Electronic Supplementary Information

Experimental section

Materials: Ni foam (NF) was provided by Hongshan District, Wuhan Instrument Surgical Instruments business. Iron(II) chloride tetrahydrate ($FeCl_2 \cdot 4H_2O$) was provided by Chengdu Kelon Chemical Reagent Factory. Sodium Molybdat Dihydrat ($Na_2MoO_4 \cdot 2H_2O$) was purchased from Aladdin Ltd. (Shanghai, China). Ruodium (III) Chloride Hydrate ($RuCl_3 \cdot 3H_2O$) was purchased from Sigma-Aldrich Chemical Reagent Co., Ltd. The water used throughout all experiments was purified through a Millipore system. All the reagents and chemicals were used as received without further purification.

Preparation of $FeMoO_4$/NF: $FeMoO_4$/NF was prepared as follows. Prior to the synthesis, the nickel foam was treated by ultrasonication in 3 M HCl solution for 10 min to remove the possible surface oxide layer and cleaned with ethanol and deionized water. $FeCl_2 \cdot 4H_2O$ (3.6 mmol) and $Na_2MoO_4 \cdot 2H_2O$ (3.6 mmol) were dissolved in 45 mL distilled water. After gentle stirring for 15 min, the clear solution was transferred to a 50 mL Teflon-lined stainless steel autoclave. The washed NF substrate (3 × 3 cm) was immersed into the reaction solution. The autoclave was sealed and maintained at 100 °C for 24 h in an electric oven. After the autoclave cooled down at room temperature, the resulting $FeMoO_4$ was taken out and washed with water and ethanol several times, followed by drying at 60 °C for 12 h.

Synthesis of RuO_2 and $FeMoO_4$ powder/NF: RuO_2 was prepared according to previous work.[1] Briefly, 2.61 g $RuCl_3 \cdot 3H_2O$ was dissolved in 100 mL distilled water and stirred for 10 min at 100 °C. Then, 30 mL NaOH solution (1.0 M) was added to the solution and kept vigorously stirring for 45 min at 100 °C. After that, the above solution was centrifuged for 10 min and filtered. The precipitates were collected and washed with distilled water several times. Finally, the product was dried at 80 °C overnight and then annealed at 350 °C for 1 h in air atmosphere. The as-prepared RuO_2 powder (0.01 g) was dispersed into a solution of Nafion, ethanol and water with a volume ratio of 10/250/250 via sonication, and deposited onto NF with a loading of

2.46 mg cm^{-2}. And the $FeMoO_4$ powder/NF sample was prepared by similar process.

Characterizations: The X-ray diffraction (XRD) patterns were obtained from a LabX XRD-6100 X-ray diffractometer with Cu Kα radiation (40 kV, 30 mA) of wavelength 0.154 nm (SHIMADZU, Japan). Scanning electron microscope (SEM) measurements were recorded on a XL30 ESEM FEG scanning electron microscope at an accelerating voltage of 20 kV. Transmission electron microscopy (TEM) images were made on a HITACHI H-8100 electron microscopy (Hitachi, Tokyo, Japan) with an accelerating voltage of 200 kV. X-ray photoelectron spectroscopy (XPS) was conducted on an ESCALABMK II X-ray photoelectron spectrometer using Mg as the exciting source.

Electrochemical measurements: Electrochemical measurements were performed with a CHI 660E electrochemical analyzer (CH Instruments, Inc., Shanghai) in a standard three-electrode system. $FeMoO_4$/NF was used as the working electrode. A graphite rod and an Hg/HgO were used as the counter electrode and the reference electrode, and KOH used as electrolyte, respectively. The temperature of solution was kept at 25 °C for all the measurements via the adjustment of air condition and heating support, which ensured the variation of diffusion coefficient below 1%. The potentials reported in this work were calibrated to RHE other than especially explained, using the following equation: E (RHE) = E (Hg/HgO) + (0.098 + 0.059 pH) V.

