

# Electronic Supplementary Information for

## Rough Ni@MoN coral for the hydrogen evolution reaction in acidic and alkaline media

Yu Zhang,<sup>a</sup> Baiqing Zhang,<sup>a</sup> Xiangcun Liu,<sup>a</sup> Zhuoxun Yin,<sup>\*,a,b</sup> Xinzhi Ma,<sup>\*,c</sup> Yang Zhou,<sup>\*,d</sup> Wei Chen,<sup>a</sup> Jinlong Li<sup>a,b</sup> and Lingling Xu<sup>c</sup>

*a College of Chemistry and Chemical Engineering, Qiqihar University, Qiqihar 161006, China. E-mail: [yzx@qqhru.edu.cn](mailto:yzx@qqhru.edu.cn);*

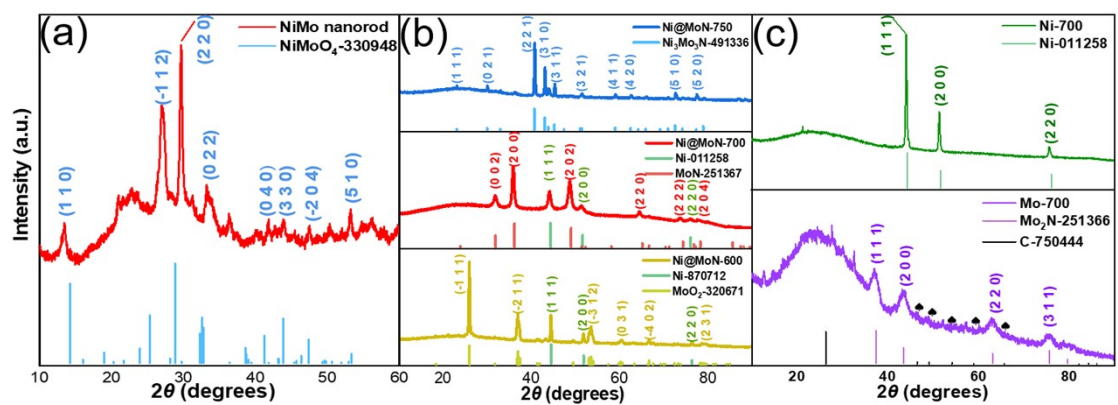
*b Key Laboratory of Fine Chemicals of College of Heilongjiang Province, Qiqihar University, Qiqihar 161006, China;*

*c Key Laboratory for Photonic and Electronic Bandgap Materials, Ministry of Education and School of Physics and Electronic Engineering, Harbin Normal University, Harbin 150025, China. E-mail: [maxz@hrbnu.edu.cn](mailto:maxz@hrbnu.edu.cn);*

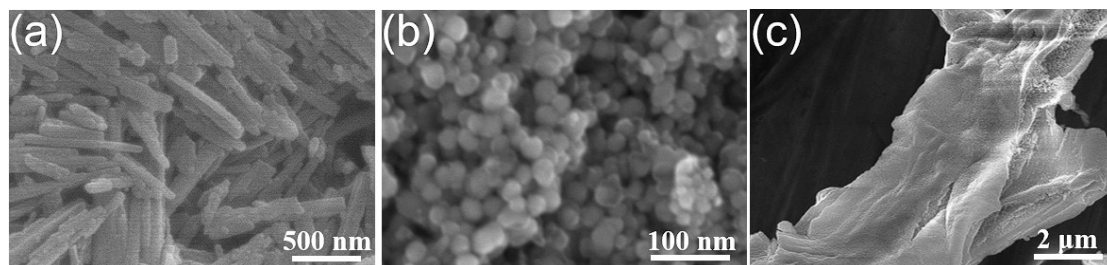
*d College of Science, Qiqihar University, Qiqihar 161006, China. E-mail: [373133430@qq.com](mailto:373133430@qq.com);*

<sup>✉</sup> Corresponding author.

