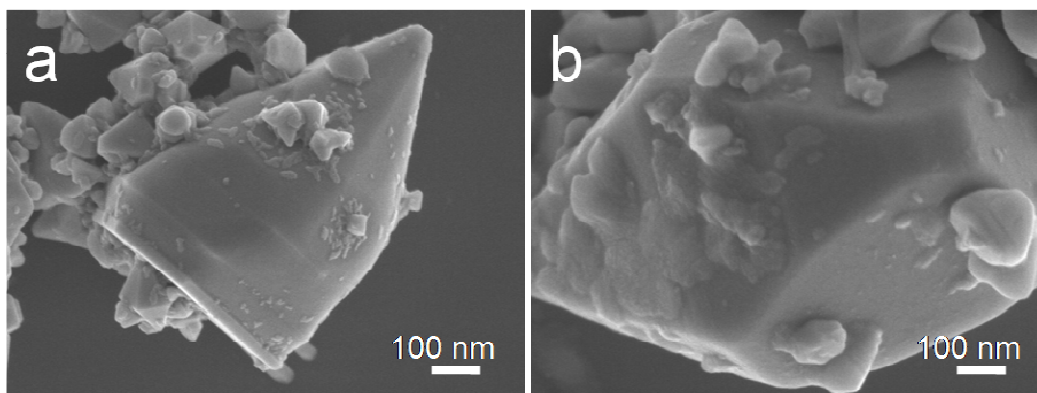
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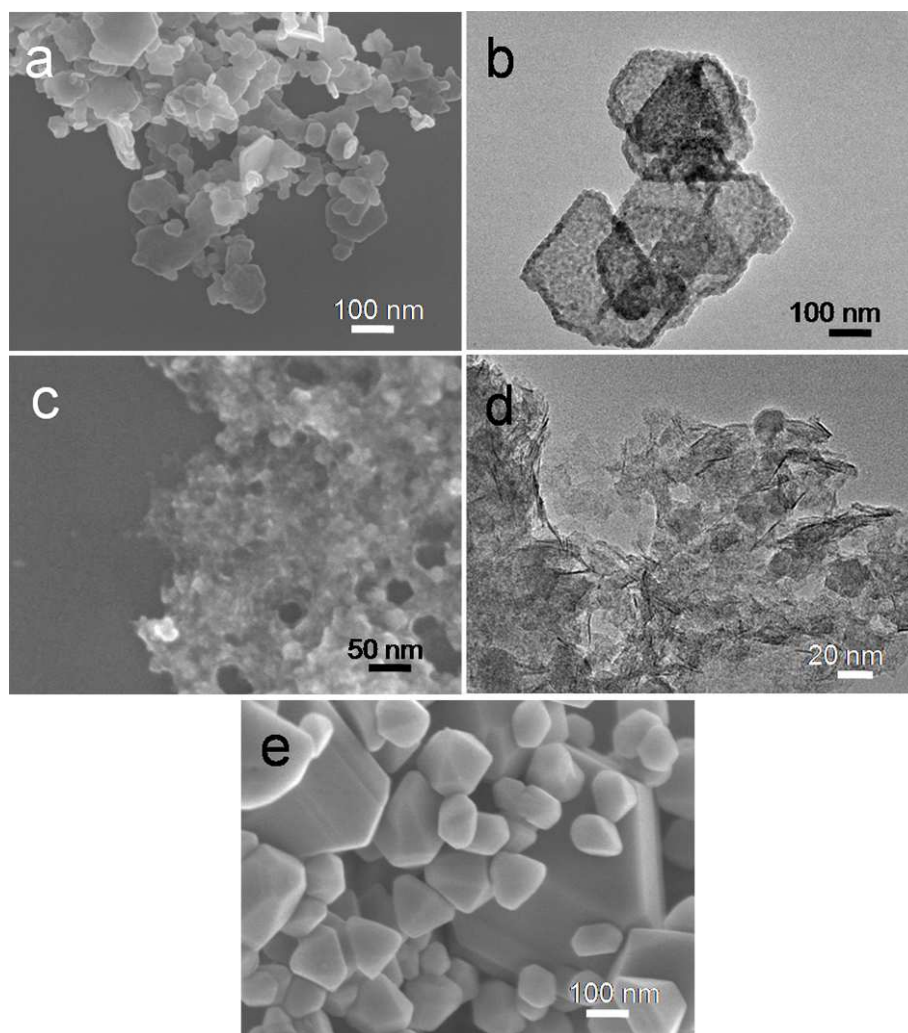
E-mail: ybchen@mail.xjtu.edu.cn (Y. Chen); lj-guo@mail.xjtu.edu.cn (L. Guo).



