# Supporting Information

## In-situ growth of MOF derived ultrafine molybdenum carbides nanoparticles supported on Ni foam as efficient hydrogen evolution electrocatalysts

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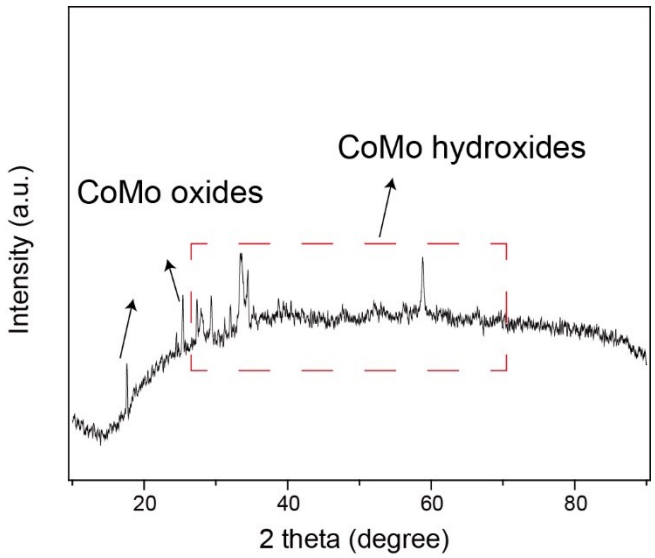


**Fig. S1.** The XRD spectra of the powder sample of CoMo hydroxides/oxides.
The peaks at 17.7 °and 25.5 °correspond to the planes (002) and (102) of CoMo oxides, respectively. (PDF # 34-0511) The peaks at 27.3 °, 28.0 °, 29.4 °, 31.3 °, 32.0 °, 33.6 °, 34.6 °, and 58.9 ° correspond to CoMo hydroxides. (PDF # 14-0087)