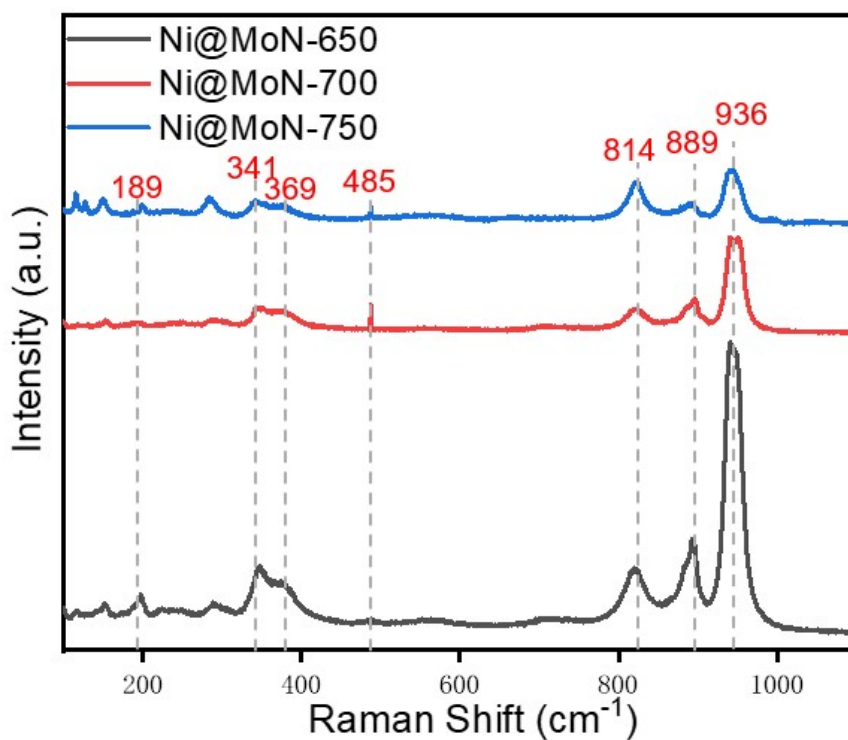
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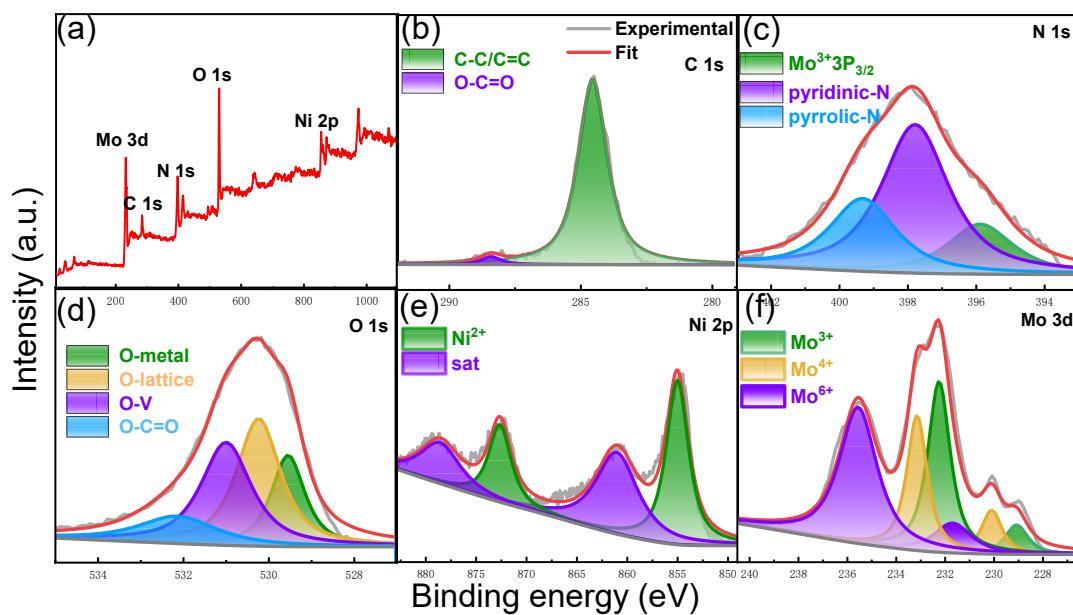
**Fig. S1.** XRD patterns of (a) NiMo nanorod, (b) Ni@MoN -650/700/750, (c) Ni-700 and Mo-700.



