Electronic Supplementary Material (ESI) for Green Chemistry.

Supporting Information

Nitrogen-doped nickel-molybdenum oxide as highly efficient electrocatalyst for benzyl alcohol oxidation

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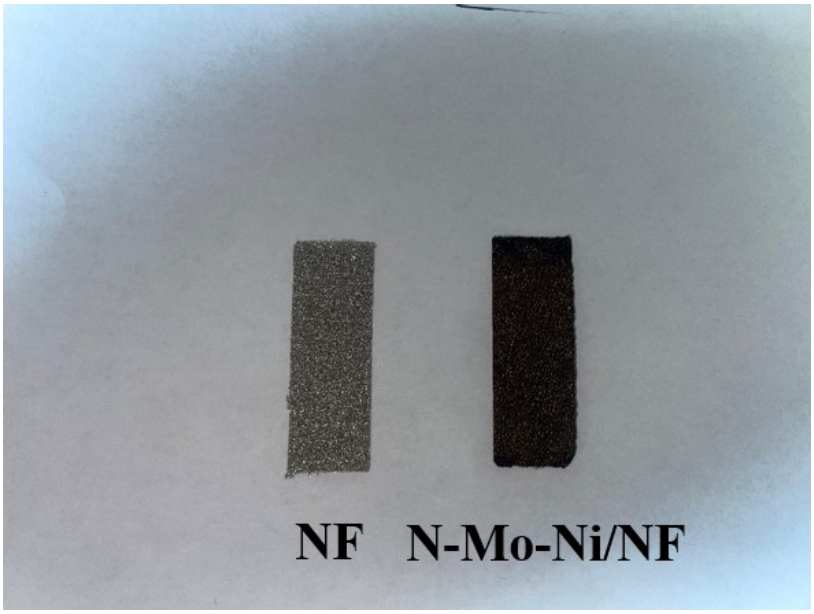

Figure S1. Optical photograph of bare NF and N-Mo-Ni/NF.

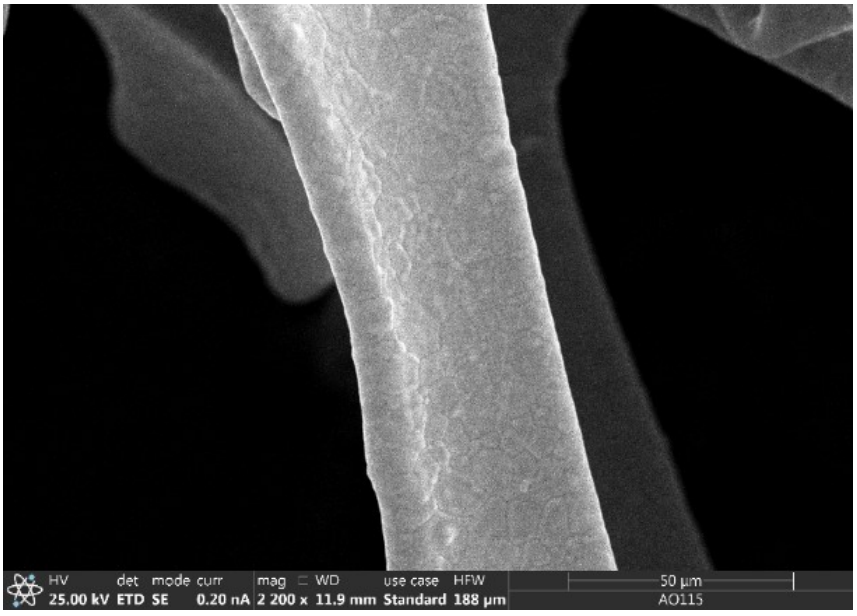

Figure S2. SEM images of Ni foam.