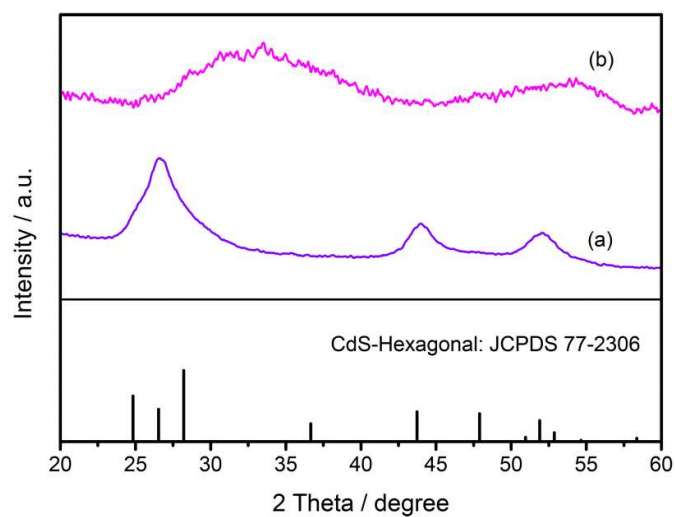
**Figure S1** Long-time photocatalytic test of NiS<sub>x</sub>/CdS (red) and NiS<sub>x</sub>@CdS (blue).



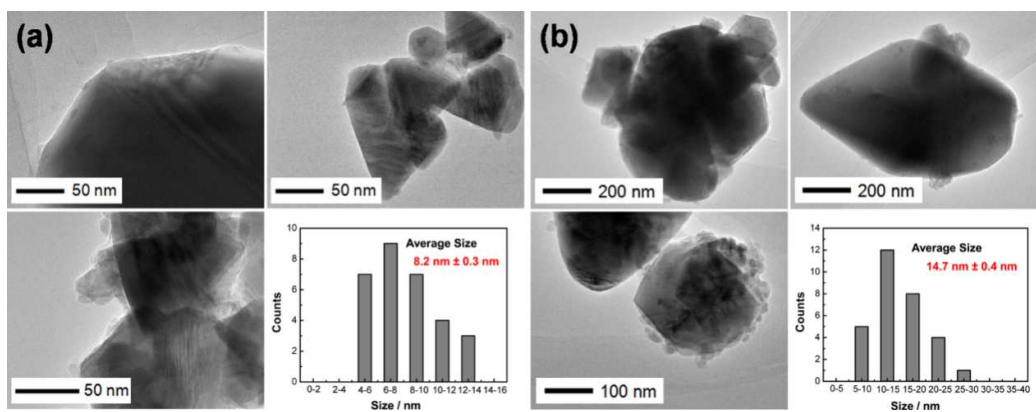
**Figure S2** (a) SEM image of NiS<sub>x</sub>/CdS-48; (b) SEM image of NiS<sub>x</sub>/CdS-72.



