Supplementary Information

NiO nanowires as hole-transfer layer for drastic enhancement of CdSe-sensitized photocathodes

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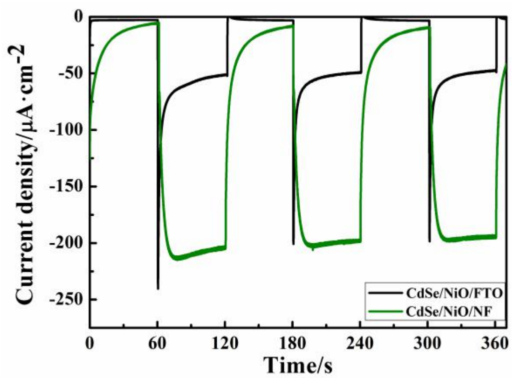

Figure S1. Photocurrent responses to on-off illumination of CdSe/NiO/FTO and CdSe/NiO/NF in air-saturated buffer solution (pH 6) at -0.222 V vs. Ag/AgCl. The NiO/NF(FTO) was prepared with 0.056 M $Ni(NO_3)_2$ and 0.112 M $CO(NH_2)_2$ precursor solution, and the SILAR cycle of CdSe was 6.

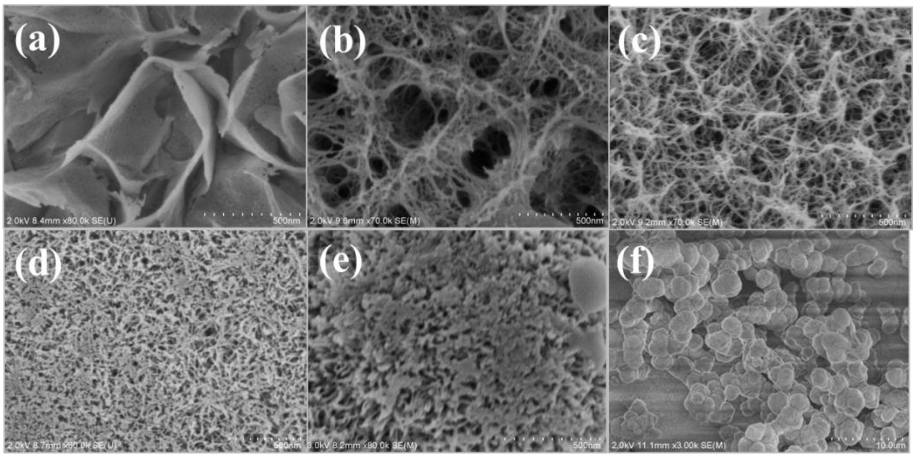

Figure S2. SEM images of (a) NiO-1/NF (b) NiO-2/NF(c) NiO-3/NF (d) NiO-4/NF (f) NiO-5/NF. (e) is the enlargement of (f). The NiO/NF prepared with 0.014 M $Ni(NO_3)_2$ and 0.028 M $CO(NH_2)_2$ precursor solution were signed as NiO-1/NF, and the electrode was signed as NiO-2/NF, NiO-3/NF, NiO-4/NF and NiO-5/NF when the concentrations of precursor solution is 2, 4, 6, 10 times of NiO-1/NF.)

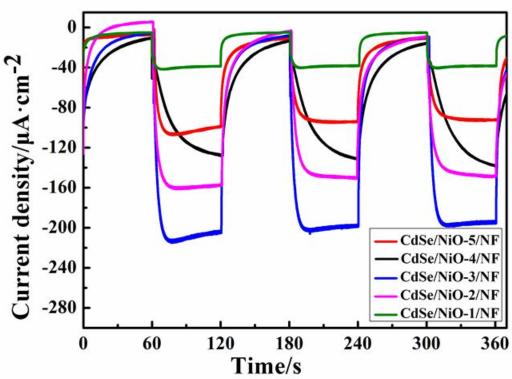

Figure S3. Photocurrent responses to on-off illumination of CdSe/NiO/NF in air-saturated buffer solution (pH 6) at -0.222 V vs. Ag/AgCl. (The NiO/NF prepared with 0.014 M $Ni(NO_3)_2$ and 0.028 M $CO(NH_2)_2$ precursor solution were signed as NiO-1/NF, and the electrode was signed as NiO-2/NF, NiO-3/NF, NiO-4/NF and NiO-5/NF when the concentrations of precursor solution is 2, 4, 6, 10 times of NiO-1/NF, and the SILAR cycle of CdSe was 6).