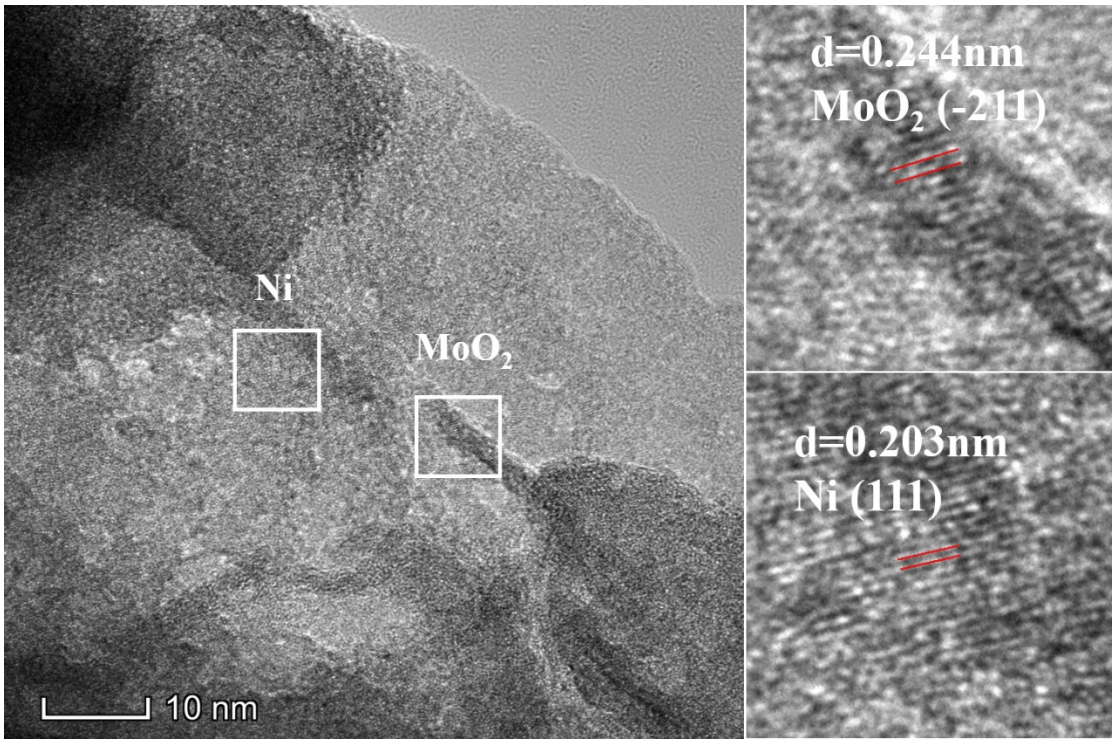

Figure S3. HRTEM pattern of N-Mo-Ni/NF.

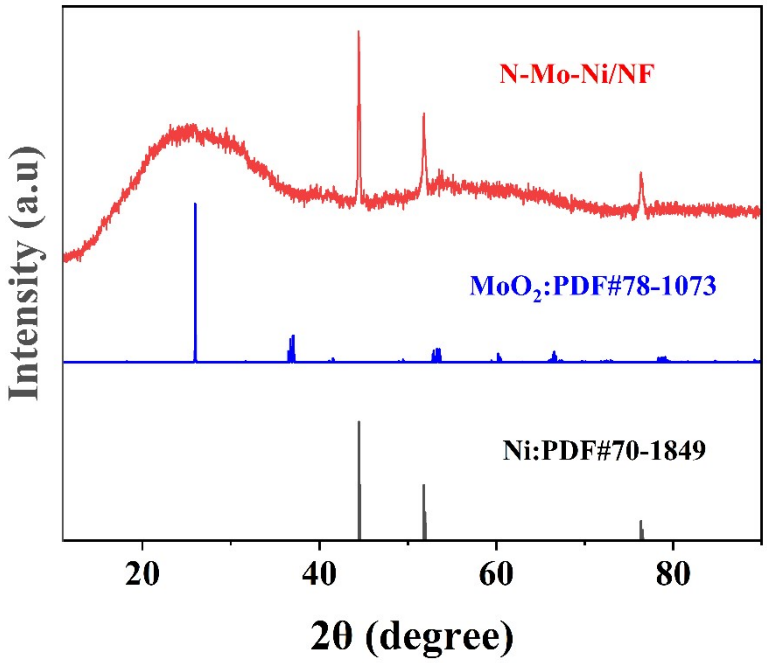

Figure S4. XRD patterns of N-Mo-Ni/NF scraped from NF substrates.

