Enabling Highly Efficient Photocatalytic Hydrogen Generation and Organics Degradation via a Perovskite Solar Cell-Assisted Semiconducting Nanocomposite Photoanode

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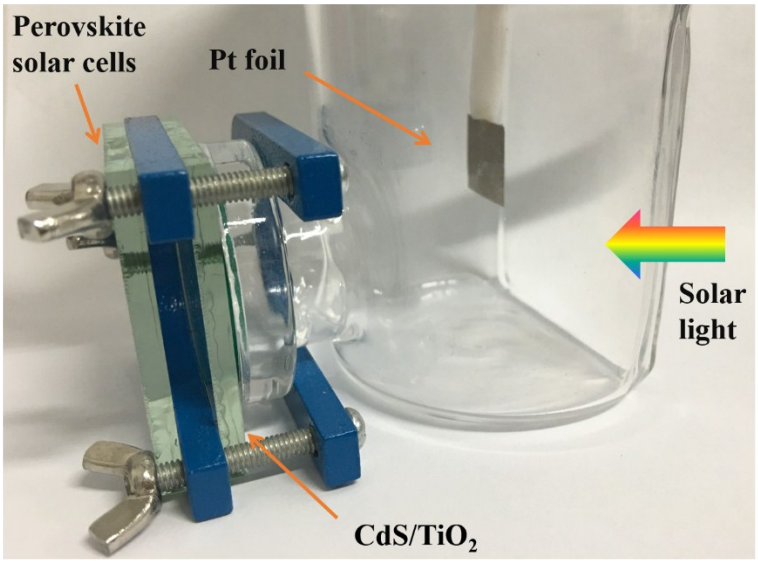


Fig. S1 Photograph of the integrated device composed of PSC and CdS/TiO_2 NRAs nanocomposite.

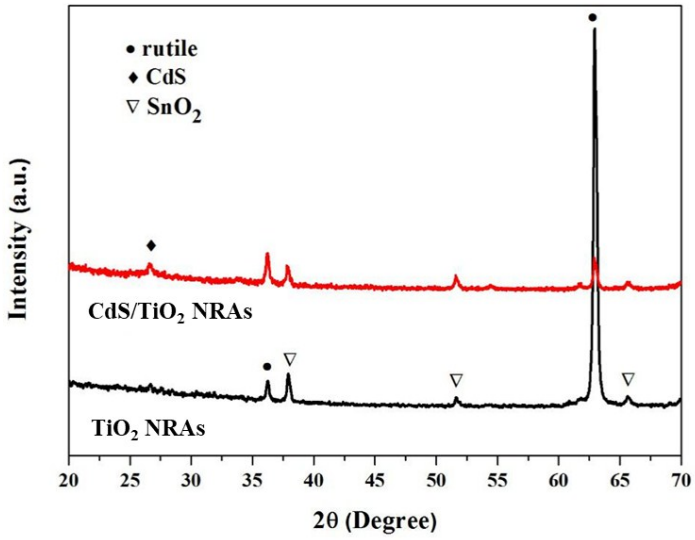


Fig. S2 The XRD spectra of TiO_2 NRAs and CdS/TiO_2 NRAs.

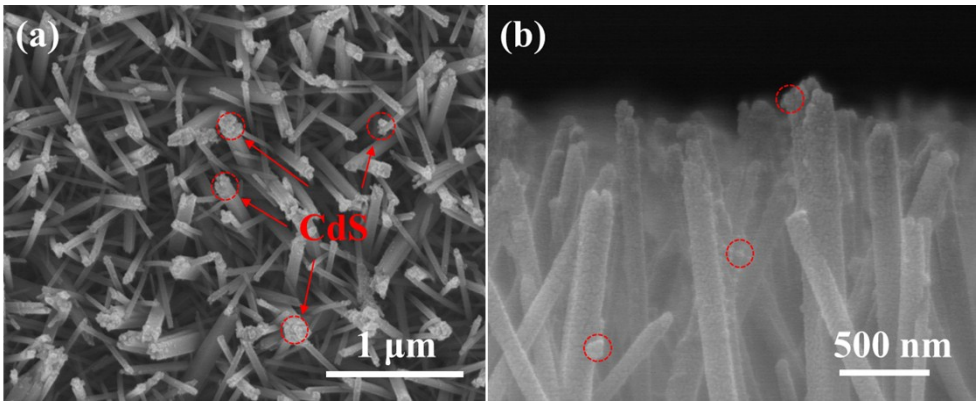


Fig. S3 The SEM images of CdS/TiO_2 NRAs.