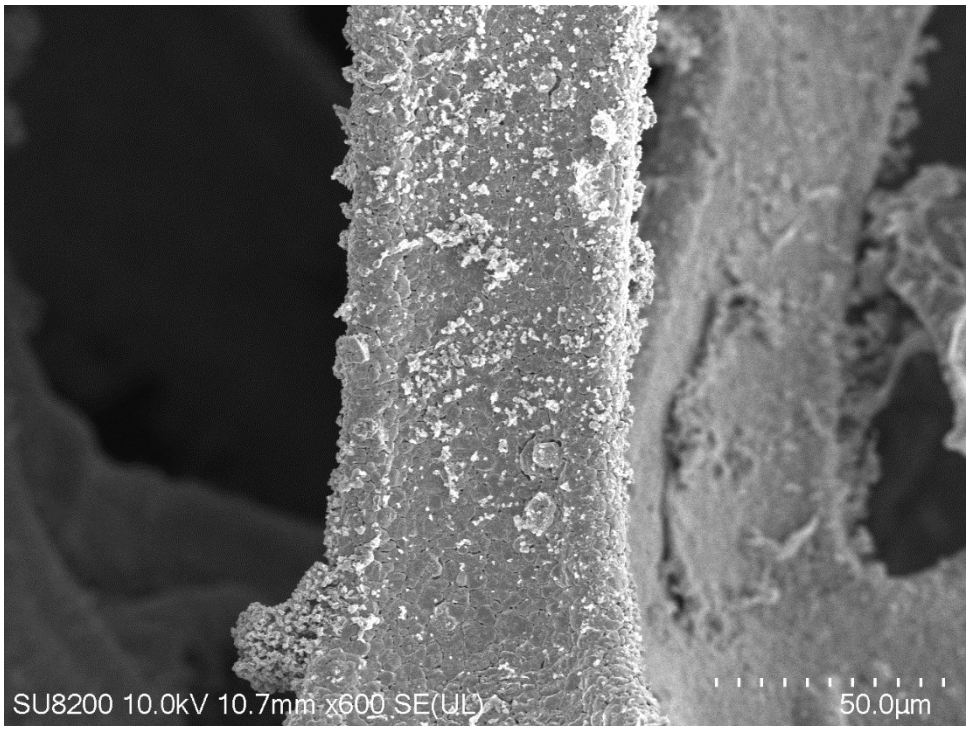


**Fig. S2.** The SEM images of the framework of NF.

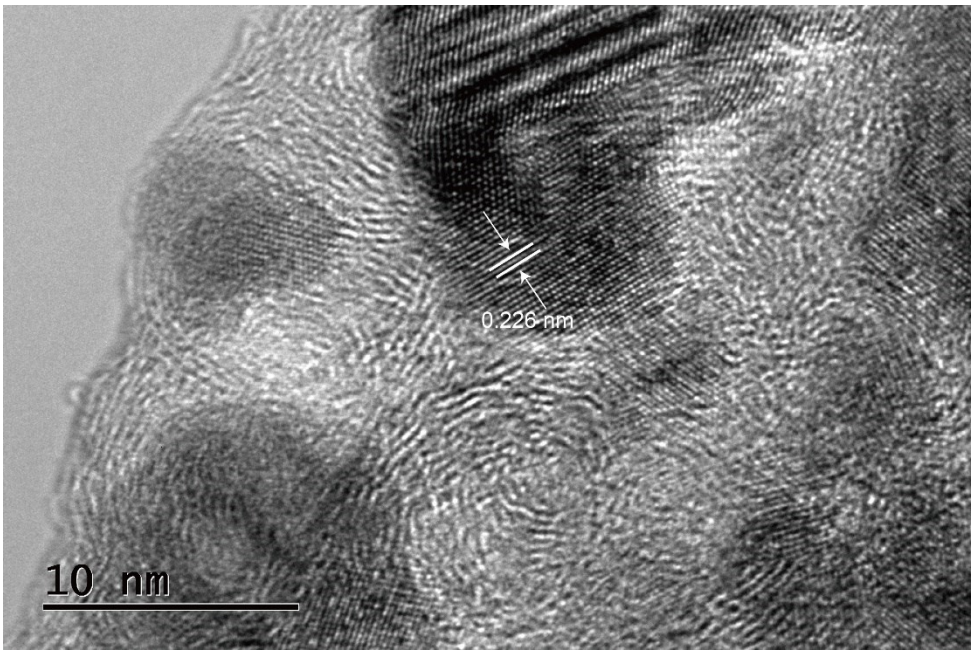


**Fig. S3.** HRTEM images of $Mo_xCo_yC$/NF. (0.226 nm, CoO (200))

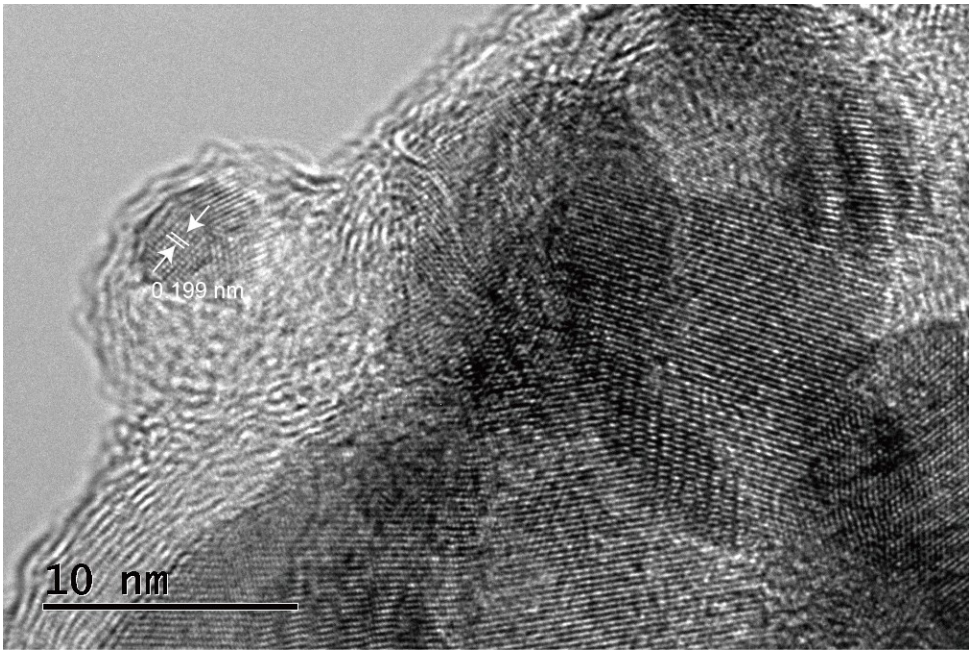


