

Solar H₂ production systems: Current status and prospective application

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Table S1: State-of-the art photoanodes materials.

Photoanode		J_{ph}, mA cm⁻² at 1,23 V_{RHE}	Ref.
NiOOH/FeOOH/BiVO ₄	BiVO ₄ based	5	Lee <i>et al.</i> ²⁷ (2018)
BiVO ₄ -NSCN/PANI@CoPi	BiVO ₄ based	4,46	Reddy <i>et al.</i> ²⁸ (2020)
NiF ₂ /BiVO ₄	BiVO ₄ based	2,8	Zhao <i>et al.</i> ²⁹ (2021)
BiVO ₄ /WO ₃ NWs	BiVO ₄ based	3,1	Rao <i>et al.</i> ³⁰ (2014)
NiFeOOH/Mo:BiVO ₄	BiVO ₄ based	4,5	Shim <i>et al.</i> ³¹ (2022)
FeOOH/TiO ₂ /Ti:Fe ₂ O ₃	Fe ₂ O ₃ based	3,1	Luo <i>et al.</i> ³² (2017)
Co-Pi/Fe ₂ O ₃	Fe ₂ O ₃ based	4,32	Kim <i>et al.</i> ³³ (2013)
CoAl-LLDHs/Fe ₂ O ₃	Fe ₂ O ₃ based	4,3	Chong <i>et al.</i> ³⁴ (2019)
WO ₃ /CDS/NiOOH/Co-Pi	WO ₃ base	2,59	Li <i>et al.</i> ³⁵ (2019)
Ni(OH) ₂ /FeOOH/TiO ₂ /Ta _x N ₅	TaN based	12,1	Liu <i>et al.</i> ³⁶ (2016)
Al spiked Ni/SiO ₂ /Si	PV grade	32	Lee <i>et al.</i> ³⁷ (2021)
NiO _x /CoO _x /SiO _x /n-Si	PV grade	27,7	Zhou <i>et al.</i> ³⁸ (2015)
CH ₃ NH ₃ PbI ₃ /Spiro-IMeTAD/Au	PSC based	16	Nam <i>et al.</i> ³⁹ (2018)
(5-AVA) _x (MA) _{1-x} PbI ₃	PSC based	12,4	Tao <i>et al.</i> ⁴⁰ (2019)
ITO/SnO ₂ /PSC/Spiro-OMeTAD/Au/Gs/Ni	PSC based	17,4	Wang <i>et al.</i> ⁴¹ (2021)

Table S2 State-of-the-art photocathodes materials

Photocathode		J_{ph}, mA cm⁻² at 0 V_{RHE}	Ref.
pn ⁺ -Si/Ta ₂ O ₅ /Pt	PV grade	-34,7	Wang <i>et al.</i> ⁴² (2019)
Pt-CdS/CIGS	PV grade	-27	Kumagai <i>et al.</i> ⁴³ (2015)
Ti-Pt/SrTiO ₃ /p-Si	PV grade	-35	Ji <i>et al.</i> ⁴⁴ (2015)
CH ₃ NH ₃ PbI ₃ /NiO/PCBM/Ti/Pt	PSC based	-18	Zhang <i>et al.</i> ⁴⁵ (2018)
CsMAFAPbIBr	PSC based	-10	Kim <i>et al.</i> ⁴⁶ (2019)
MoS ₂ /Ti foil/OHP	PSC based	-20,6	Choi <i>et al.</i> ⁴⁷ (2021)
RuO _x /TiO _x /Cu ₂ O	Cu ₂ O based	-7,8	Luo <i>et al.</i> ⁴⁸ (2016)
Cu ₂ O/CuO/C	Cu ₂ O based	-7,5	Kunturu <i>et al.</i> ⁴⁹ (2019)
Cu-doped NiO _x /Sb ₂ Se ₃	Sb ₂ Se ₃ based	-17,5	Lee <i>et al.</i> ⁵⁰ (2019)

Table S3: 2019-2021 state-of-the-art PEC devices.