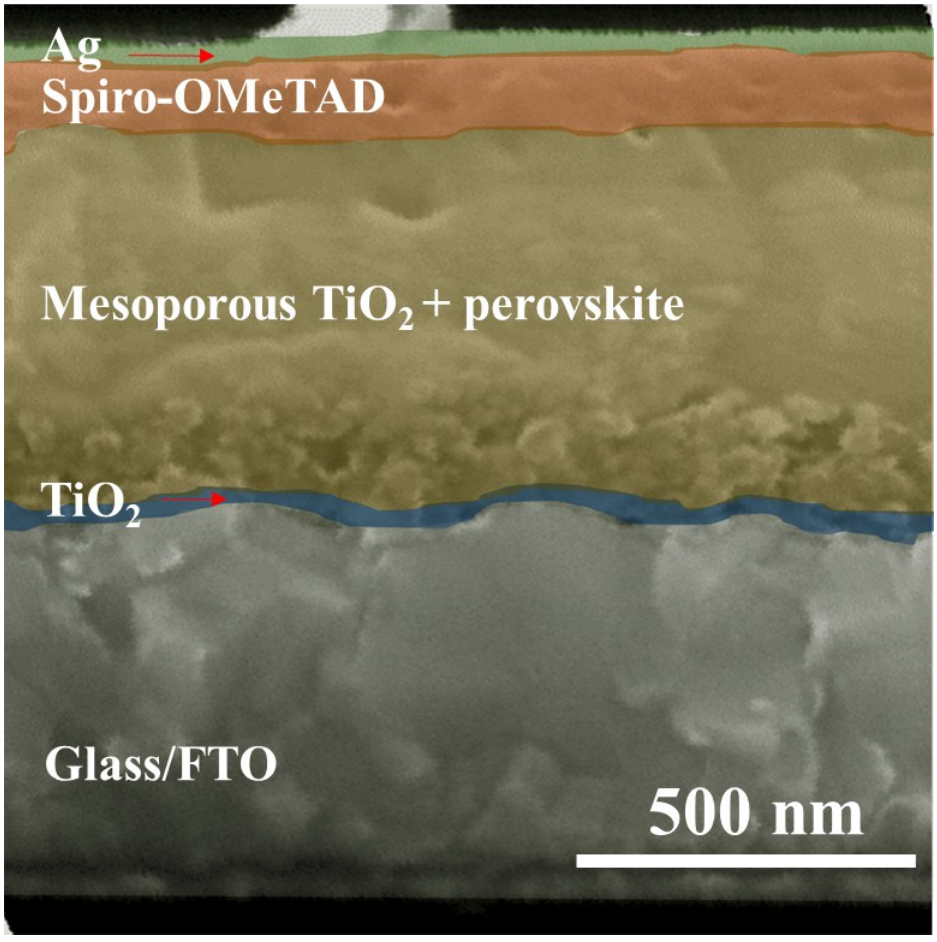
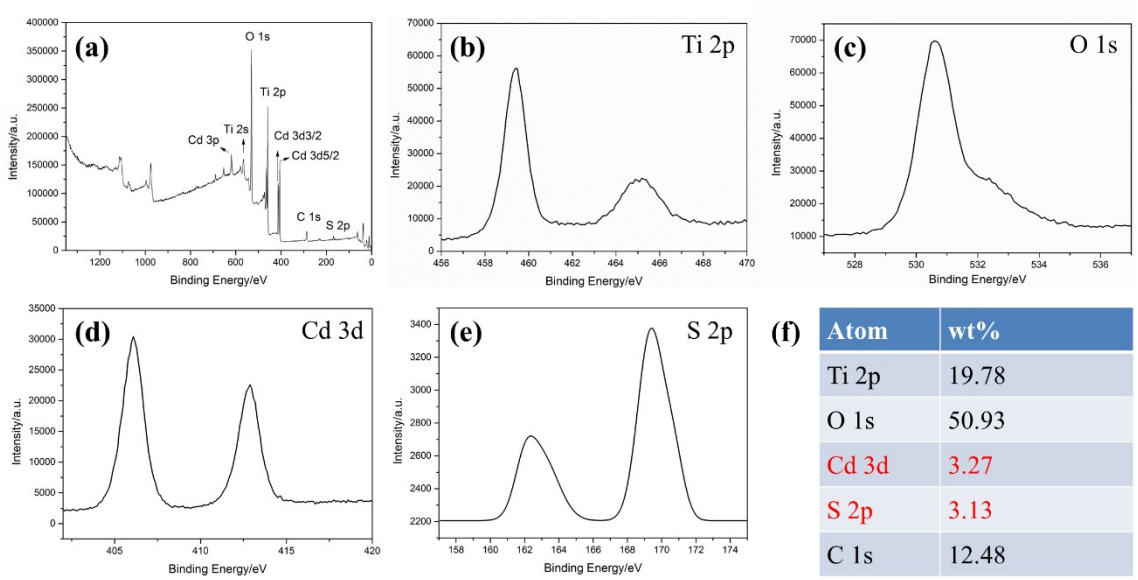


