Supporting information

Construction of Al-ZnO/CdS Photoanodes Modified with Distinctive Alumina Passivation Layer for Improvement of Photoelectrochemical Efficiency and Stability

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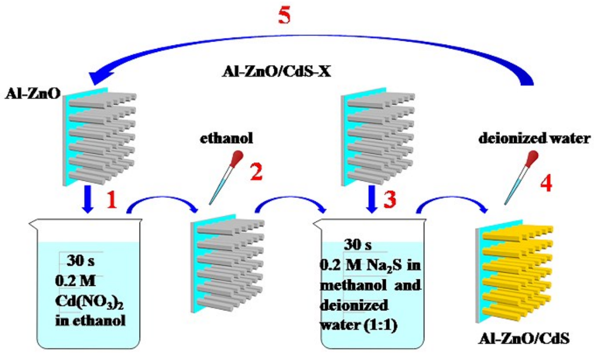

Figure S1. Schematic diagram of depositing CdS on Al-ZnO NRs by SILAR.

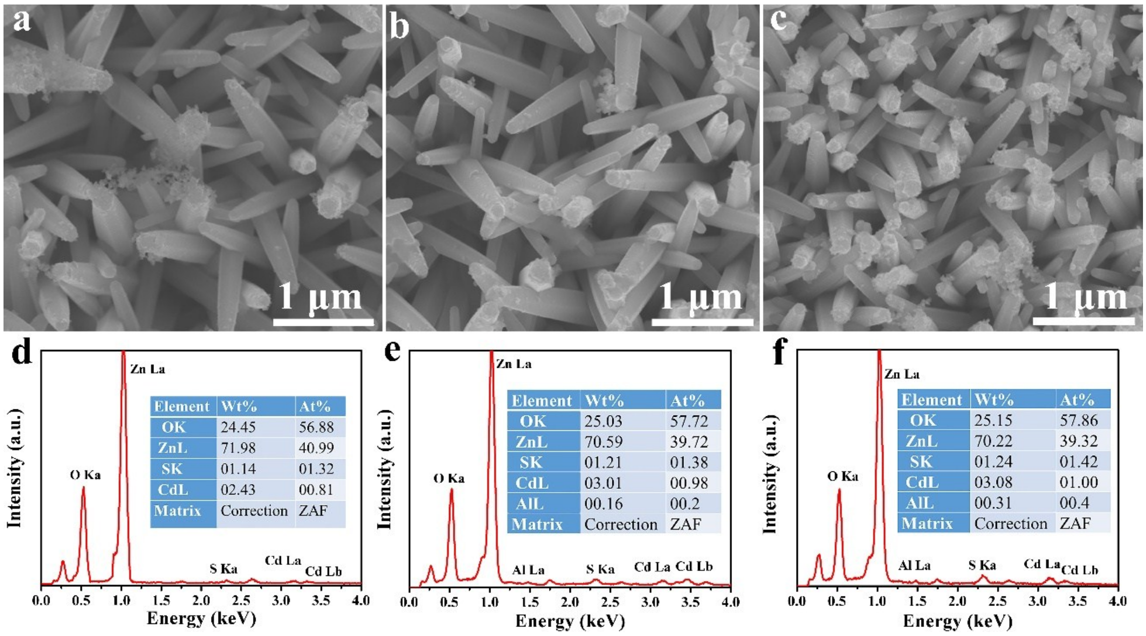

Figure S2. FE-SEM image and corresponding EDS, (a) and (d) for Al-ZnO, (b) and (e) for 0.01 Al-ZnO/CdS, (c) and (f) for 0.03 Al-ZnO/CdS.

