

Supplementary Material

Fe, Ni-codoped $W_{18}O_{49}$ grown on nickel foam as bifunctional electrocatalyst for boosted water splitting

Guojuan Hai^{a,b}, Jianfeng Huang^{a,*}, Liyun Cao^{a,*}, Koji Kajiyoshi^c, Long Wang^b, Liangliang Feng^a,

Yijun Liu^d, Limin Pan^d

^a School of Material Science and Engineering, International S&T Cooperation Foundation of Shaanxi Province, Xi'an Key Laboratory of Green Manufacture of Ceramic Materials, Shaanxi University of Science and Technology, Xi'an, 710021, China

^b Faculty of Engineering and Information Sciences, University of Wollongong, Northfields Avenue, Wollongong, NSW 2522, Australia.

^c Kochi University, Research Laboratory of Hydrothermal Chemistry, Kochi 780-8520, Japan.

^d Guangdong Monalisa Ceramics Co., Ltd. Guangdong, Foshan 528211, China.

E-mail addresses: huangjf@sust.edu.cn

caoliyun@sust.edu.cn

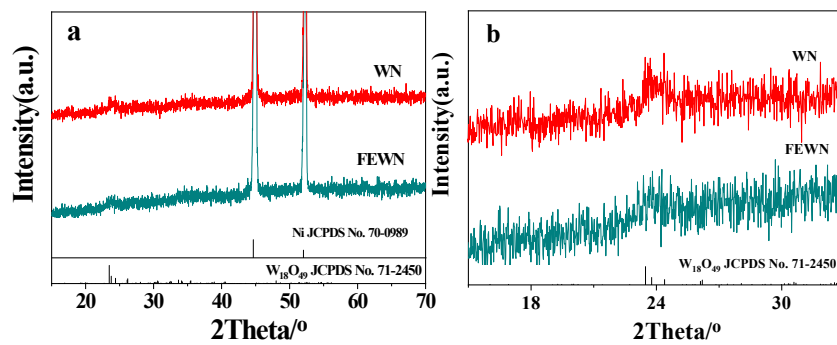


Fig. S1. XRD patterns of (a) as-synthesized Ni-doped $W_{18}O_{49}/NF$ (WN) and Fe, Ni-codoped

$W_{18}O_{49}/NF$ (FEWN). (b) 2Theta range: 15~33° .

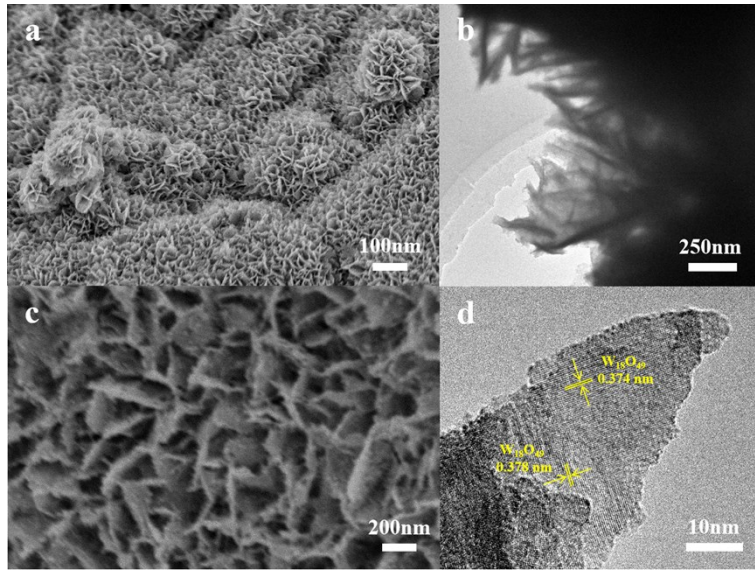


Fig. S2. (a, c) SEM, (b, d) TEM and (c) HRTEM images of Ni-doped $W_{18}O_{49}/NF$ (WN).