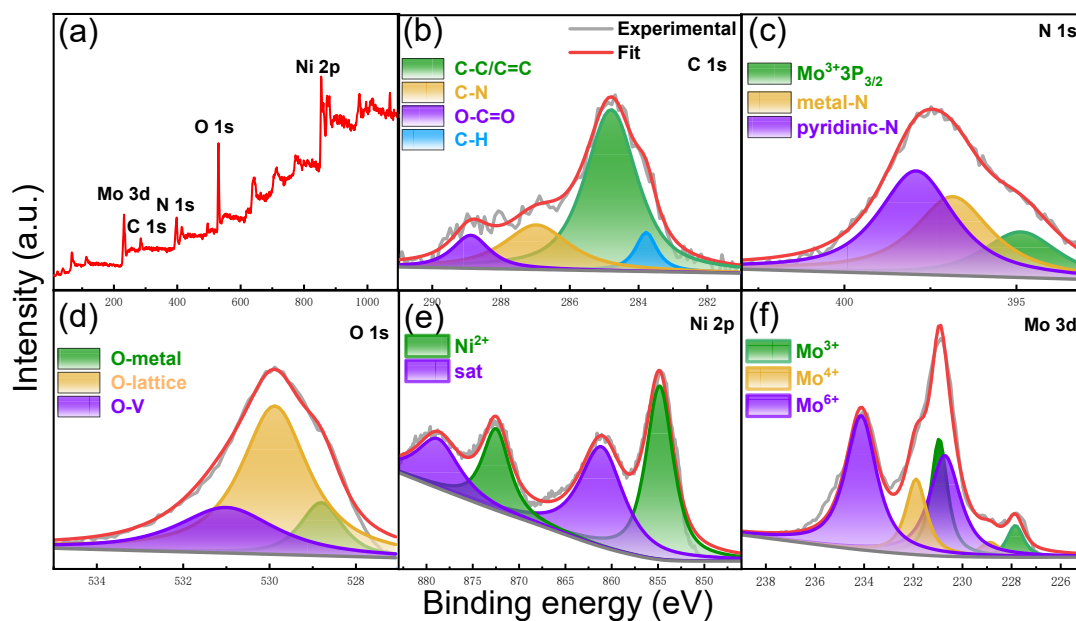
**Fig. S2.** SEM images of (a) NiMoO<sub>4</sub> nanorod, (b) Ni -700, (c) Mo-700.



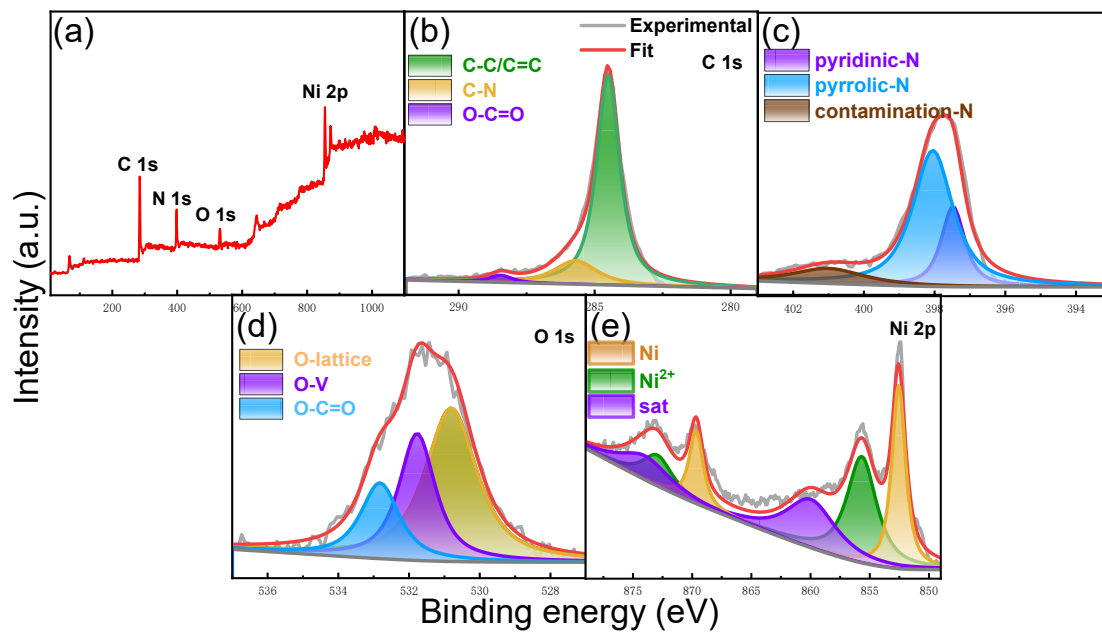
**Fig. S3.** Raman of Ni@MoN-650/700/750.