Fig. S4 The cross sectional SEM image of PSC.



(f)

Atom	wt%
Ti 2p	19.78
O 1s	50.93
Cd 3d	3.27
S 2p	3.13
C 1s	12.48

Fig. S5 XPS spectra of CdS/TiO_2 NTAs. (a) Full spectrum, (b) Ti 2p spectrum, (c) O 1s spectrum, (d) Cd 3d spectrum, and (e) S 2p spectrum. (f) Weight fraction of all elements in CdS/TiO_2 NRAs.

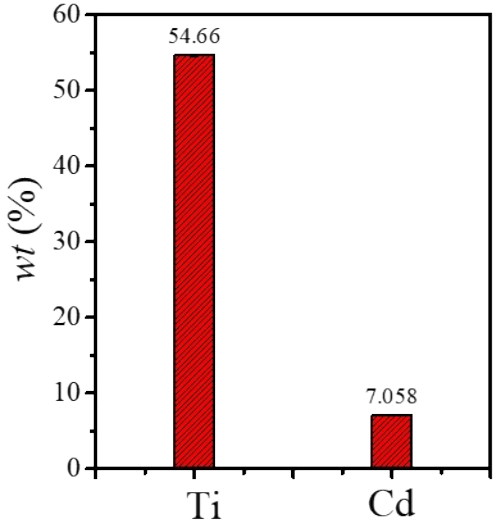


Fig. S6 ICP-OES analyses of CdS/TiO_2 RNAs composite.

As shown in **Fig. S6**, according to the amount-of-substance of Cd and Ti, the amount of CdS on CdS/TiO_2 NRAs can be obtained (8.39 wt% or 4.80 at%).

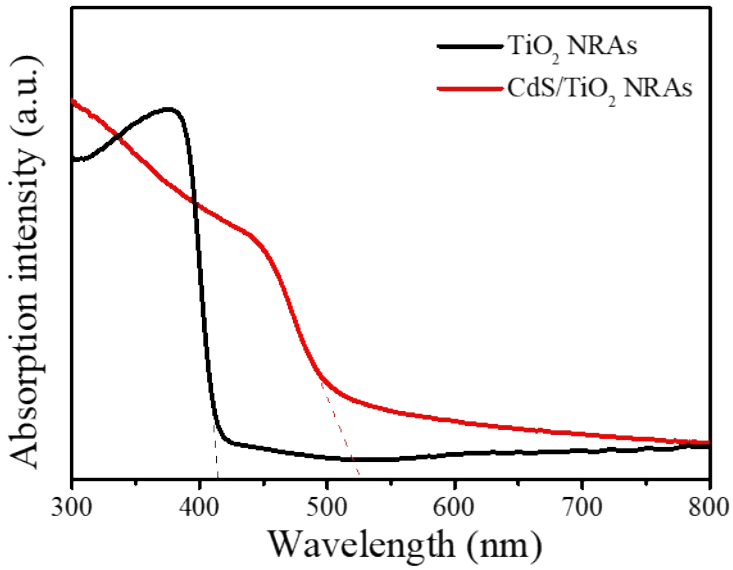


Fig. S7 UV-vis diffuse reflectance spectra of CdS/TiO_2 NTAs and pure TiO_2 NRAs.