**Fig. S4.** HRTEM images of $Mo_xCo_yC$/NF. (0.199 nm, $Co_2C$ (210))

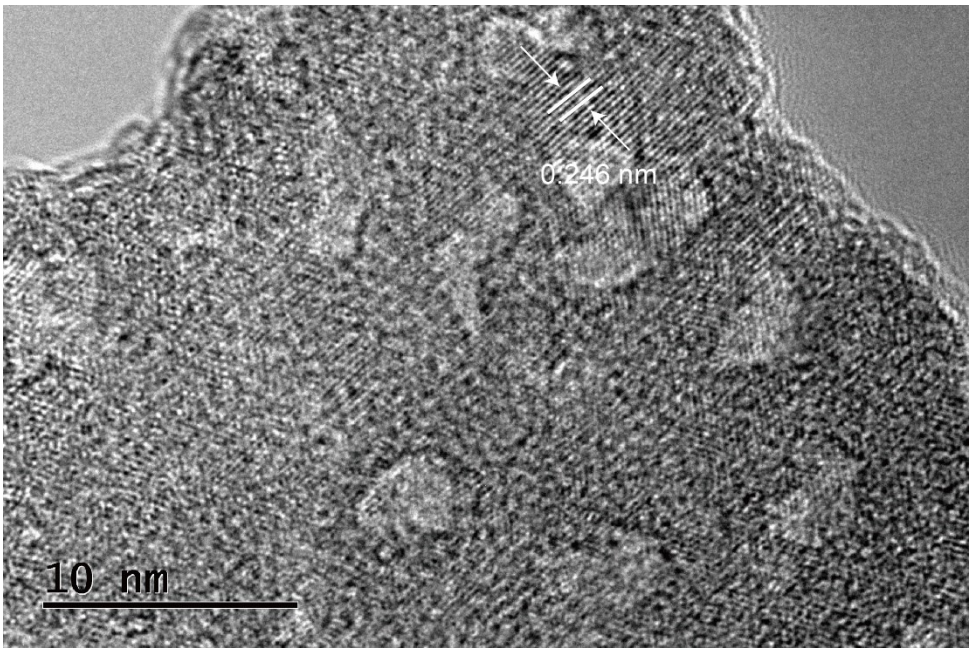


**Fig. S5.** HRTEM images of $Mo_xCo_yC$/NF. (0.246 nm, $MoO_2$ (100))

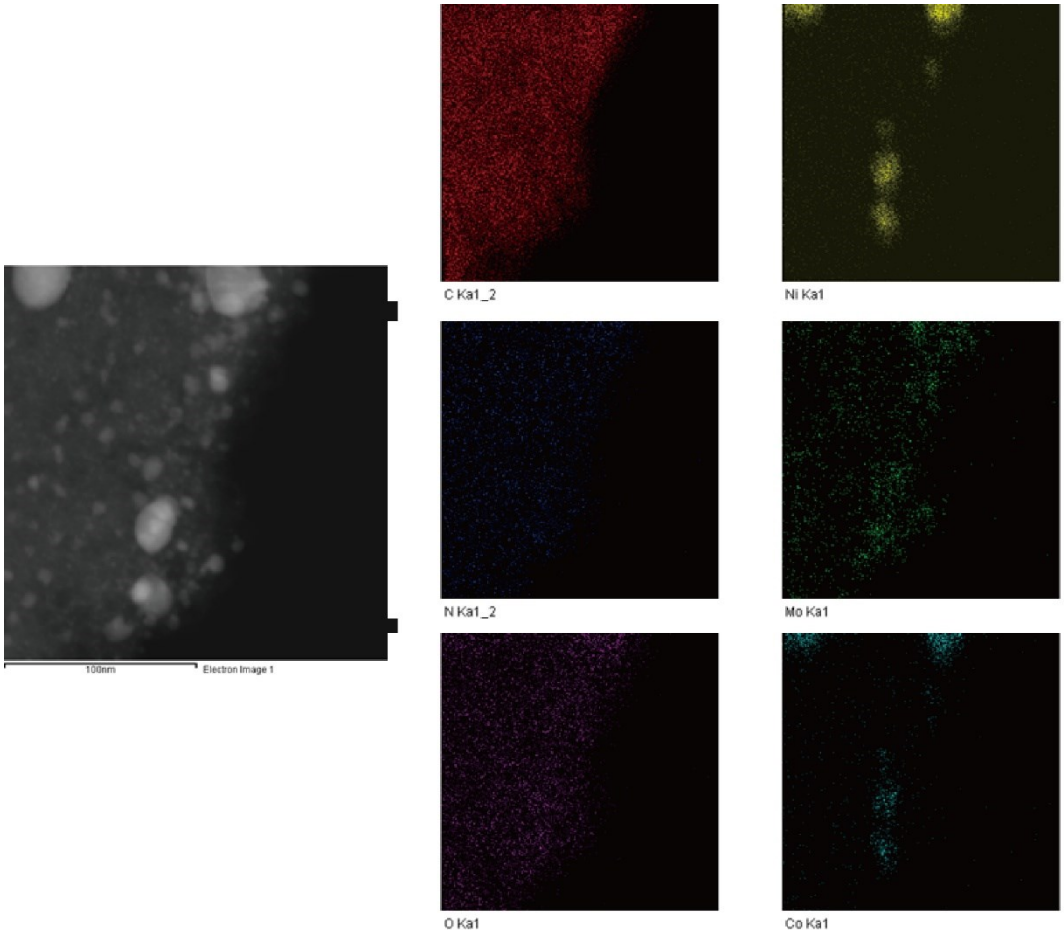