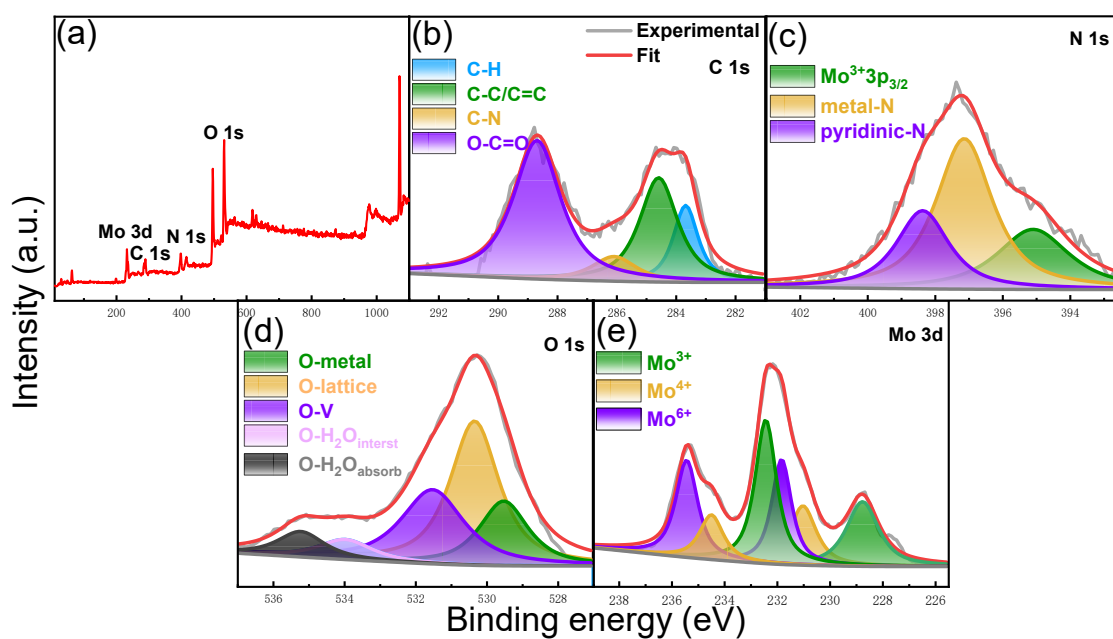
**Fig. S4.** XPS spectra of the Ni@MoN-650 catalysts: (a) survey, (b) C 1s, (c) N 1s, (d) O 1s, (e) Ni 2p and (f) Mo 3d.



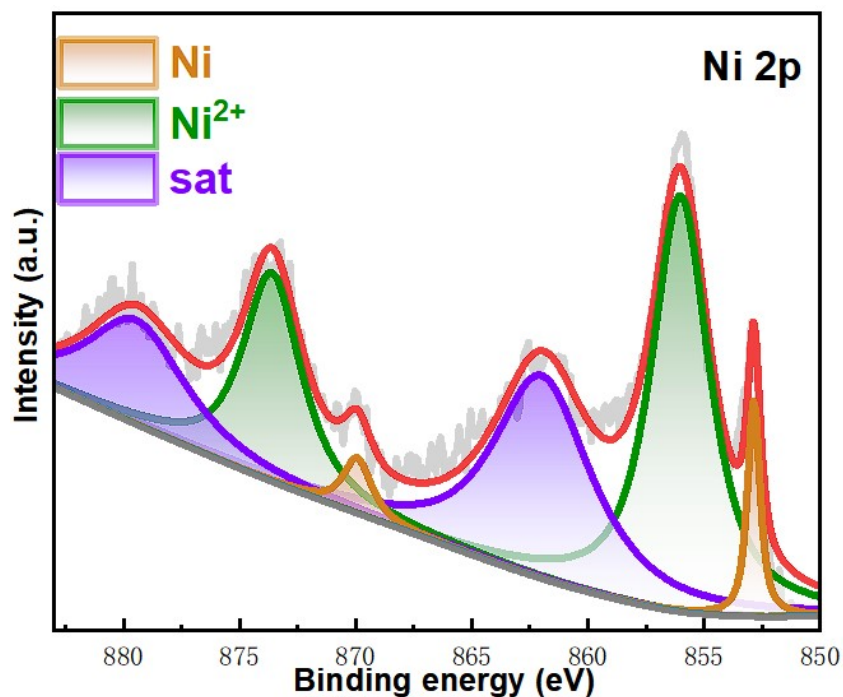
**Fig. S5.** XPS spectra of the Ni@MoN-750 catalysts: (a) survey, (b) C 1s, (c) N 1s, (d) O 1s, (e) Ni 2p and (f) Mo 3d.