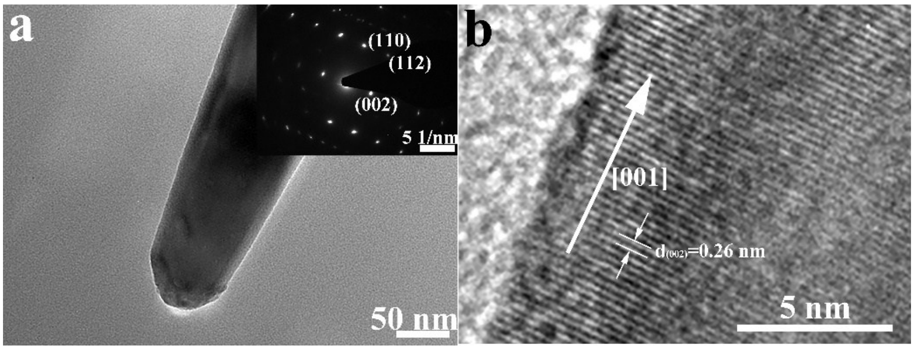

Figure S3. (a) TEM and (b) HRTEM images of ZnO. The inset of (a) shows selected area electron diffraction patterns.

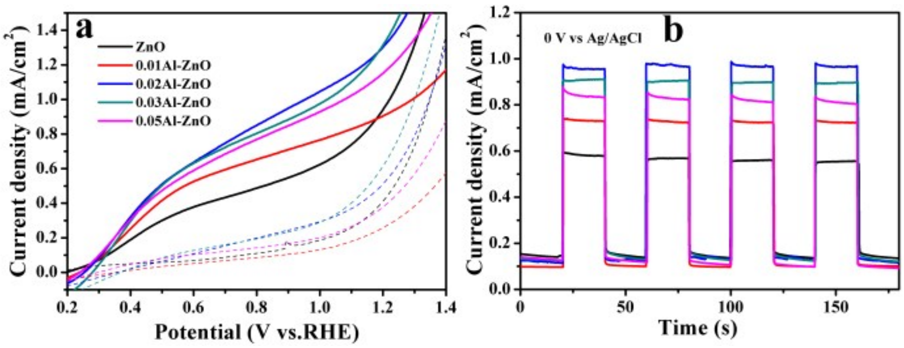

Figure S4. (a) Linear sweep voltammograms of Al-ZnO with different Al doping amount. The dotted line is the corresponding dark current curves), and (b) the corresponding amperometric I-t curves plotted at an external potential of 0 V versus Ag/AgCl, under chopped illumination.

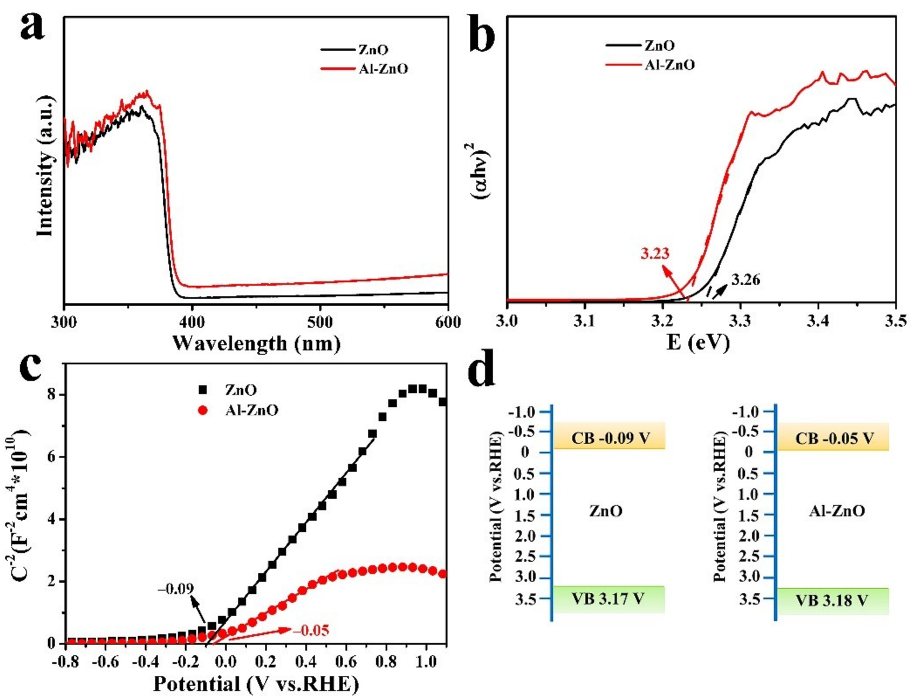

Figure S5. (a) and (b) UV-vis absorption spectra of ZnO and Al-ZnO. (c) Mott-Schottcky plots for ZnO and Al-ZnO, measured at 1 kHz. (d) Band positions of ZnO and Al-ZnO.