**Fig. S6.** The mapping image of $Mo_xCo_yC$/NF.

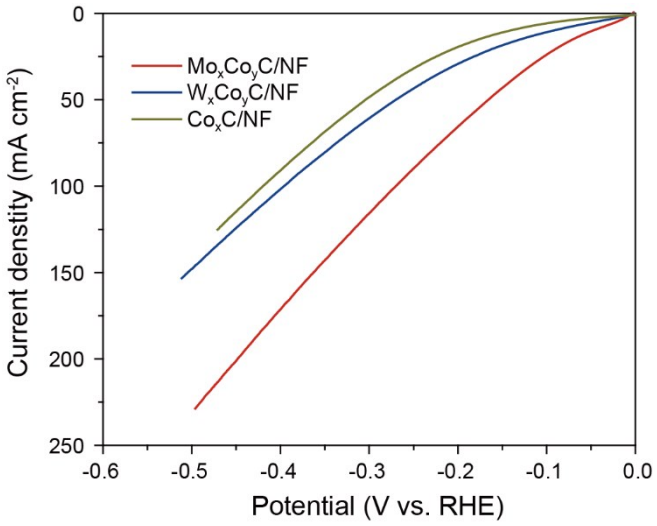


**Fig. S7.** The LSV curves of $Mo_xCo_yC/NF$, $W_xCo_yC/NF$, and $Co_xC/NF$ (without iR compensation).

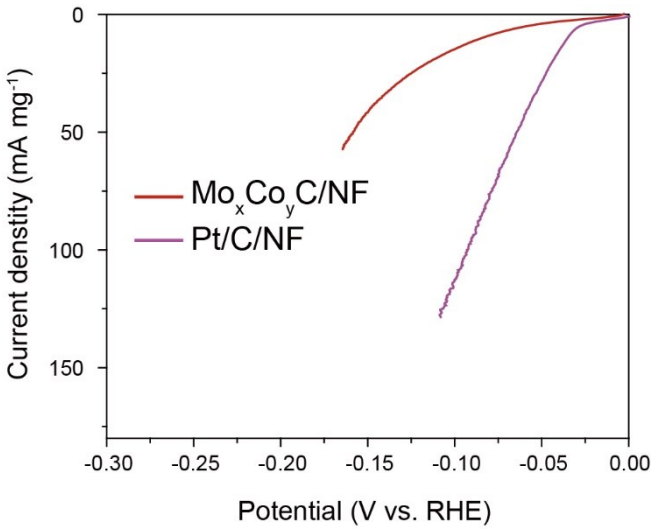