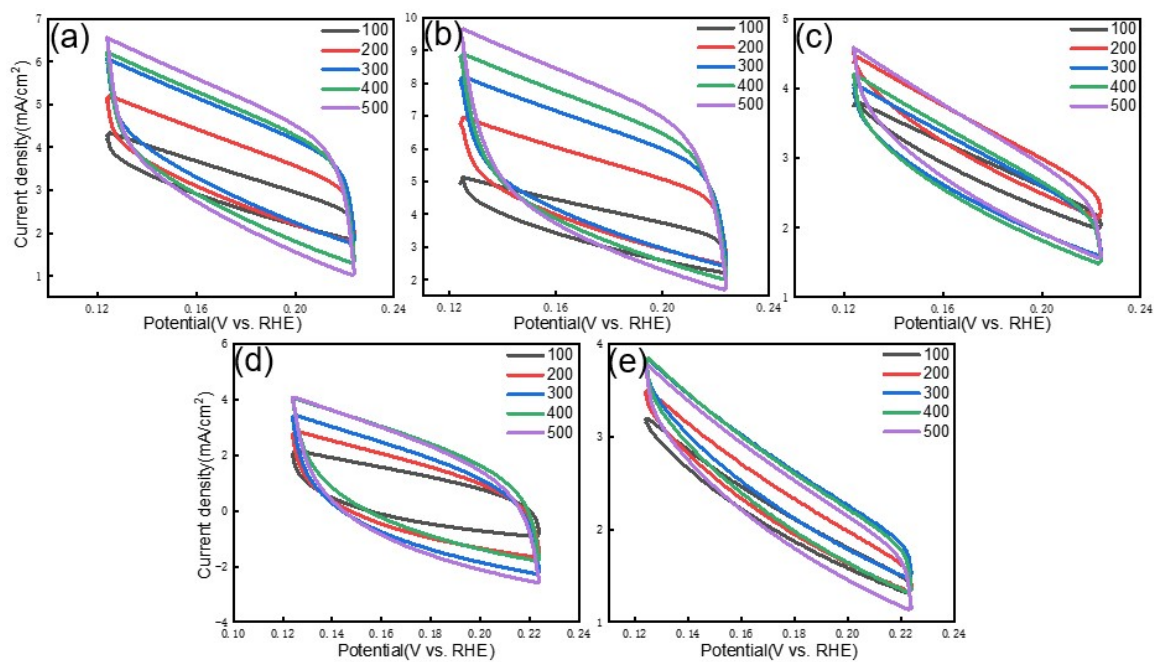
**Fig. S6.** XPS spectra of the Ni-700 catalysts: (a) survey, (b) C 1s, (c) N 1s, (d) O 1s and (e) Ni 2p.



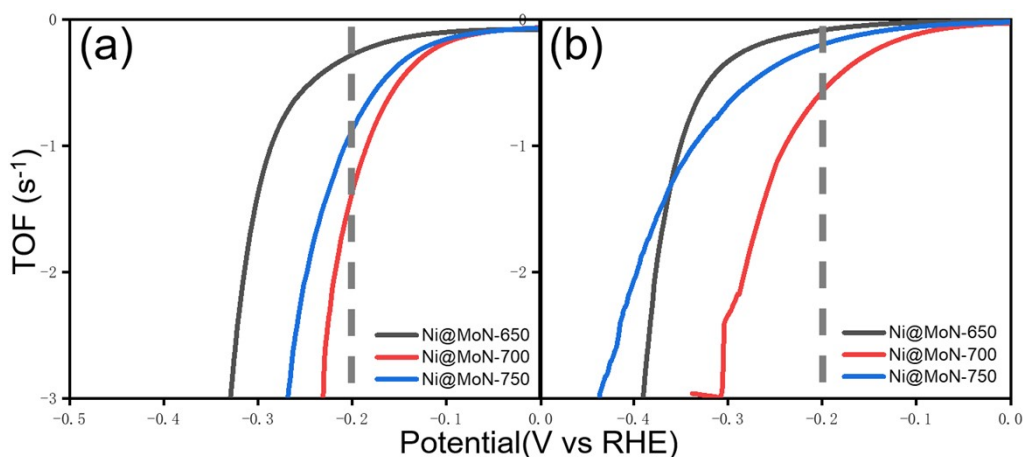
**Fig. S7.** XPS spectra of the Mo-700 catalysts: (a) survey, (b) C 1s, (c) N 1s, (d) O 1s and (e) Mo 3d.



