Electronic supplementary information

$MnFe_2O_4/BiVO_4$ film photoanode with heterojunction, co-catalytic and photothermal effects for effective solar water oxidation

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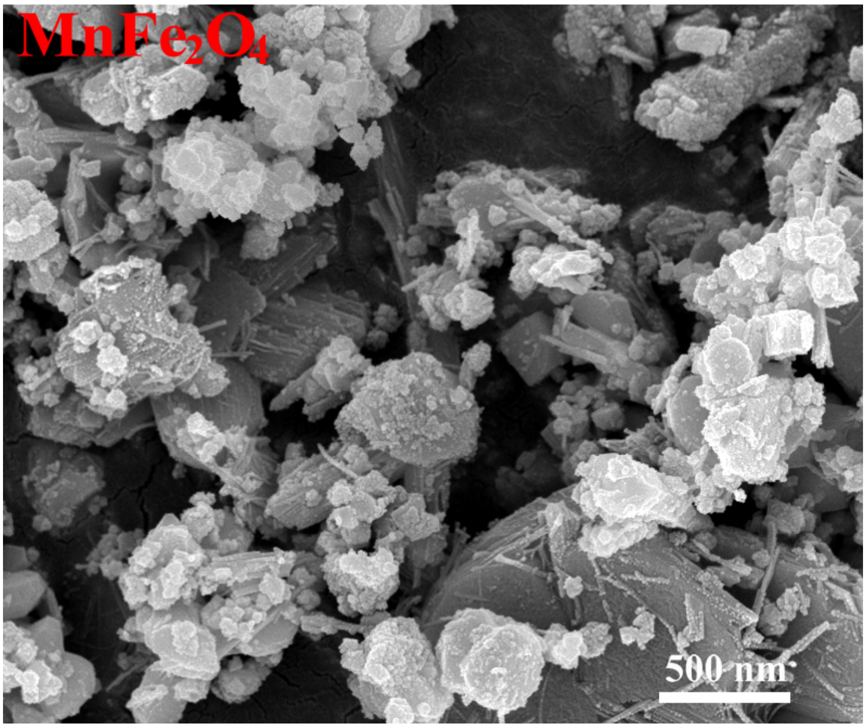

Fig. S1 SEM image of $MnFe_2O_4$ sample.

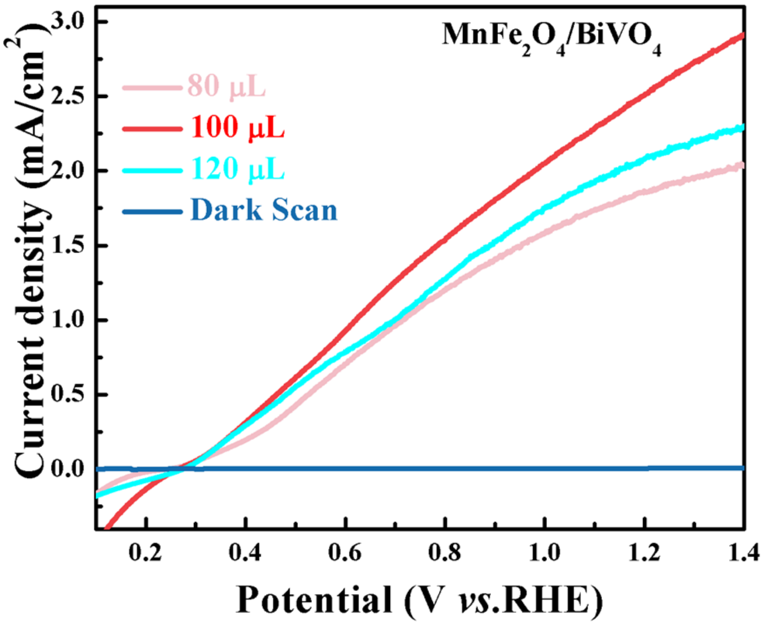

Fig. S2 LSV curves of the $MnFe_2O_4/BiVO_4$ films in 0.1 M NaPi under AM 1.5G irradiation. The $MnFe_2O_4/BiVO_4$ films were prepared using different $MnFe_2O_4$-containing suspensions on $BiVO_4$ film.