**Fig. S8.** The LSV curves of $Mo_xCo_yC/NF$, and Pt/C/NF (qualitatively normalized).

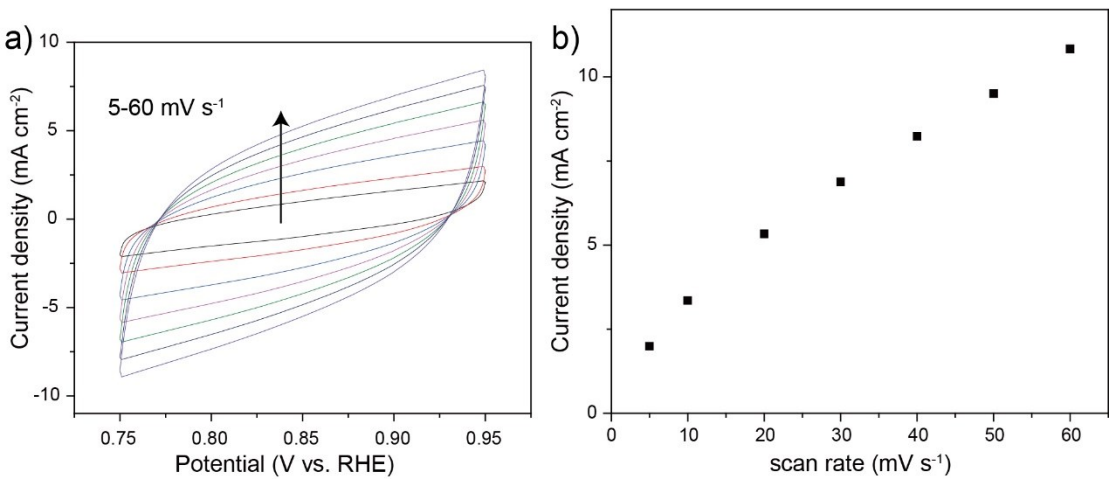

**Fig. S9** a) CV curves of $Mo_xCo_yC$/NF, and b) half of the capacitive current density as a function of scan rates, measured in 1.0 M KOH solution.