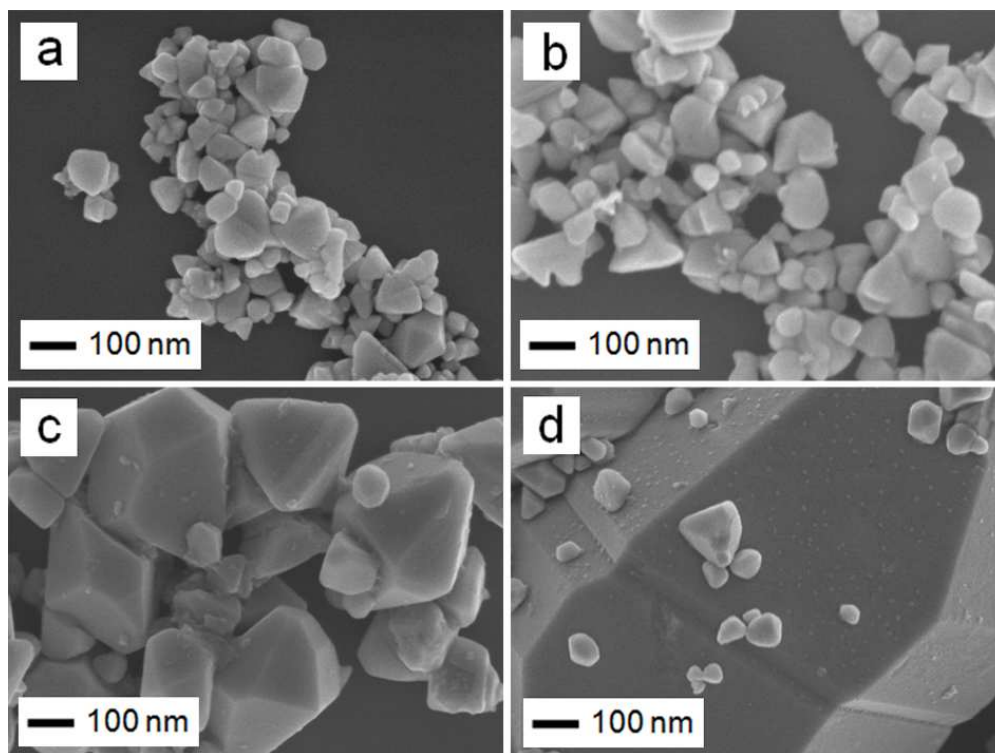
**Figure S3** (a) SEM image of CdS-0; (b) TEM image of CdS-0; (c) SEM image of NiS<sub>x</sub>-0; (d) TEM image of NiS<sub>x</sub>-0; (e) SEM image of CdS-48.



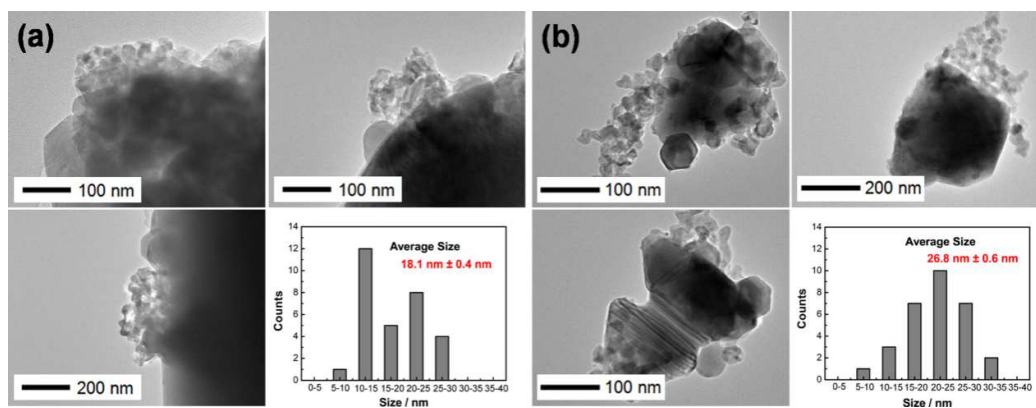
**Figure S4** XRD patterns of (a) CdS-0 and (b) NiS<sub>x</sub>-0.