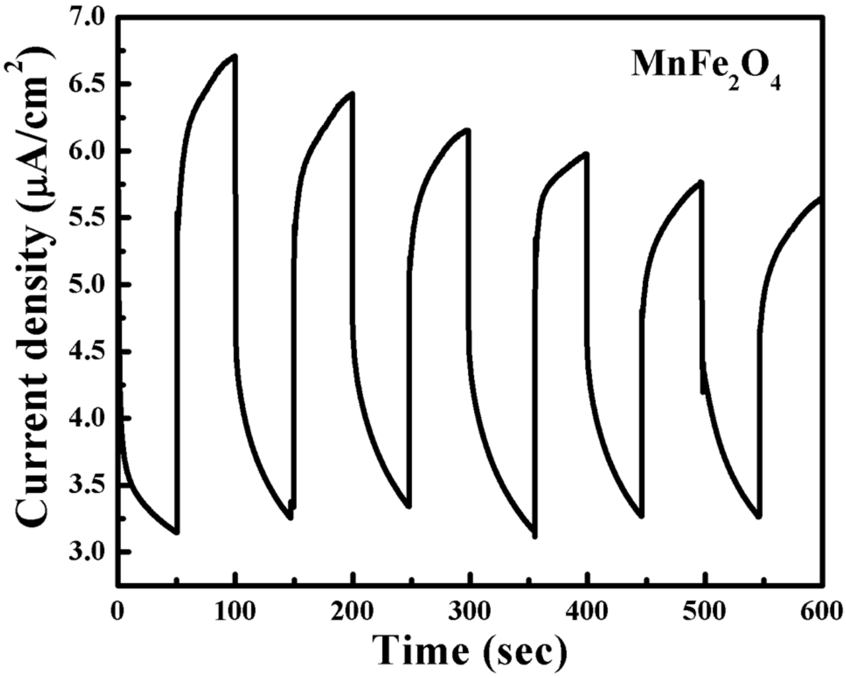

Fig. S3 The photocurrent response of $MnFe_2O_4$ film in 0.1 M NaPi at 1.23 V vs. RHE under AM 1.5G irradiation.

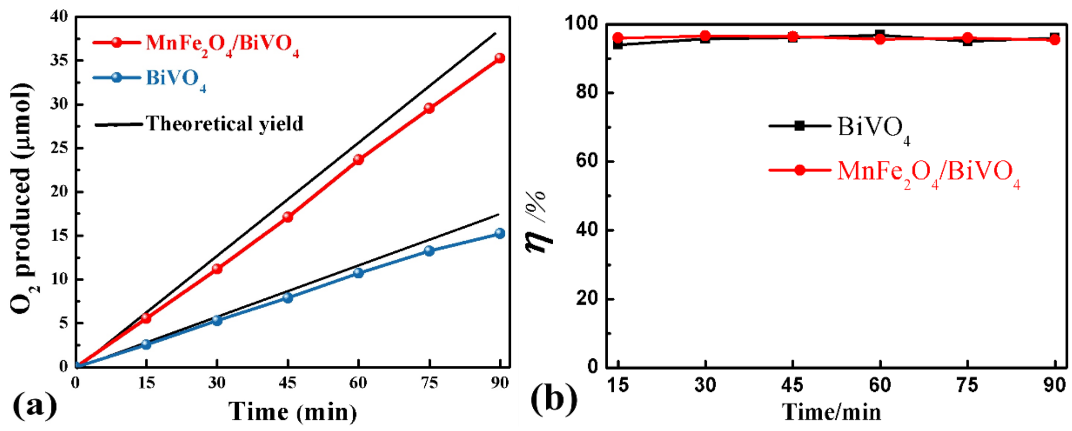

Fig. S4 (a) The curves of O_2 generation *vs.* reaction time, and (b) faradic efficiency of oxygen evolution reaction on $BiVO_4$ and $MnFe_2O_4/BiVO_4$ film photoelectrode in 0.1 M NaPi under AM 1.5G irradiation at 1.23 V *vs.* RHE.

Table S1 The activity comparison of the present $MnFe_2O_4/BiVO_4$ photoanode to the $BiVO_4$-based photoanodes in recent reports.

Photoanode	Testing electrolyte	*J* (mA cm^{-2}) At 1.23 V vs. RHE	Year of publication	*Ref.*
$BiVO_4$/DLC	0.5 M phosphate buffer	2.39	2023	1
$BiVO_4$/ZnCoMOF	0.5 M Na_2SO_4 solution	3.08	2023	2
$BiVO_4$/FeOOH	0.2 M Na_2SO_4	2.02	2023	3
CoOx/C/$BiVO_4$	0.1 M NaPi buffer	1.47	2023	4
BiVO4-MOF-N_2	0.5 M Na_2SO_4	2.32	2023	5
$MnFe_2O_4/BiVO_4$	**0.1 M NaPi buffer**	**2.58**	**This work**	