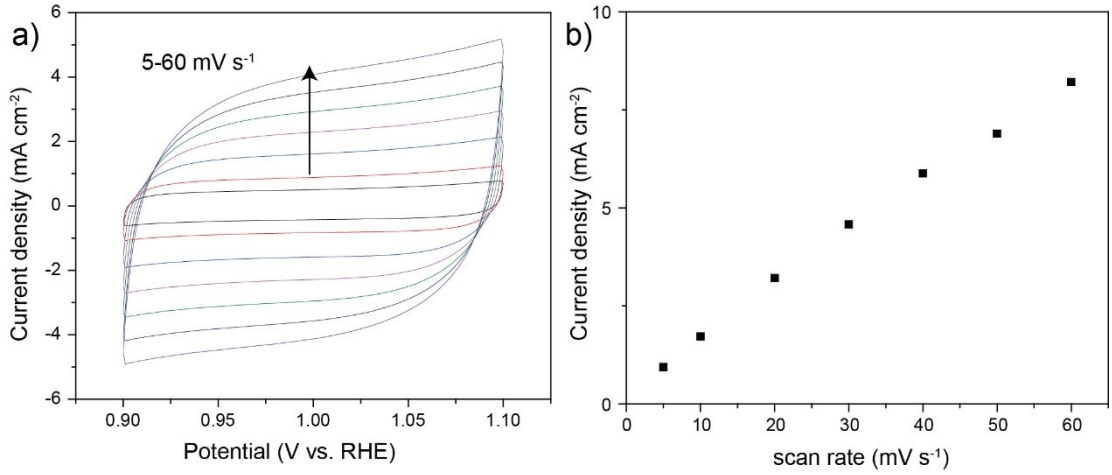


**Fig. S10** a) CV curves of $W_xCo_yC$/NF, and b) half of the capacitive current density as a function of scan rates, measured in 1.0 M KOH solution.

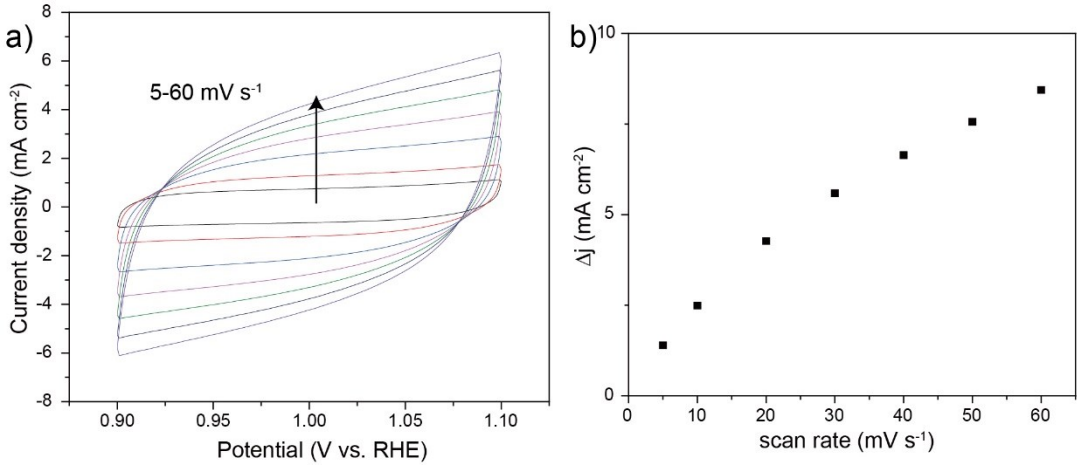


**Fig. S11** a) CV curves of $Co_xC$/NF, and b) half of the capacitive current density as a function of scan rates, measured in 1.0 M KOH solution.