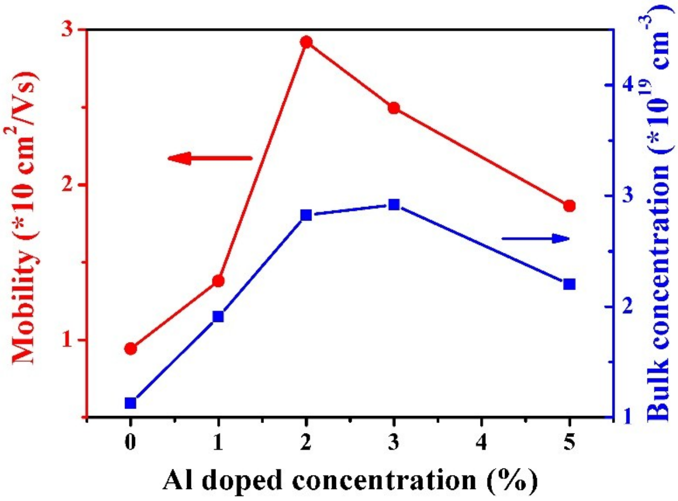

Figure S6. The mobility and charge carrier bulk concentration obtained from Hall Effect measurement of Al-ZnO with different Al doped concentration.

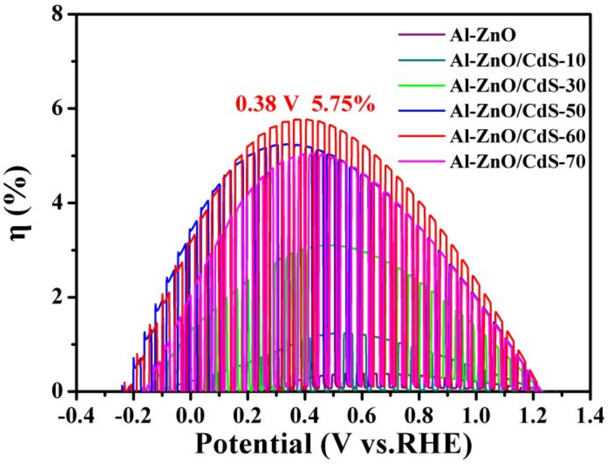

Figure S7. Photoconversion efficiencies of Al-ZnO and Al-ZnO/CdS with different SILAR cycles.

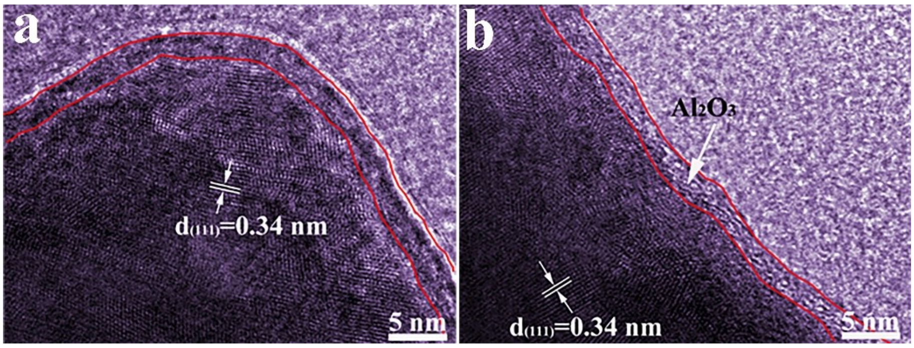

Figure S8. The HRTEM images of the Al-ZnO/CdS photoanode coating with ～3 nm Al_2O_3 by (a) DCMS and (b) ALD.