Turnover frequency (TOF) calculations: For TOF calculations, the surface concentration of active sites associated with the redox Fe species should be first calculated, According to the electrochemical CV curves, the oxidation peak current of redox species presents linear change on scan rates. The slope of the line can be calculated using the following equation:

$$\text{Slope} = n^2F^2A\Gamma_0 /4RT$$

Where n is the number of electrons transferred; F is Faraday's constant; A is the surface area of the electrode; Γ_0 is the surface concentration of active sites (mol cm^{-2}), and R and T are the ideal gas constant and the absolute temperature, respectively.[2] TOF values can be finally calculated from the formula:

$$TOF = JA/4Fm$$

Where J is the current density at a certain overpotential, A is the area of the electrode, 4 indicates the mole of electrons consumed for evolving one mole of O_2 from water, F is Faraday's constant and m is the number of moles of active sites.[3]

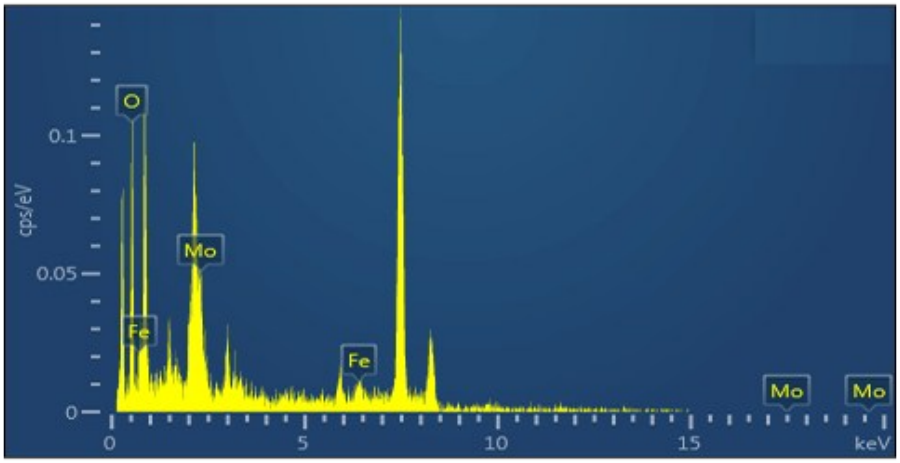

Fig. S1. EDX spectrum for $FeMoO_4$/NF.

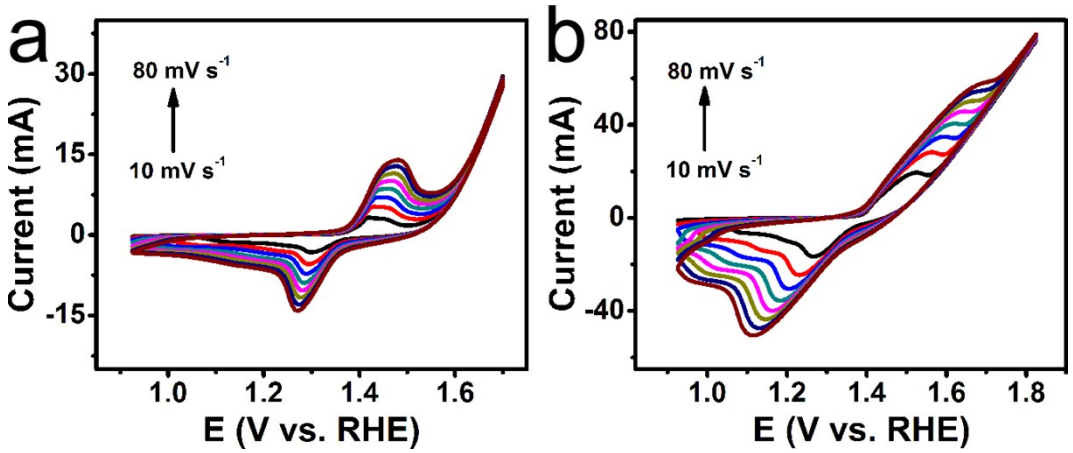

Fig. S2. CVs for (a) $FeMoO_4$ powder/NF and (b) $FeMoO_4$/NF in the Faradic capacitance current range at scan rates from 10 to 80 mV s^{-1}.