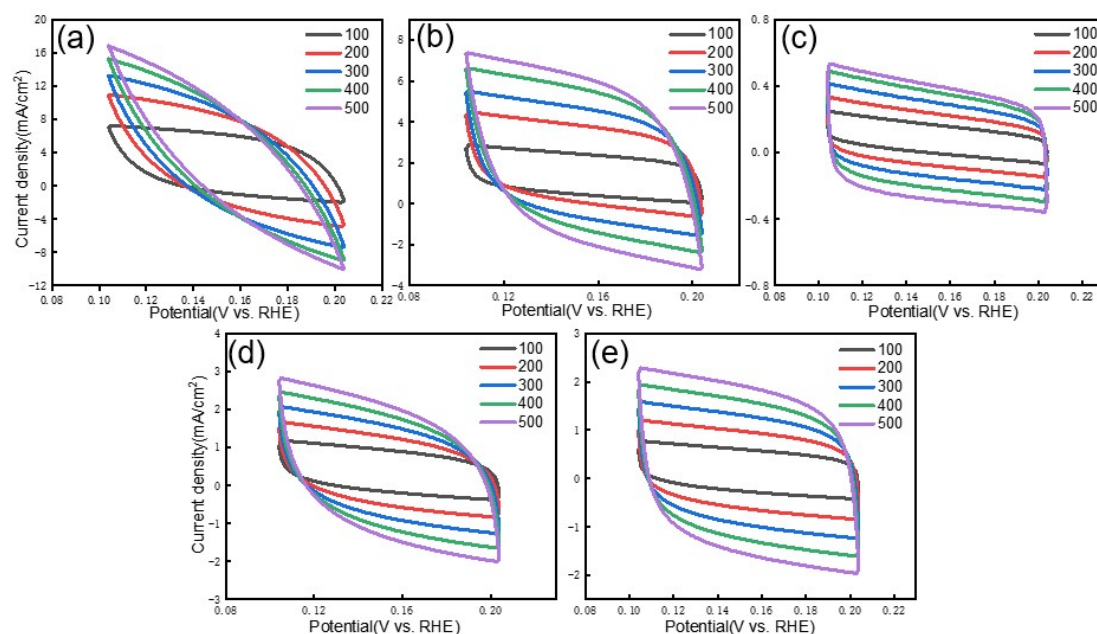
**Fig. S8.** XPS of Ni@MoN-700 after argon plasma etching , Ni 2p.



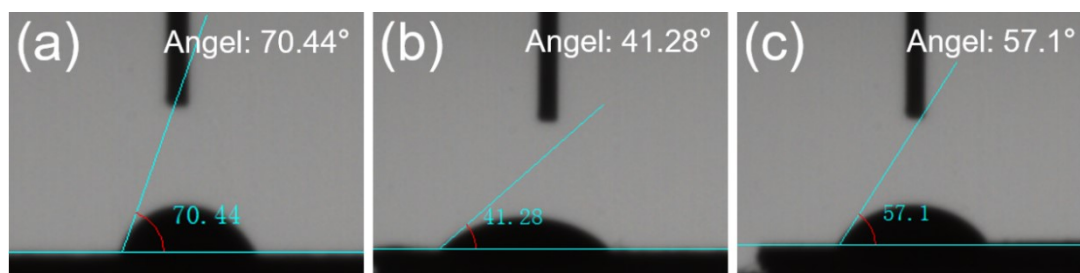
**Fig. S9.** (a) CV curves of Ni@MoN-650 electrode, (b) CV curves of Ni@MoN-700 electrode, (c) CV curves of Ni@MoN-750 electrode, (d) CV curves of Ni-700 electrode, (e) CV curves of Mo-700 electrode, in 1 M KOH.