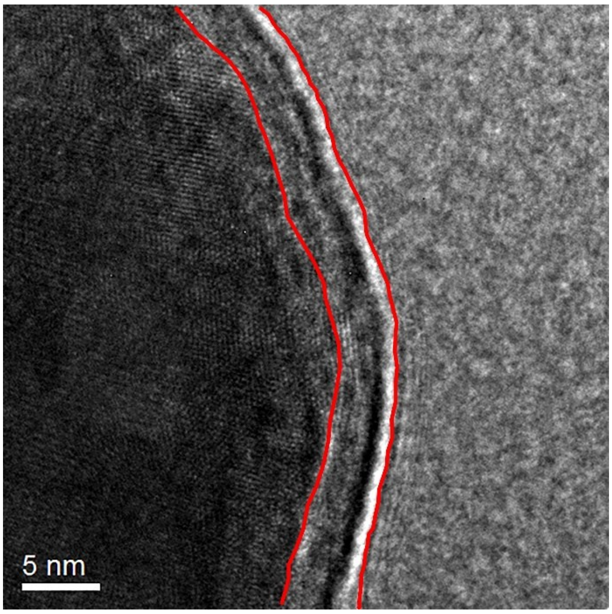

Figure S9. The HRTEM images of the Al-ZnO/CdS photoanode coating with ～5 nm Al_2O_3 by DCMS.

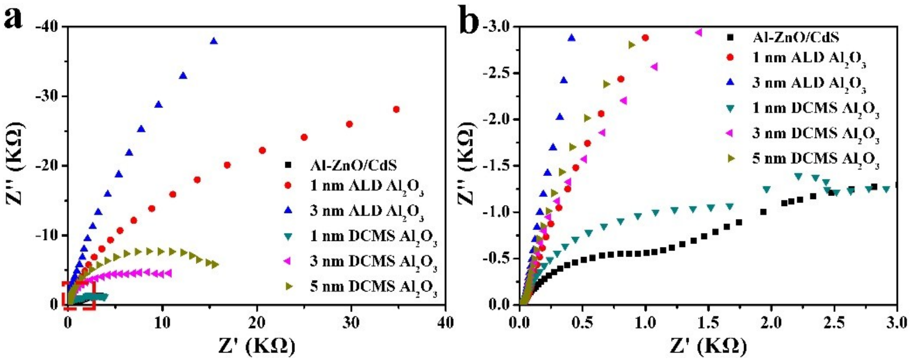

Figure S10. (a) EIS Nyquist plots of Al-ZnO/CdS coated with 1 and 3 nm Al_2O_3 by ALD and DCMS. (b) Amplified section in (a).

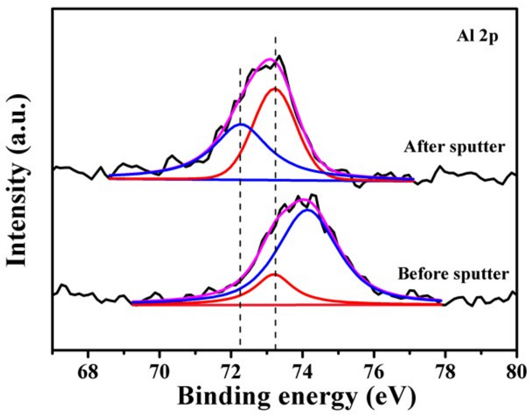

Figure S11. Al 2p spectra of Al-ZnO/CdS DCMS 3nm Al_2O_3 before and after Ar sputter.