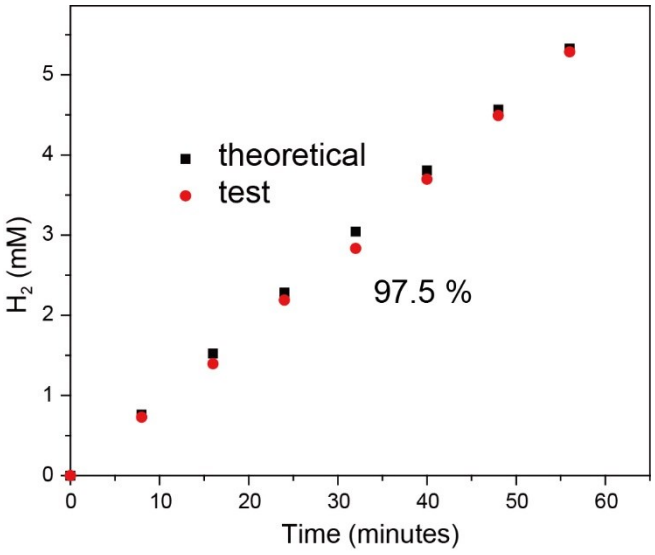


**Fig. S12** The faradic efficiency of $Mo_xCo_yC$/NF electrode.

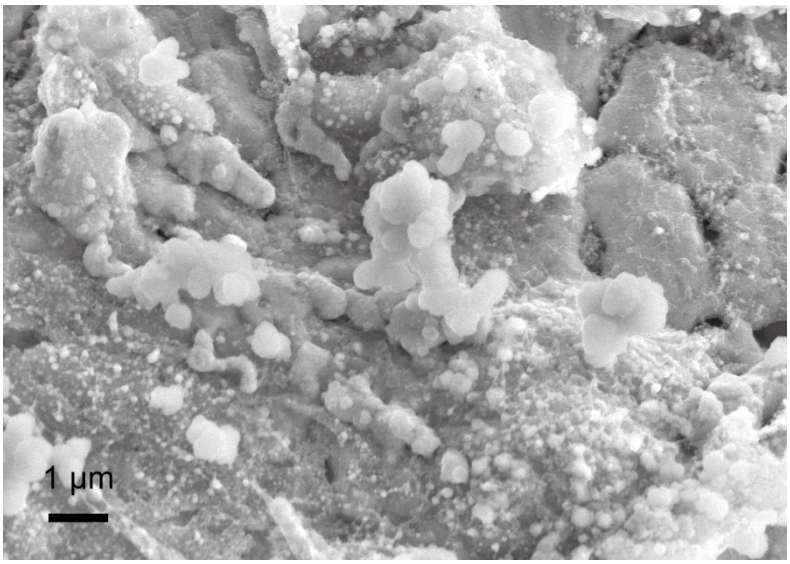


**Fig. S13** SEM image of $Mo_xCo_yC$/NF electrode after the long-term stability test.

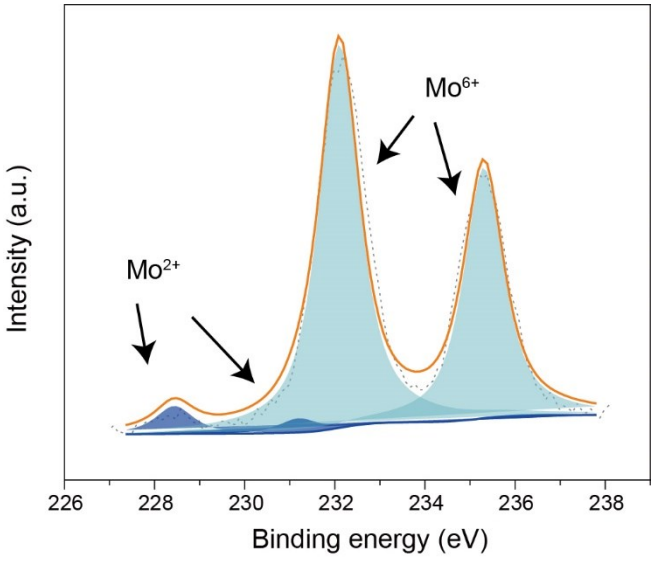

**Fig. S14** high-resolution XPS spectrum of $Mo_xCo_yC$/NF (Mo 3d) after the long-term stability test.

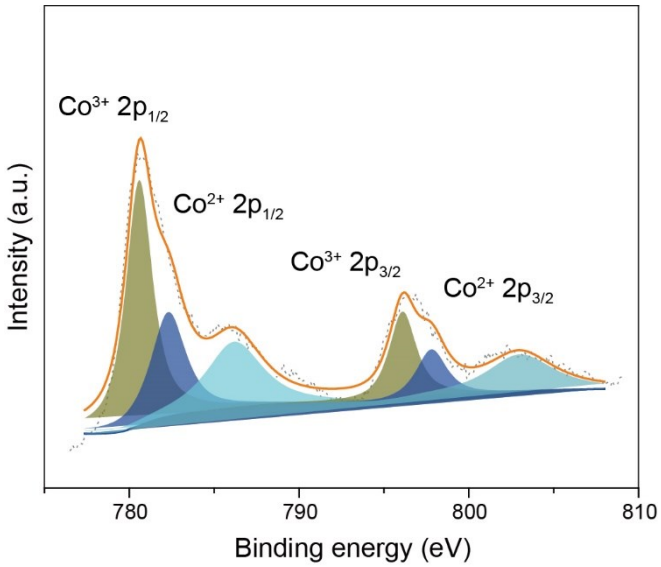


**Fig. S15** high-resolution XPS spectrum of $Mo_xCo_yC$/NF (Co 2p) after the long-term stability test.

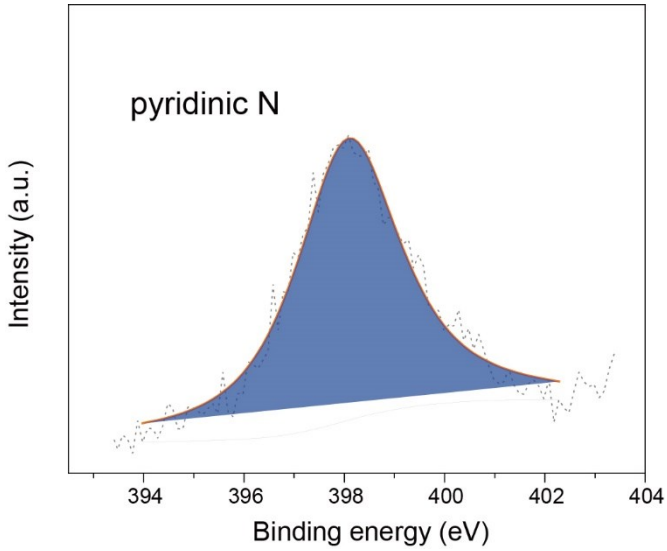


**Fig. S16** high-resolution XPS spectrum of $Mo_xCo_yC$/NF (N 1s) after the long-term stability test.

**Table S1.** The comparison of the electrocatalytic activities of $Mo_xCo_yC$/NF with some representative carbide-based HER electrocatalysts recently reported in 1.0 M KOH solution

| catalysts | $\eta_{10}$ (mV) | $\eta_{100}$ (mV) | ref |
|---|---|---|---|
| $Mo_xCo_yC$/NF | 33.5 | 124 | This work |
| MoC-$Mo_2C$/PNCDs | 121 | 182 | 1 |
| $Mo_2C$@NC | 60 | | 2 |