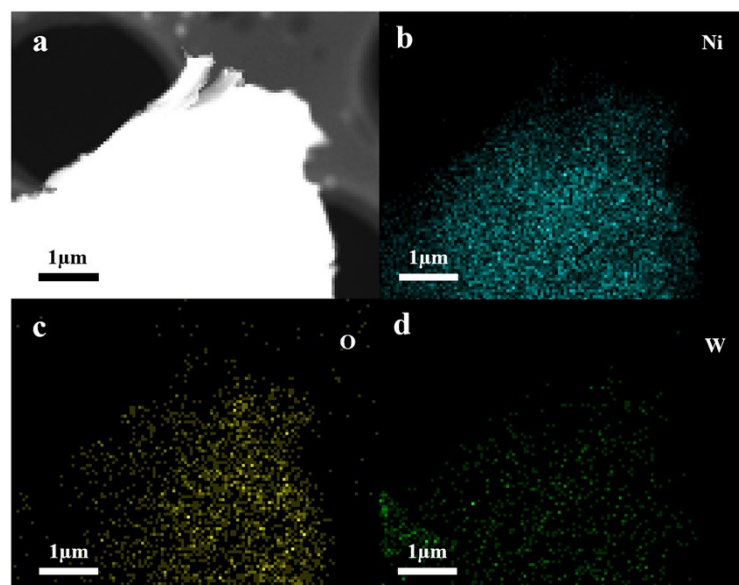


Fig. S3. (a) STEM image and (b-d) Elemental mappings of W, Ni and O of Ni-doped

$W_{18}O_{49}/NF$ (WN).

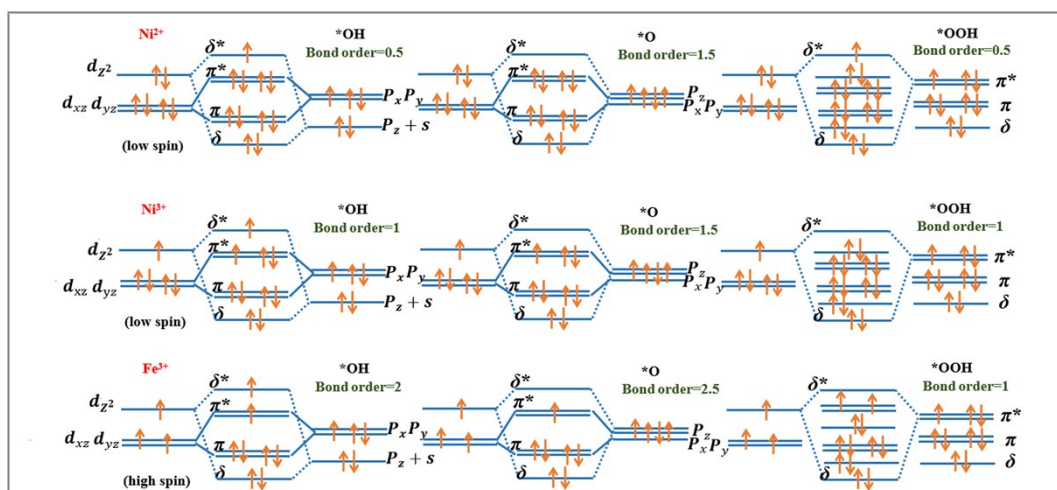


Fig. S4. The orbital interactions between cations (Ni^{2+} , Ni^{3+} , Fe^{3+}) and the OER intermediates.