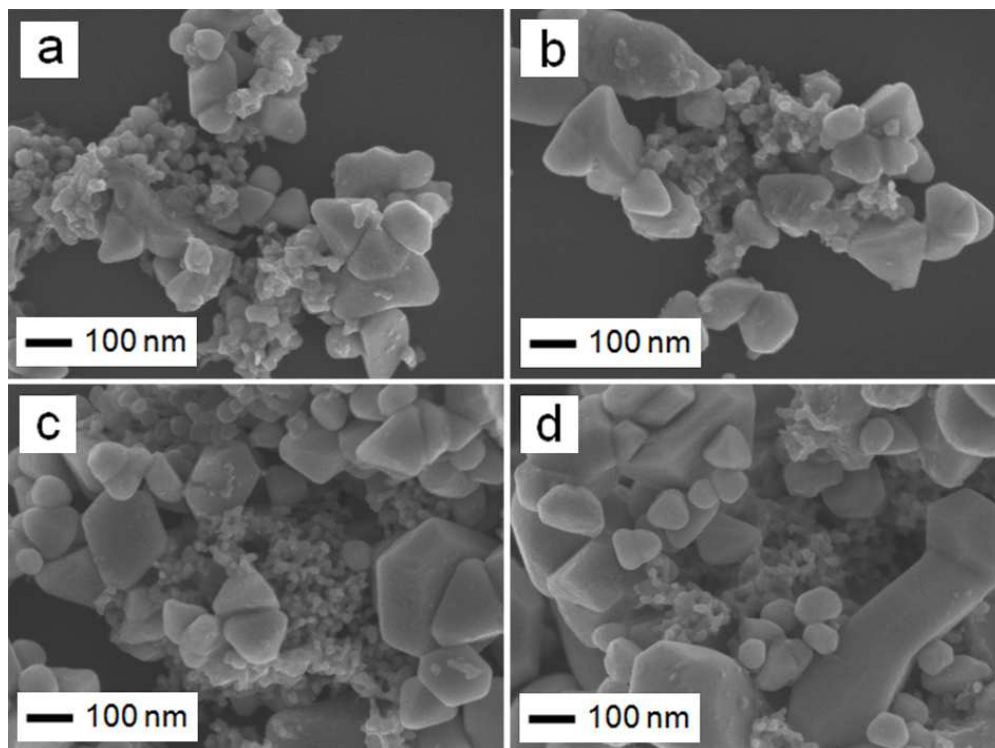
**Figure S5** (a) TEM images of NiS<sub>x</sub>/CdS-6 and the size distribution of NiS<sub>x</sub> nanoparticles in NiS<sub>x</sub>/CdS-6; (b) TEM images of NiS<sub>x</sub>/CdS-48 and the size distribution of NiS<sub>x</sub> nanoparticles in NiS<sub>x</sub>/CdS-48.



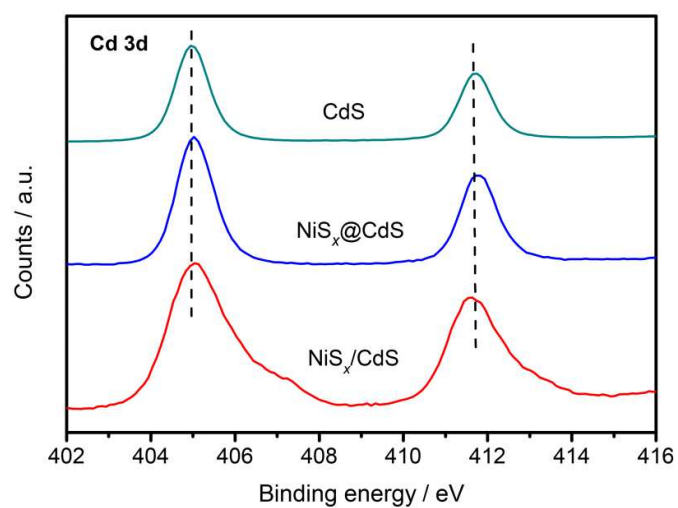
**Figure S6** SEM images of (a, b)  $\text{NiS}_x/\text{CdS-6}$ ; (c, d)  $\text{NiS}_x/\text{CdS-48}$ .