| $NiMo_2C$@C | 181 | | 3 |
| $Mo_2C$@2D-NPC | 45 | | 4 |
| Co-NC@$Mo_2C$ | 99 | | 5 |
| $MoNi_4/MoO_2$@Ni | 15 | | 6 |
| $NiMo_2C$/NF | | 150 | 7 |
| $Mo_2C$@ NC NPs/CC | 123 | | 8 |


[1] X. F. Lu, L. Yu, J. Zhang, X. W. Lou, *Adv. Mater.* **2019**, 31, 1900699.
[2] Y. Liu, G. Yu, G.-D. Li, Y. Sun, T. Asefa, W. Chen, X. Zou, *Angew. Chem. Inter. Ed.* **2015**, 54, 10752-10757.
[3] X. Li, L. Yang, T. Su, X. Wang, C. Sun, Z. Su, *J. Mater. Chem. A* **2017**, 5, 5000-5006.
[4] C. Lu, D. Tranca, J. Zhang, F. n. Rodríguez Hernández, Y. Su, X. Zhuang, F. Zhang, G. Seifert, X. Feng, *ACS Nano* **2017**, 11, 3933-3942.
[5] Q. Liang, H. Jin, Z. Wang, Y. Xiong, S. Yuan, X. Zeng, D. He, S. Mu, *Nano Energy* **2019**, 57, 746-752.
[6] J. Zhang, T. Wang, P. Liu, Z. Liao, S. Liu, X. Zhuang, M. Chen, E. Zschech, X. Feng, *Nat. Commun.* **2017**, 8, 15437.
[7] K. Xiong, L. Li, L. Zhang, W. Ding, L. Peng, Y. Wang, S. Chen, S. Tan, Z. Wei, *J. Mater. Chem. A* **2015**, 3, 1863-1867.
[8] H. Sun, Z. Yan, F. Liu, W. Xu, F. Cheng, J. Chen, *Adv. Mater.* **2020**, 32, 1806326.