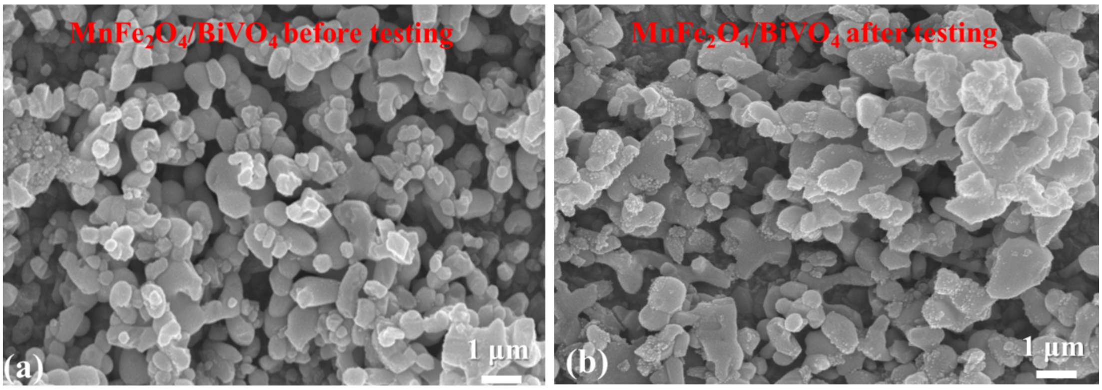

Fig. S5 SEM image of $MnFe_2O_4/BiVO_4$ film photoanode (a) before and (b) after 2 h of testing in 0.1 M NaPi at 1.23 *vs*. RHE under AM 1.5G irradiation.

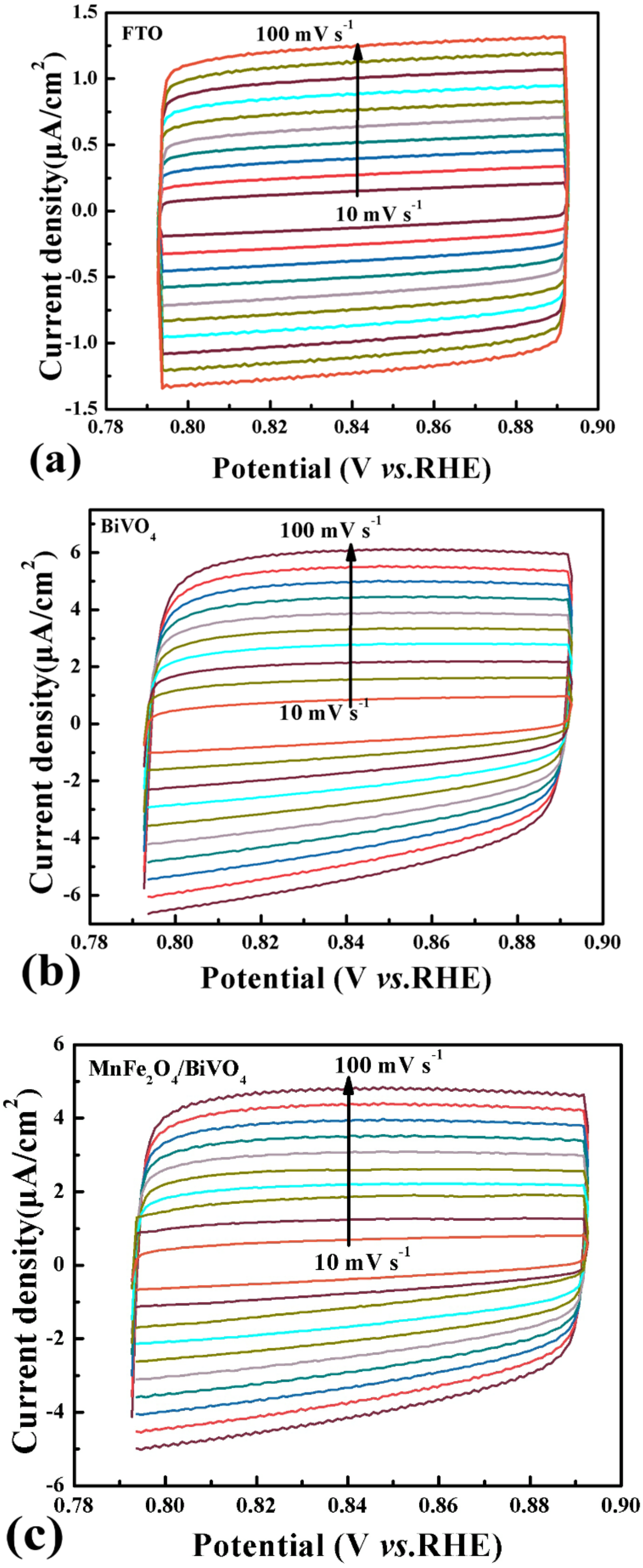

Fig. S6 The *ΔI ~v* plots used for the calculation of double-layer capacitance (C_{dl}) for (a) FTO, (b) $BiVO_4$ and (c) $MnFe_2O_4/BiVO_4$ electrode at 0.85 V vs. RHE.