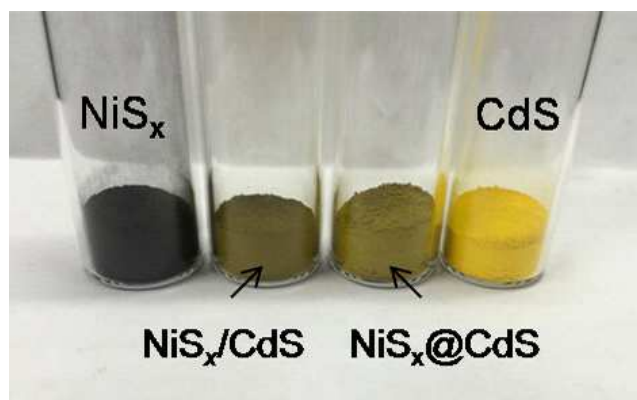
**Figure S7** (a) TEM images of  $\text{NiS}_x@\text{CdS-6}$  and the size distribution of  $\text{NiS}_x$  nanoparticles in  $\text{NiS}_x@\text{CdS-6}$ ; (b) TEM images of  $\text{NiS}_x@\text{CdS-48}$  and the size distribution of  $\text{NiS}_x$  nanoparticles in  $\text{NiS}_x@\text{CdS-48}$ .



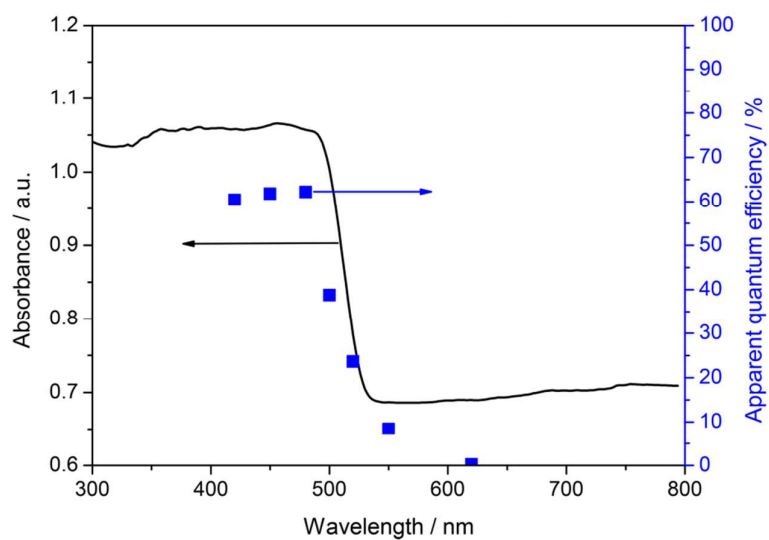
**Figure S8** SEM images of (a, b)  $\text{NiS}_x\text{@CdS-6}$ ; (c, d)  $\text{NiS}_x\text{@CdS-48}$ .



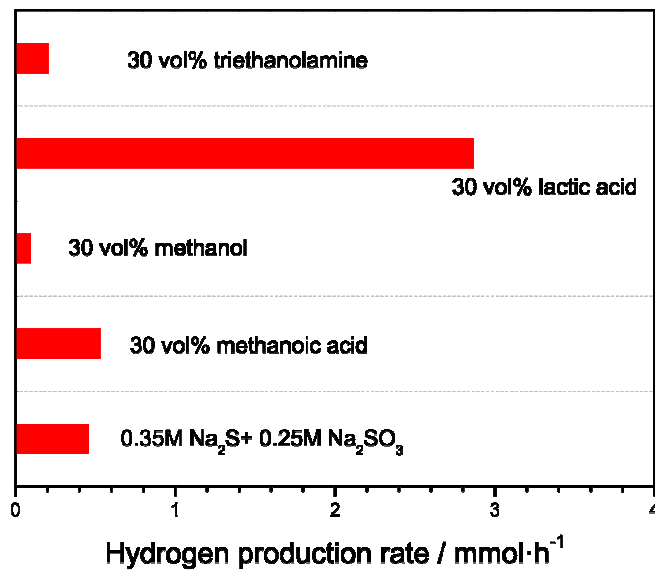
**Figure S9** Cd 3d XPS spectra of  $\text{NiS}_x/\text{CdS}$ ,  $\text{NiS}_x\text{@CdS}$ , and CdS samples.