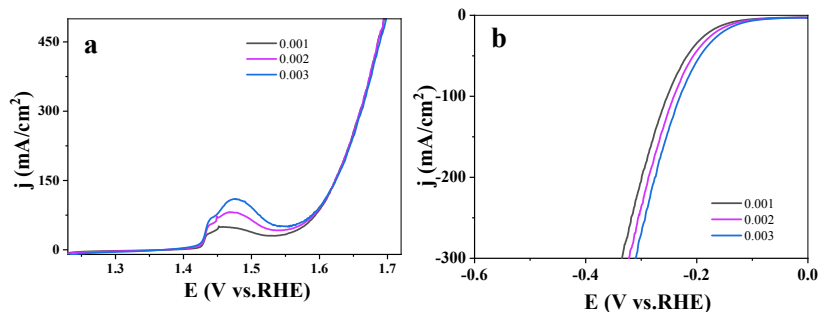


Fig. S5. (a) OER and (b) HER polarization curves of Fe, Ni-codoped $W_{18}O_{49}/NF$ measured at different sweep speeds.

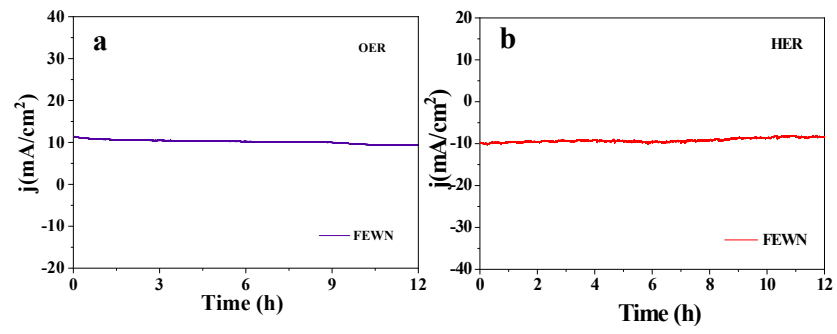


Fig. S6. Chronopotentiometry curves of Fe, Ni-codoped $W_{18}O_{49}/NF$ for water splitting at 10 mA cm⁻² in a 1 M KOH solution: (a) OER, (b) HER.

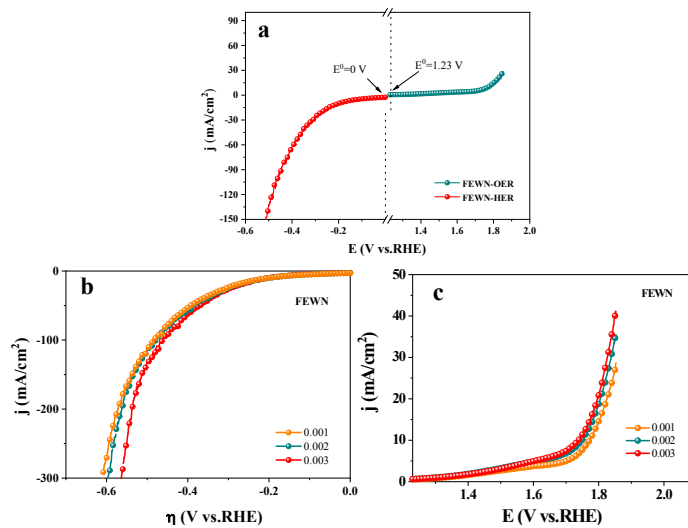


Fig. S7. (a) Polarization curves of Fe, Ni-codoped $W_{18}O_{49}/NF$ in neutral media, (b)

Overpotentials required for different current densities, OER and (b) HER polarization curves of

Fe, Ni-codoped $W_{18}O_{49}/NF$ measured at different sweep speeds in neutral media.

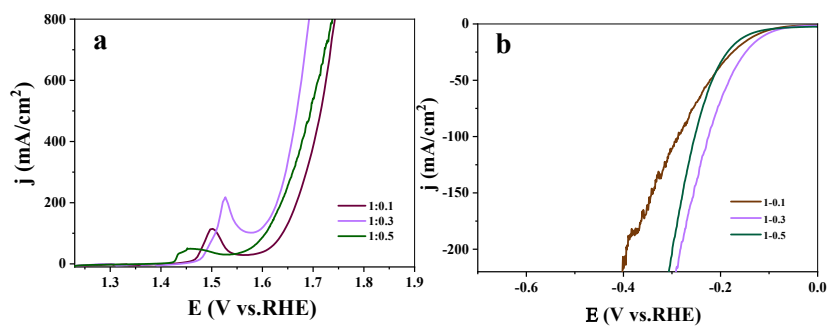


Fig. S8. Polarization curves of Fe, Ni-codoped $W_{18}O_{49}/NF$ measured in 1M KOH. The molar ratios of $WCl_6:FeCl_2 \cdot 4H_2O$ is 1:0.1, 1:0.3 and 1:0.5, respectively.