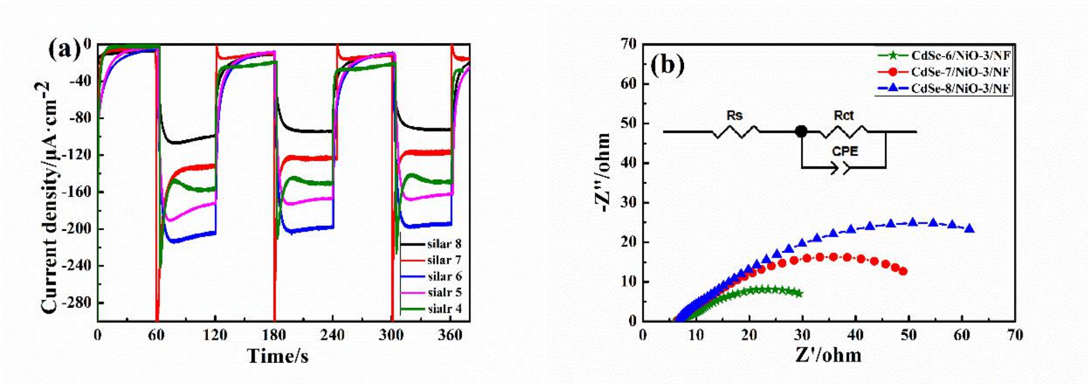

Figure S4. (a) Photocurrent responses to on-off illumination of CdSe/NiO/NF with different CdSe-SILAR cycle numbers (4-8) in air-saturated buffer solution (pH 6) at -0.222 V vs. Ag/AgCl. (b) Nyquist plots of CdSe/NiO/NF with different CdSe-SILAR cycle numbers (6-8) in nitrogen-saturated buffer solution (pH 6) with an equivalent circuit model in the inset. (The NiO/NF was prepared with 0.056 M $Ni(NO_3)_2$ and 0.112 M $CO(NH_2)_2$ precursor solution.)

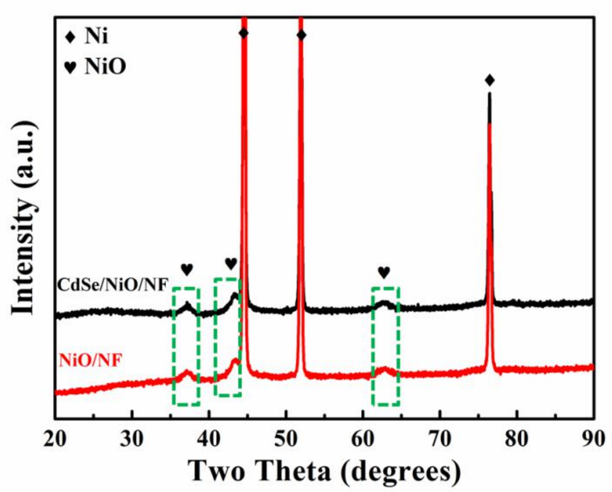

Figure S5. XRD patterns of NiO/NF and CdSe/NiO/NF photocathode. (The NiO/NF was prepared with 0.056 M $Ni(NO_3)_2$ and 0.112 M $CO(NH)_2$ precursor solution, and the SILAR cycle of CdSe was 6.)

Table S1. The results of EIS fitting into equivalent circuit model for CdSe/NiO/NF with different prepare conditions

Sample	$Ni(NO_3)_2 \cdot 6H_2O$ (M)	$CO(NH)_2$ (M)	SILAR cycles of CdSe	Rct (Ω)	CPE (μF)
CdSe-6/NiO/NF	0.056	0.112	6	49.05	10.64
CdSe-7/NiO/NF	0.056	0.112	7	61.94	6.11
CdSe-8/NiO/NF	0.056	0.112	8	98.83	2.99

Table S2. Comparison of different NiO-based photocathodes in a three-electrode PEC cell for the HER

Photocathode	conditions	Cocatalysist	Photocurrent density at an applied potential (V vs. NHE)	Ref.
CdSe(SILAR)/NiO NWs/NF	buffer solution (pH=6); λ >400 nm	No	50 μA cm^{-2} at -0.014 V	Present work
MoS_2/CdSe（SILAR）/porous NiO/FTO	buffer solution (pH=6); λ>400 nm	MoS_2	22 μA cm^{-2} at -0.014 V	1
CdSe(SILAR)/ NiO/FTO	0.1 M $LiClO_4$, 0.01 M PBS(pH= 6.8); λ > 420 nm	No	<20 μA cm^{-2} at 0 to 0.5 V	2
CdS/NiO/ FTO	0.05 M Na_2SO_4	Cobaloxime	25 μA cm^{-2} at 0 V	3
CdSe/NiO/FTO linker-engineered CdSe/NiO/FTO	0.1 M Na_2SO_4, (pH=6.8); λ>400 nm	No	8 μA cm^{-2} 55 μA cm^{-2}at -0.1 V	4 4
CdSe/NiO/FTO	0.1 M Na_2SO_4, (pH=6.8); λ>400 nm	CoP Co	102 μA cm^{-2} 100 μA cm^{-2} at 0 V	5 5

Table S3. The results of EIS fitting into equivalent circuit model for CdSe/NiO/NF with different prepare conditions

Sample	$Ni(NO_3)_2 \cdot 6H_2O$ (M)	$CO(NH)_2$ (M)	SILAR cycles of CdSe	Rct (Ω)	CPE (μF)
CdSe/NiO-1/NF	0.014	0.028	6	202.2	0.57
CdSe/NiO-2/NF	0.028	0.056	6	117.4	2.50
CdSe/NiO-3/NF	0.056	0.112	6	49.05	10.64
CdSe/NiO-4/NF	0.084	0.168	6	71.77	3.49
CdSe/NiO-5/NF	0.14	0.28	6	161.4	0.72

Notes and references

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