OEP	HEP	Active area, cm ²	η _{STH} , %	Durability, h	Electrolyte	Ref.
NiFeO _x /H _x Mo:BiVO ₄ /FTO	Pt/TiO ₂ /CdS/Sb ₂ Se ₃ /Au/FTO	0,32	1,5	10	0,5 M phosphate buffer+0,01 M V ₂ O ₅ , pH 7	Yang <i>et al.</i> ¹⁰ (2020)
n-Se/BiVO ₄	p-Cr ₂ O ₃ /CuO:Ni	1	0,05	-	0,5 Na ₂ SO ₄ , pH 7	Mohd Nasir <i>et al.</i> ¹¹ (2020)
WO ₃ -ZIF-67	BiVO ₄ -BP	2	1,9	4	0,5 Na ₂ SO ₄ , pH 7	Wang <i>et al.</i> ¹² (2020)
BiVO ₄ /NiFeO _x	CuOx/BHJ/TiO ₂ /Pt	4	1,1	0,5	0,1 M K ₃ PO ₄ , pH 7	Shi <i>et al.</i> ¹³ (2020)
PSC/FeNiOOH/Ni	PSC/CoP/Sn	1	8,54	3	0,5 M NaOH	Chen <i>et al.</i> ¹⁴ (2021)
Photoelectrode	PV					
HIT/ALD-TiO ₂ /Ti/Pt (titanium anode)	2 a-Si HIT cell	2,85	12,2	120	1 M H ₂ SO ₄	Tan <i>et al.</i> ¹⁵ (2019)
p ⁺ nn ⁺ -Si/Ti/Pt (DSA anode)	Perovskite (1,75 eV)	0,6	17,6	72	1 M H ₂ SO ₄	Karuturi <i>et al.</i> ¹⁶ (2020)
BiVO ₄ /CoPi	Printable triple-mesoscopic perovskite solar cells	0,6	3,1	6	0,1 M PBS, pH 7	Zhang <i>et al.</i> ¹⁷ (2020)
2 x H,W:BiVO ₄ /CoPi (dual)	2 x SHJ Si	0,244	5,5	7	0,5 M Na ₂ SO ₃ /0,1 M KPi, pH 7	Ahmet <i>et al.</i> ¹⁸ (2019)
Co(OH) ₂ /BiVO ₄	Carbon-based perovskite	1	4,6	10	1 M borate buffer, ph 9,1	Li <i>et al.</i> ¹⁹ (2020)
BGLC (NiMo cathode)	c-Si	4	6,6	71	1 M NaOH	Zhu <i>et al.</i> ²⁰ (2021)
CIGS/ZnS/CdS (IrO _x anode)	Perovskite	0,2	9	6,5	c:0,5M KPi/a: 1M KOH	Koo <i>et al.</i> ²¹ (2020)
NiFeO _x @Ti:SiFeO ₃ (Pt cathode)	Perovskite	0,44	4,49	>8	1M NaOH	Park <i>et al.</i> ²² (2020)
PE buried						
CoP-CoP	2 x glass/FTO/TiO ₂ /perovskite/carbon	0,18	6,7	-	1 M KOH	Liang <i>et al.</i> ²³ (2020)
Ti-Ti	GaInP/GaAs/Ge	4	17,12	2	water	Temburne <i>et al.</i> ²⁴ (2019)
Ir-Pt	III-V triple junction	1	14	1000	Vapour	Kristler <i>et al.</i> ²⁵ (2020)
Pt	3S-BBJ-Pt	24	15,62	40	1 M H ₂ SO ₄	Fu <i>et al.</i> ²⁶ (2020)

Table S4: 2019-2021 state-of-the-art PV-EC devices.