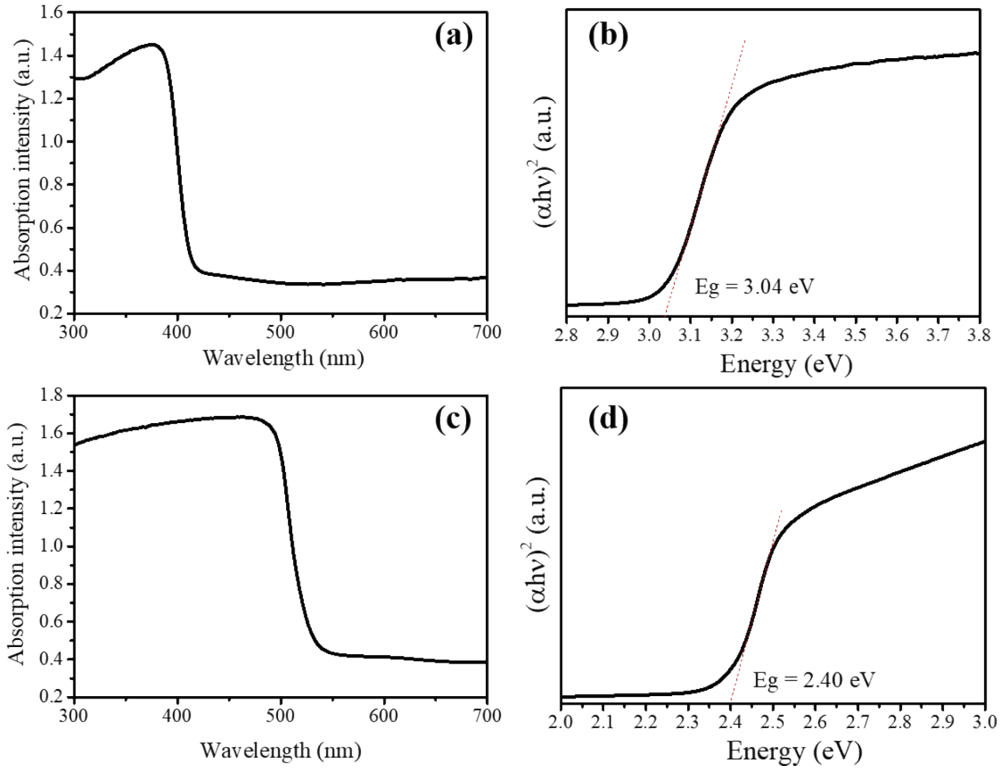


Fig. S8 (a and c) UV-Vis diffuse reflectance spectra and (b and d) plots of $(\alpha hv)^2$ *vs.* photon energy for (a) TiO_2 NRAs and (c) CdS film, respectively.