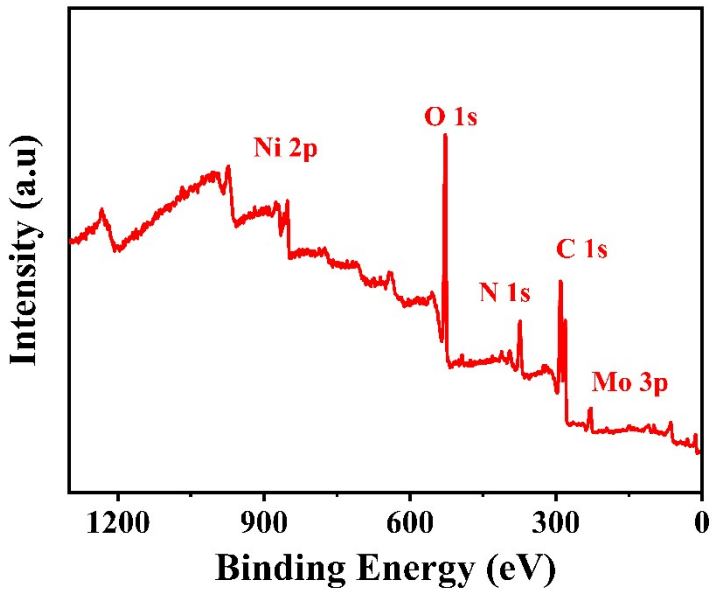

Figure S5. XPS survey spectrum of N-Mo-Ni/NF electrode.

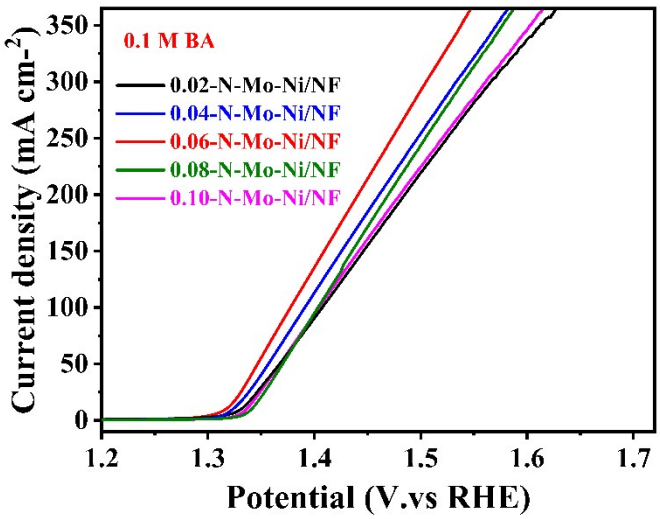

Figure S6. The LSV curves of the series of x-N-Mo-Ni/NF electrodes synthesized with different concentrations of Mo species (x-N-Mo-Ni/NF, x represents the molar amount of ammonium molybdate).