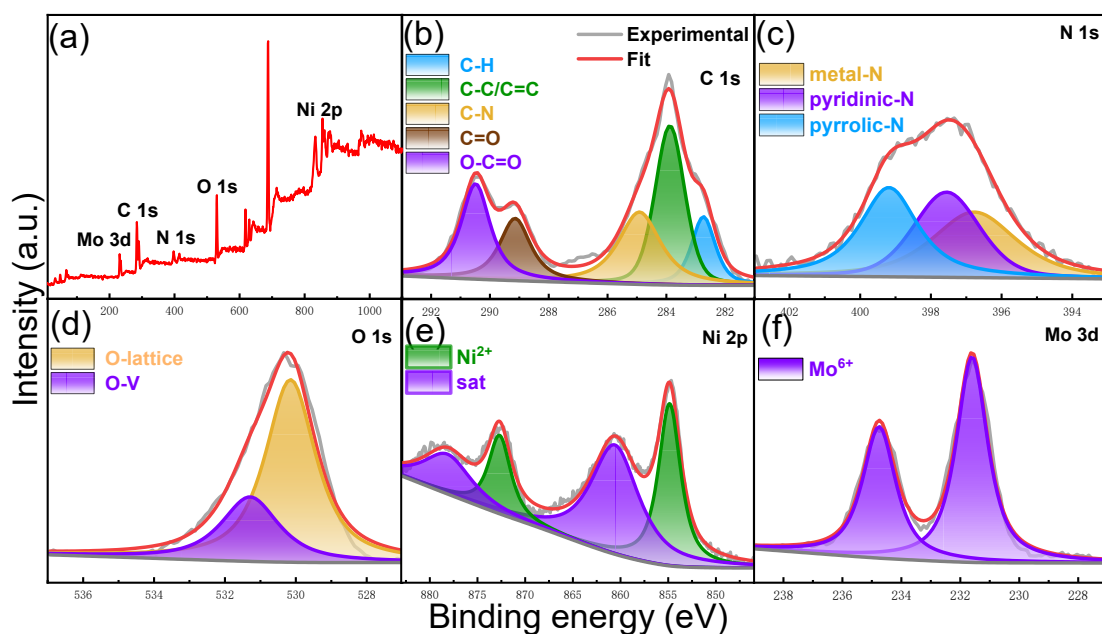
**Fig. S10.** (a) The HER-TOFs of the Ni@MoN-650/700/750 in 1 M KOH solution (b) The HER-TOFs of the Ni@MoN-650/700/750 in 0.5 M  $\text{H}_2\text{SO}_4$  solution.



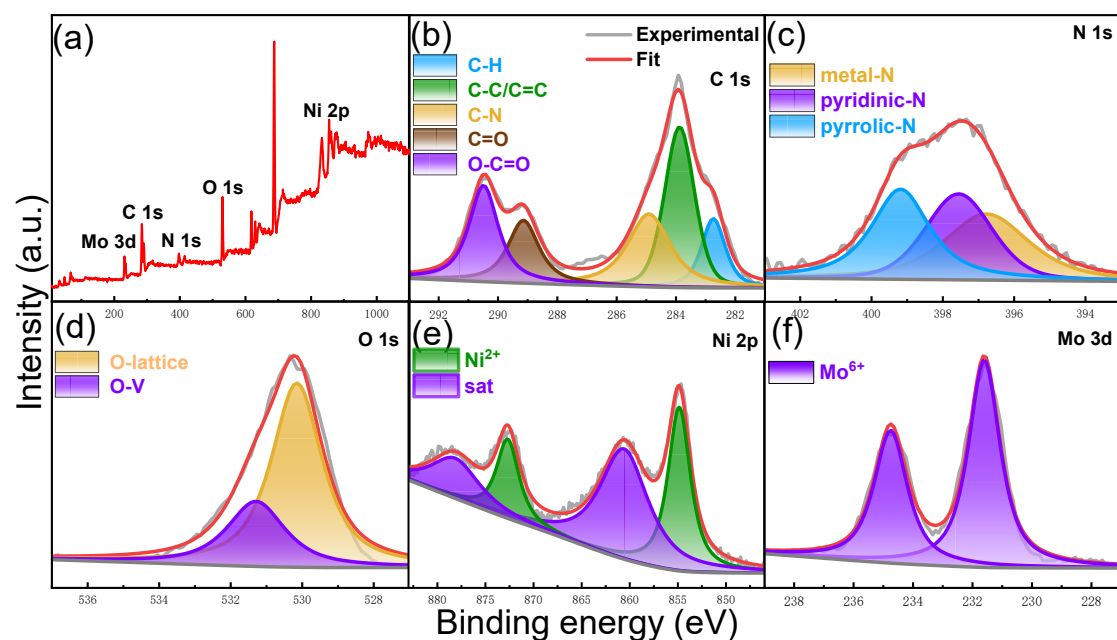
**Fig. S11.** (a) CV curves of Ni@MoN-650 electrode, (b) CV curves of Ni@MoN-700 electrode, (c) CV curves of Ni@MoN-750 electrode, (d) CV curves of Ni-700 electrode, (e) CV curves of Mo-700 electrode, in 0.5 M  $\text{H}_2\text{SO}_4$ .