Table S1. Comparison of water oxidation performance for $FeMoO_4$/NF with other non-noble-metal electrocatalysts in alkaline media.

Catalyst	j (mA cm^{-2})	η (mV)	Electrolyte	Ref.
$FeMoO_4$/NF	50	293	1.0 M KOH	This work
$CoMoO_4$ (0.285)	10	312	1.0 M KOH	4
$CoMoO_4$ nanorod	10	343	1.0 M KOH	5
Fe-Co_3O_4 nanocast	10	486	0.1 M KOH	6
$Ni_{30}Fe_7Co_{20}Ce_{43}O_x$	10	410	1.0 M NaOH	7
α-Fe_2O_3 NA/CC	10	420	0.1 M KOH	8
NiFe-NS	10	300	1.0 M KOH	9
β-$NiMoO_4$	10	300	1.0 M KOH	10
$NiMoO_4$ Nanotubes	10	359	1.0 M KOH	11
$CoMoO_4$-$NiMoO_4$ Nanotubes		300		
$Zn_xCo_{3-x}O_4$ nanowire array	10	320	1.0 M KOH	12
$CuCo_2O_4$/NrGO	10	360	1.0 M KOH	13
$CoWO_4$	10	388	1.0 M KOH	14

References

1 J. C. Cruz, V. Baglio, S. Siracusano, V. Antonucci, A. S. Aricò, R. Ornelas, L. Ortiz-Frade, G. Osorio-Monreal, S. M. Durón-Torres and L. G. Arriaga, *Int. J. Electrochem. Sci.,* 2011, **6**, 6607–6619.

2 S. Pintado, S. Goberna-Ferron, E. C. Escudero-Adan and J. R. Galan-Mascaros, *J. Am. Chem. Soc.*, 2013, **135**, 13270–13273.

3 M. Gong, Y. Li, H. Wang, Y. Liang, J. Wu, J. Zhou, J. Wang, T. Regier, F. Wei and H. Dai, *J. Am. Chem. Soc.*, 2013, **135**, 8452–8455.

4 M. Yu, L. Jiang and H. Yang, *Chem. Commun.*, 2015, **51**, 14361–14364.

5 X. Liu, Y. Yang and S. Guan, *Chem. Phys. Lett.*, 2017, **675**, 11–14.

6 T. Grewe, X. Deng and H. Tüysüz, *Chem. Mater.*, 2014, **26**, 3162–3168.

7 J. A. Haber, Y. Cai, S. Jung, C. Xiang, S. Mitrovic, J. Jin, A. T. Bell and J. M. Gregoire, *Energy Environ. Sci.*, 2014, **7**, 682–688.

8 Q. Liu, A. M. Asiri and X. Sun, *Electrochem. Commun.,* 2014, **49**, 21–24.

9 F. Song, X. Hu, *Nat. Commun.*, 2014, **5**, 4477.

10 S. Ratha, A. K. Samantara, K. K. Singha, A. S. Gangan, B. Chakraborty, B. K. Jena and C. S. Rout, *ACS Appl. Mater. Interfaces*, 2017, **9**, 9640–9653.

11 Z. Yin, Y. Chen, Y. Zhao, C. Li, C. Zhu and X. Zhang, *J. Mater. Chem. A*, 2015, **3**, 22750–22758.

12 X. Liu, Z. Chang, L. Luo, T. Xu, X. Lei, J. Liu and X. Sun, *Chem. Mater.*, 2014, **26**, 1889–1895.

13 S. K. Bikkarolla and P. Papakonstantinou, *J. Power Sources*, 2015, **281**, 243–251.

14 V. K. V. P. Srirapu, A. Kumar, P. Srivastava, R. N. Singh and A. S. K. Sinha, *Electrochim. Acta*, 2016, **209**, 75–84.

15 Seok-Hu Bae, Ji-Eun Kim, Hyacinthe Randriama hazaka,

Song-Yi Moon, 16 Jeong-Young Park, and

Il-Kwon Oh

17 Seok-Hu Bae, Ji-Eun Kim, Hyacinthe

Randriama hazaka, Song-Yi Moon, 18 Jeong-Young

Park, and Il-Kwon Oh