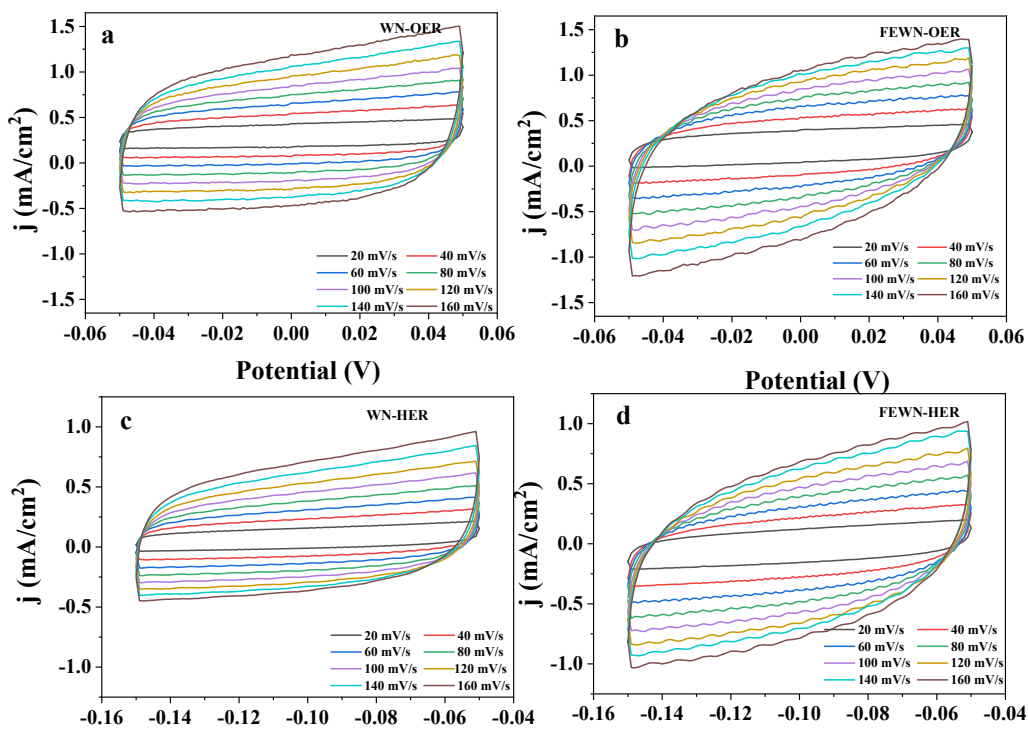


Fig. S9. CV curves obtained at different scanning rates of Ni-doped $W_{18}O_{49}/NF$ (WN) and Fe, Ni-codoped $W_{18}O_{49}/NF$ (FEWN).

Table S1. Comparison of charge transfer resistance (R_2) values of all samples in alkaline solution (OER).

Catalysts	$R_S(\Omega)$	$R_1(\Omega)$	$R_{ct}(\Omega)$
NF	4.39	2.00	28.01
WN	4.00	2.12	10.97
FEWN	3.98	1.34	4.43

Table S2. Comparison of charge transfer resistance (R_2) values of all samples in alkaline solution (HER).

Catalysts	$R_S(\Omega)$	$R_1(\Omega)$	$R_{ct}(\Omega)$
NF	3.847	2.308	21.81
WN	3.442	1.73	4.68
FEWN	3.31	0.80	2.99