Elecrolyzer (anode/cathode)	PV	Active area, cm²	η_{STH}, %	Durability, h	Electrolyte	Reference
MEA electrolyzer, Ni-Pt coating on Ti mesh	GaInP/GaInAs/Ge 3jn	36	18,3	100	5 M KOH	Khan <i>et al.</i> ¹ (2020)
NiFe (oxy)-hydroxide-Electrodeposited Ni ₄ Mo films	Perovskite/Si tandem	0,1875	17,52	24	1 M NaOH, pH 14	Park <i>et al.</i> ² (2019)
Co&Fe-WO-Pt coated Ni	c-Si solar cell	4,73	16,9	50	1 M KOH	Chen <i>et al.</i> ³ (2019)
NiFe LDH-Pt/C	Perovskite organic tandem solar cell	0,13	12,3	-	1 M KOH	Li <i>et al.</i> ⁴ (2020)
NiFe-LDH -CC/TiO ₂ /Pt	Perovskite/Silicon tandem cell	1,42	12,3	100	1 M KOH	Gao <i>et al.</i> ⁵ (2019)
NiFe/NF-NiMo/NF	Perovskite/Silicon tandem cell	1	20	15	1 M KOH	Wang <i>et al.</i> ⁶ (2021)
NiCoFe-NiMo ₄ /MnO _{3-X}	Perovskite/Si	0,5	21,32	8	1M KOH	Pan <i>et al.</i> ⁷ (2021)
Ni foil-Pt/Ti mesh	(3jn) InGaP/InGaAs/Ge (41 suns)	12,25	28	-	5M KOH	Khan <i>et al.</i> ⁸ (2021)
Ru(O)(tda)(py) ₂ -Ptmesh	PSC	0,18	21,2	>15	Phosphate buffer, pH 7	Shi <i>et al.</i> ⁹ (2020)

Table S5: Anodic electrocatalysts overpotentials towards oxygen evolution reaction at 10 mA cm⁻² in alkaline media.

Anodic electrocatalyst	Overpotential (mV) at 10 mA cm ⁻²	Ref.
NiFe LDH	200	Gao <i>et al.</i> ⁵ (2019)
NiFe (oxy)hydroxide	250	Park <i>et al.</i> ² (2019)
Ni-Fe-P	192	Zhang <i>et al.</i> ⁵¹ (2020)
Ni@Ru/CNS-x	356	Wu <i>et al.</i> ⁵² (2019)
Ni ₃ S ₄	257	Wan <i>et al.</i> ⁵³ (2019)
Ir-doped NiCo	192	Fan <i>et al.</i> ⁵⁴ (2020)
Ni ₂ P/rGO	221	Luo <i>et al.</i> ⁵⁵ (2021)
Co&Fe-WO/NF	226	Chen <i>et al.</i> ³ (2019)
CoP/FTO	188	Jang <i>et al.</i> ²³ (2020)
Mo ₂ CT _x MFs	180	Kou <i>et al.</i> ⁵⁶ (2019)
RuO ₂ /CeO ₂	350	Galani <i>et al.</i> ⁵⁷ (2020)
BP/Au	160	Qiao <i>et al.</i> ⁵⁸ (2020)
Ir	380	McCroy <i>et al.</i> ⁵⁹ (2015)
Ru	366	McCroy <i>et al.</i> ⁵⁹ (2015)

Table S6: Cathodic electrocatalysts overpotentials towards hydrogen evolution reaction at -10 mA cm⁻² in alkaline media.

Cathodic electrocatalyst	Overpotential (mV) at -10 mA cm ⁻²	Ref.
C _c /TiC/Pt	-37	Gao <i>et al.</i> ⁵ (2019)
Pt/Ni	-200	Chen <i>et al.</i> ³ (2019)
Pt/C	-56,3	Chen et al. ⁶⁰ (2019)
PtCoRu	-22	Chen et al. ⁶¹ (2020)
Ni ₄ Mo	-100	Park <i>et al.</i> ² (2019)
Mo ₂ CT _x MFs	-154	Kou <i>et al.</i> ⁵⁶ (2019)
Ni@Ru/CNS-x	-20,1	Wu <i>et al.</i> ⁵² (2019)
MoS _x @NiO	-406	Ibupoto <i>et al.</i> ⁶² (2019)
CoP@NPC	-86	Chen et al. ⁶⁰ (2019)
CoP/FTO	-188	Jang <i>et al.</i> ²³ (2020)
Ir-doped NiCo	-21	Fan <i>et al.</i> ⁵⁴ (2020)

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