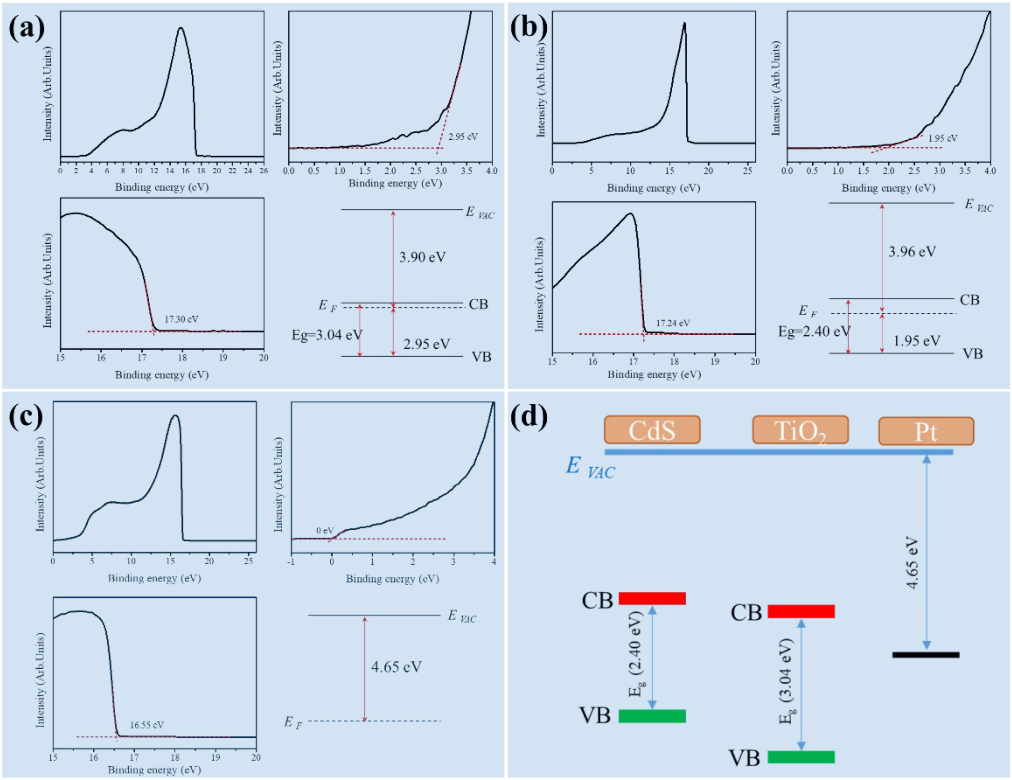


Fig. S9 Ultraviolet photoelectron spectra (UPS) and energy levels of (a) TiO_2 NRAs, (b) CdS, and (c) Pt/FTO films. (d) Energy band diagrams of CdS, TiO_2 NRAs, and Pt/FTO films.

The energy band diagrams of CdS, TiO_2 NRAs, and Pt/FTO films based on normal hydrogen electrode (NHE) can be obtained by the following equation:

$$E_{NHE} = -4.5 - E_{VAC}$$

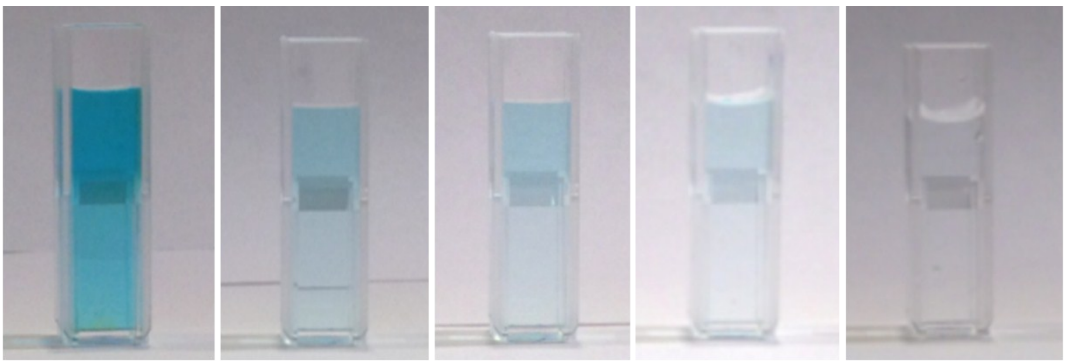


Fig. S10 Photographs of color-change of MB solution during photoelectrocatalysis.

Tab. S1 Summary on solar-to-hydrogen efficiency and degradation rate of the related integrated devices or materials in literatures.

Samples	**STH(%)**	**Degradation rate**	**REF.**
Cu_2O-perovskite-IrO_2 tandem cell	2.5	--	[1]
Bismuth vanadate−cuprous oxide tandem cell	0.5	--	[2]
Oxide photoanode and a dye-sensitized solar cell	3.1	--	[3]
p-type Cu-Ti-O film combined with n-type TiO_2 film	0.3	--	[4]
Perovskite−hematite tandem cell	2.4	--	[5]
Lead halide perovskite−$BiVO_4$ tandem cell	2.5	--	[6]
ZnTe-based photocathode and perovskite solar cell in tandem	0.43 (solar-to-fuel)	--	[7]
CdS/TiO_2 NTs/ZnO NRs	--	1.08×10^{-2} min^{-1}	[8]
TiO_2 with H_2O_2	--	1.52×10^{-2} min^{-1} (4-cholophenol)	[9]
Perovskite solar cell and CdS/TiO_2 NRAs photoanode	1.54	9.66×10^{-2} min^{-1}	this work

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