**Fig. S12.** Contact angles of (a) Ni@MoN-650, (b) Ni@MoN-700 and (c) Ni@MoN-750.



**Fig. S13.** XPS spectra of the Ni@MoN-700 catalysts after long-term electrolysis in 1M KOH: (a) survey, (b) C 1s, (c) N 1s, (d) O 1s, (e) Ni 2p and (f) Mo 3d.



**Fig. S14.** XPS spectra of the Ni@MoN-700 catalysts after long-term electrolysis in 0.5 M H<sub>2</sub>SO<sub>4</sub>: (a) survey, (b) C 1s, (c) N 1s, (d) O 1s, (e) Ni 2p and (f) Mo 3d.

**Table S1.** The concentration of oxygen vacancies for different samples as calculated from the O 1s XPS spectra.

Catalyst	$S_{O-v}/S_{total\ other\ peak}$
Ni@MoN-650	0.43
Ni@MoN-700	0.54
Ni@MoN-750	0.35
Ni -700	0.43
Mo-700	0.37
KOH-after	0.41
H <sub>2</sub> SO <sub>4</sub> -after	0.16

**Table S2.** Comparison of the R<sub>CT</sub> values of the prepared materials .

Sample	RCT (Ohm)-KOH	RCT (Ohm)-H <sub>2</sub> SO <sub>4</sub>
Ni@MoN-650	1.64	1.62
Ni@MoN-700	1.43	1.40
Ni@MoN-750	1.58	1.56
Ni-700	1.71	1.65
Mo-700	1.74	1.68



**Table S3.** Comparison of the catalytic activities of HER on Ni@MoN-700 with recently reported catalysts in the 1.0 mol·L<sup>-1</sup> KOH medium

Catalyst	$\eta$ /mV vs. RHE	Ref.
Ni@MoN-700	30	This work
Ni/NiO-cp	124	[2]
W-MoP	71	[7]
Mo-N/Mo-C	135	[8]
Mo-N/C@MoS <sub>2</sub>	117	[9]
MoS <sub>2</sub> /MoN	132	[10]
NiSA-MoS <sub>2</sub>	98	[17]
Ni <sub>3</sub> N	74	[24]
NiO/Ni-CNT	80	[25]
NiCoDPA	112	[41]

Note:  $\eta$  is the overpotential measured at 10 mA·cm<sup>-2</sup>

**Table S4.** Comparison of the catalytic activities of HER on Ni@MoN-700 with recently reported catalysts in the 0.5 mol·L<sup>-1</sup> H<sub>2</sub>SO<sub>4</sub> medium

Catalyst	$\eta$ /mV vs. RHE	Ref.
Ni@MoN-700	76	This work
Co-N-V <sub>3</sub> S <sub>4</sub>	268	[1]
MoS <sub>2</sub> /MoN	117	[10]
VN/Mo <sub>2</sub> C	140	[15]
NiSA-MoS <sub>2</sub>	110	[17]
PCN@MoS <sub>2</sub> @C	130	[19]
Cu electrode	182	[39]
CoP <sub>3</sub> /CoMoP	125	[40]
CoMoOF/GF	94	[42]

Note:  $\eta$  is the overpotential measured at 10 mA·cm<sup>-2</sup>.