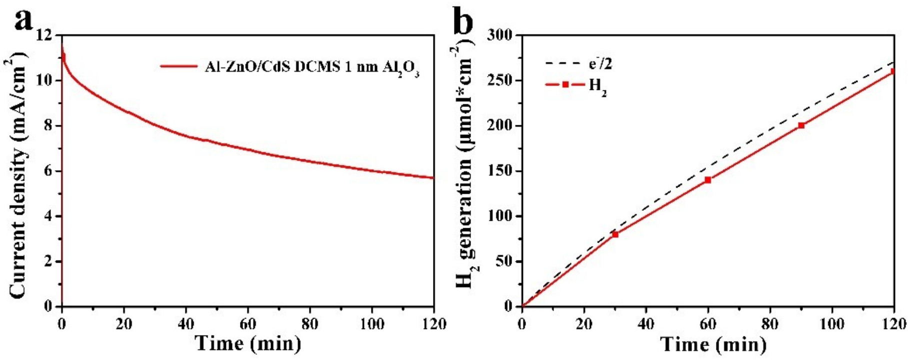

Figure S12. (a) Photocurrent stability of the Al-ZnO/CdS DCMS 1 nm Al_2O_3 obtained at 1.23 V *vs*. RHE. (b) H_2 evolution for the Al-ZnO/CdS DCMS 1 nm Al_2O_3 sample derived from the potentiostatic photocurrent measurement. The dashed line correspond to a faradaic efficiency of 100%.

Table S1. A brief review of similar ZnO/CdS photoelectrodes and the corresponding photoresponses.

Photoanode	Electrolyte	Photocurrent density (mA/cm^2)	Maximum Photoconversion efficiency (%)	Ref.
ZnO/CdS NAs	0.25 M Na_2S and 0.35 M Na_2SO_3	6 (0 $V_{Ag/AgCl}$, λ≥435 nm)	—	[1]
ZnO/Ag/CdS NAs	0.25 M Na_2S and 0.35 M Na_2SO_3	4 (0V_{SCE}, 100mW/cm^2)	3.13 (0.34 V vs.RHE)	[2]
3D branched ZnO NWA/CdS	0.5 M Na_2S	3.58 (0 $V_{Ag/AgCl}$, 70 mW/cm^2)	3.1 (not given)	[3]
$ZnFe_2O_4$/ZnO/CdS NAs	0.5 M Na_2S	3.88 (0 $V_{Ag/AgCl}$,70 mW/cm^2)	4.43 (0.2 V vs.RHE)	[4]
ZnO/CdS NAs	1 M Na_2S	3.31 (0 $V_{Ag/AgCl}$, 100 mW/cm^2)	—	[5]
ZnO/CdS NTs	0.25 M Na_2S and 0.35 M Na_2SO_3	~7.5 (0 V_{SEC}, λ≥420 nm)	—	[6]
ZnO NRs/CdS	1 M Na_2S	6 (0 $V_{Ag/AgCl}$, 100 mW/cm^2)	—	[7]
3D ZnO/Au/CdS sandwich	0.25 M Na_2S and 0.35 M Na_2SO_3	5.7 (0 $V_{Ag/AgCl}$, 100 mW/cm^2)	—	[8]
ZnO NRs/CdS	0.25 M Na_2S and 0.35 M Na_2SO_3	9.16 (0.4 V_{SCE}, 100 mW/cm^2)	4.03 (about -0.4 V_{SCE})	[9]
H-ZnO/CdS/$Ni(OH)_2$	0.5 M Na_2SO_4 (with pH buffered to ~7)	4.65 (0.4 $V_{Ag/AgCl}$, 60 mW/cm^2)	4.12 (0.68 V vsRHE)	[10]
Al-ZnO/CdS 60 SILAR cycles	0.25 M Na_2S and 0.35 M Na_2SO_3	9.7 (0 $V_{Ag/AgCl}$, 100 mW/cm^2)	5.75 (0.38 V vs.RHE)	This work
Al-ZnO/CdS/Al_2O_3 5 s DCMS	0.25 M Na_2S and 0.35 M Na_2SO_3	11.4 (0 $V_{Ag/AgCl}$, 100 mW/cm^2)	6.6 (0.41 V vs.RHE)	This work

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