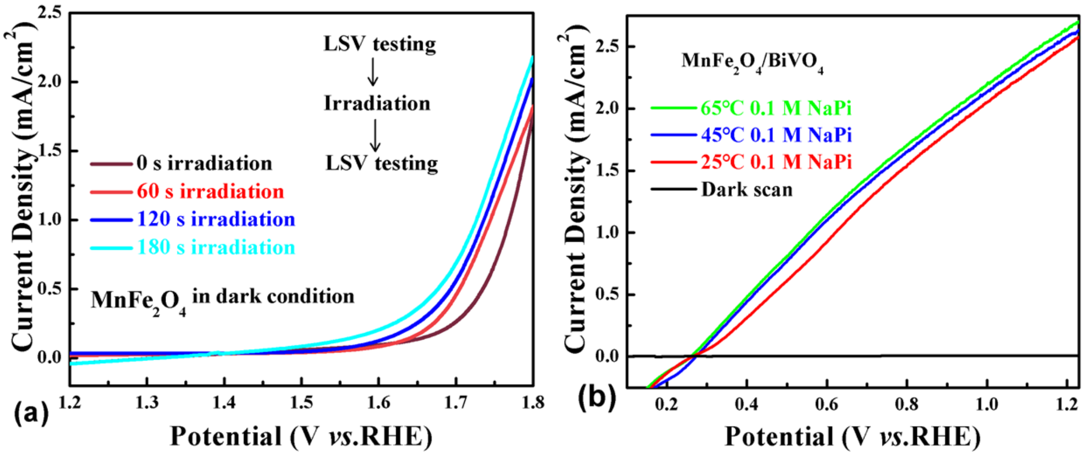

Fig. S7 (a) LSV curves of $MnFe_2O_4$ film electrode in 0.1 M NaPi in dark condition after different AM 1.5G irradiation times. (b) LSV curves of $MnFe_2O_4/BiVO_4$ film in 0.1 M NaPi under/without AM 1.5G irradiation, the temperature of 0.1 M NaPi was controlled at different temperatures.

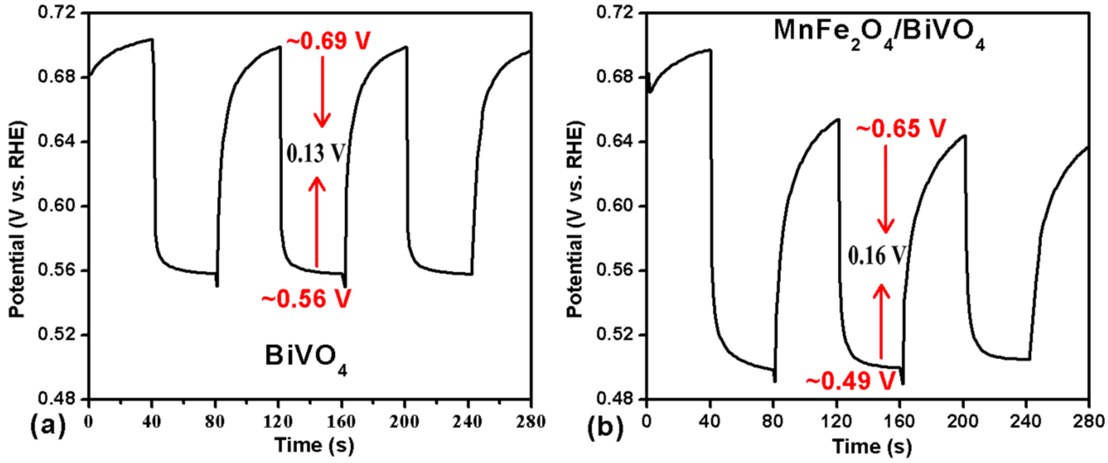

Fig. S8 The OCP of $BiVO_4$ and $MnFe_2O_4/BiVO_4$ film photoanodes in 0.1 M NaPi under 1.5G illumination and in dark, respectively.

References

1. Yuan *et al.,* A novel $BiVO_4$/DLC heterojunction for efficient photoelectrochemical water splitting, Chem. Eng. J. 2023, 459, 141637.
2. Kubendhiran *et al.,* Enhanced photoelectrochemical water oxidation on $BiVO_4$ by addition of ZnCo-MOFs as effective hole transfer co-catalyst, Int. J. Hydrog. Energy 2023, 48, 101-112.
3. Yang *et al.,* Manipulating the surface states of $BiVO_4$ through electrochemical reduction for enhanced PEC water oxidation, Nanoscale 2023, 15, 4536-4545.
4. Wang *et al.,* Promoting photoelectrochemical water oxidation of $BiVO_4$ photoanode via Co-MOF-derived heterostructural cocatalyst, Appl. Surf. Sci. 2023, 619, 156710.
5. He *et al.,* Photothermal-enhanced solar water oxidation on NiO/amorphous carbon/$BiVO_4$ and CoOx/amorphous carbon/$BiVO_4$ photoanodes, Catal. Sci. Technol. 2023, 13, 5776-5784.