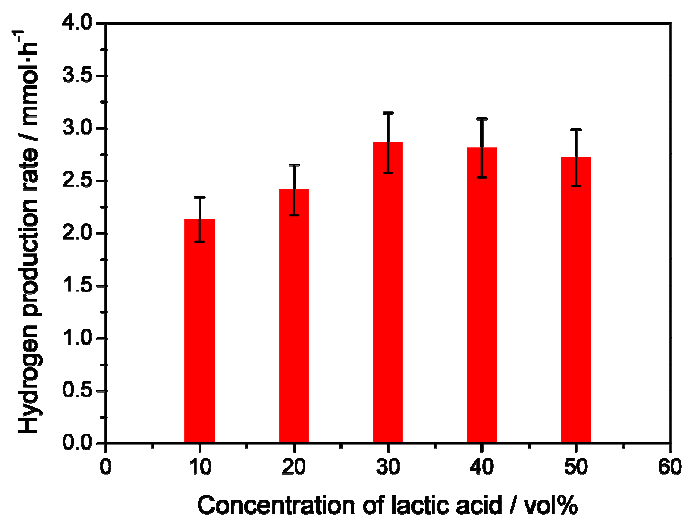
**Figure S10** Photograph of  $\text{NiS}_x$ ,  $\text{NiS}_x/\text{CdS}$ ,  $\text{NiS}_x@\text{CdS}$ , and  $\text{CdS}$  samples.



**Figure S11** The action spectrum for hydrogen evolution in 30 vol% lactic acid aqueous solution over  $\text{NiS}_x/\text{CdS}$  photocatalysts and their UV-vis absorption spectrum.

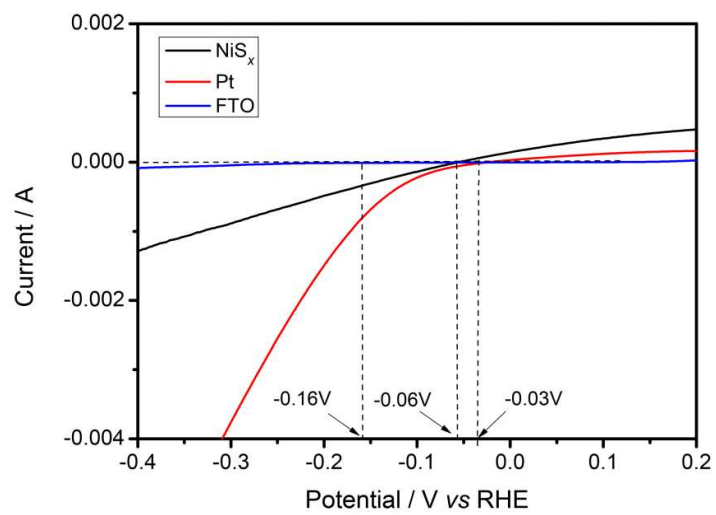


**Figure S12** Photocatalytic activities of NiS<sub>x</sub>/CdS under different sacrificial systems.



**Figure S13** Photocatalytic activities of NiS<sub>x</sub>/CdS in the aqueous solution with different concentrations of lactic acid.





**Figure S14** Current-voltage curves of the NiS<sub>x</sub>, Pt, and FTO electrodes.