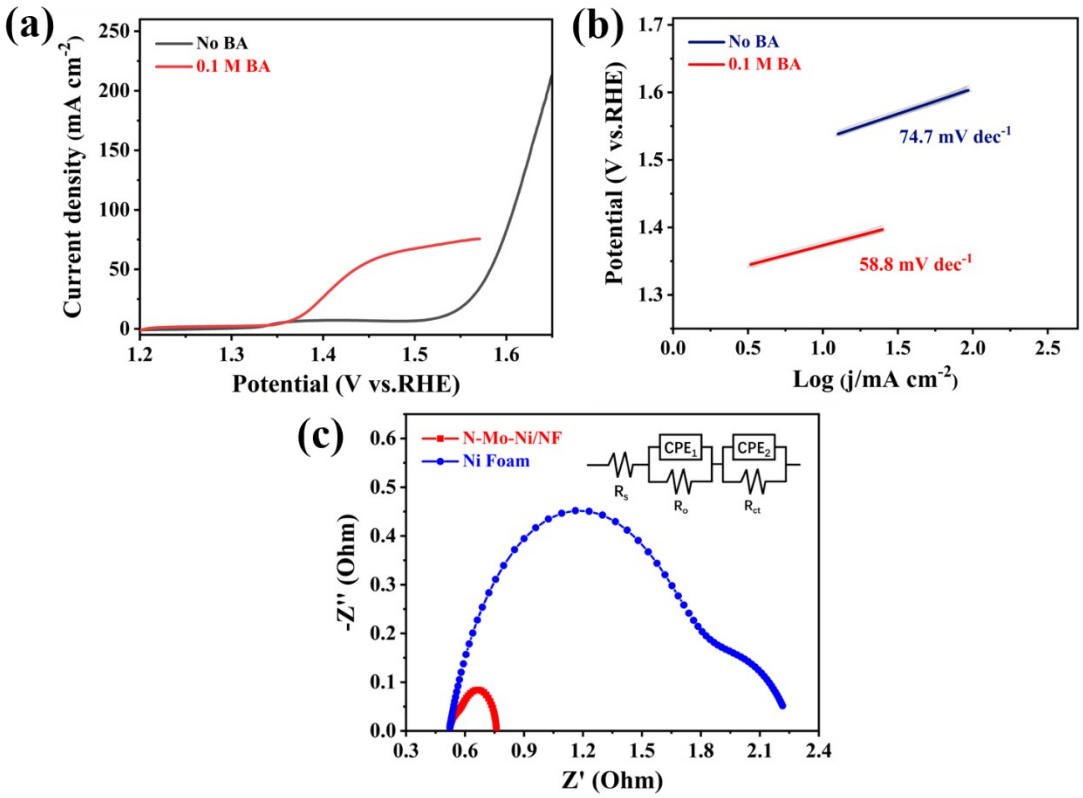

Figure S7. (a) LSV curves of Ni foam at the anode and corresponding Tafel plots in 1.0 M KOH with and without 0.1 M benzyl alcohol, (c) The Nyquist plots over the N-Mo-Ni/NF and the NF electrocatalysts in 1 M KOH with 0.1 M BA solution.

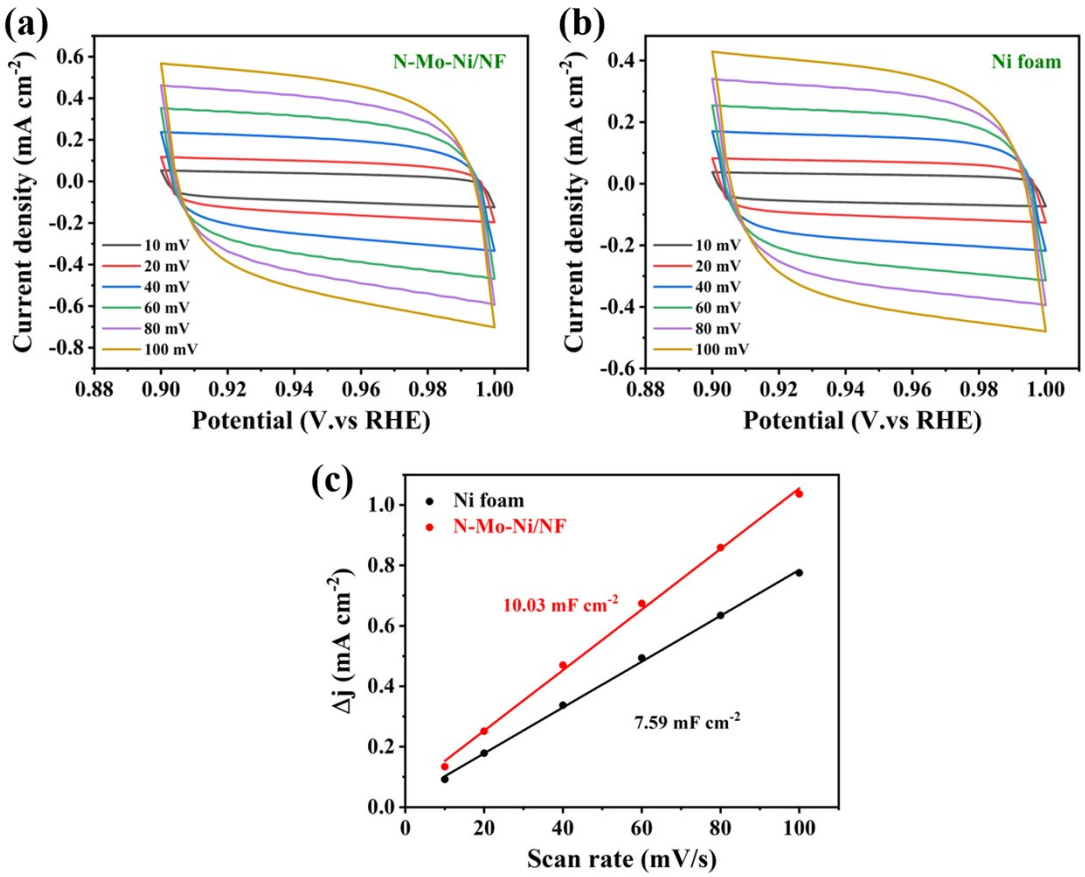

Figure S8. The CVs for (a) N-Mo-Ni/NF, (b) Ni foam and (c) corresponding capacitive current as a function of scan rate in 1 M KOH with 0.1 M benzyl alcohol.

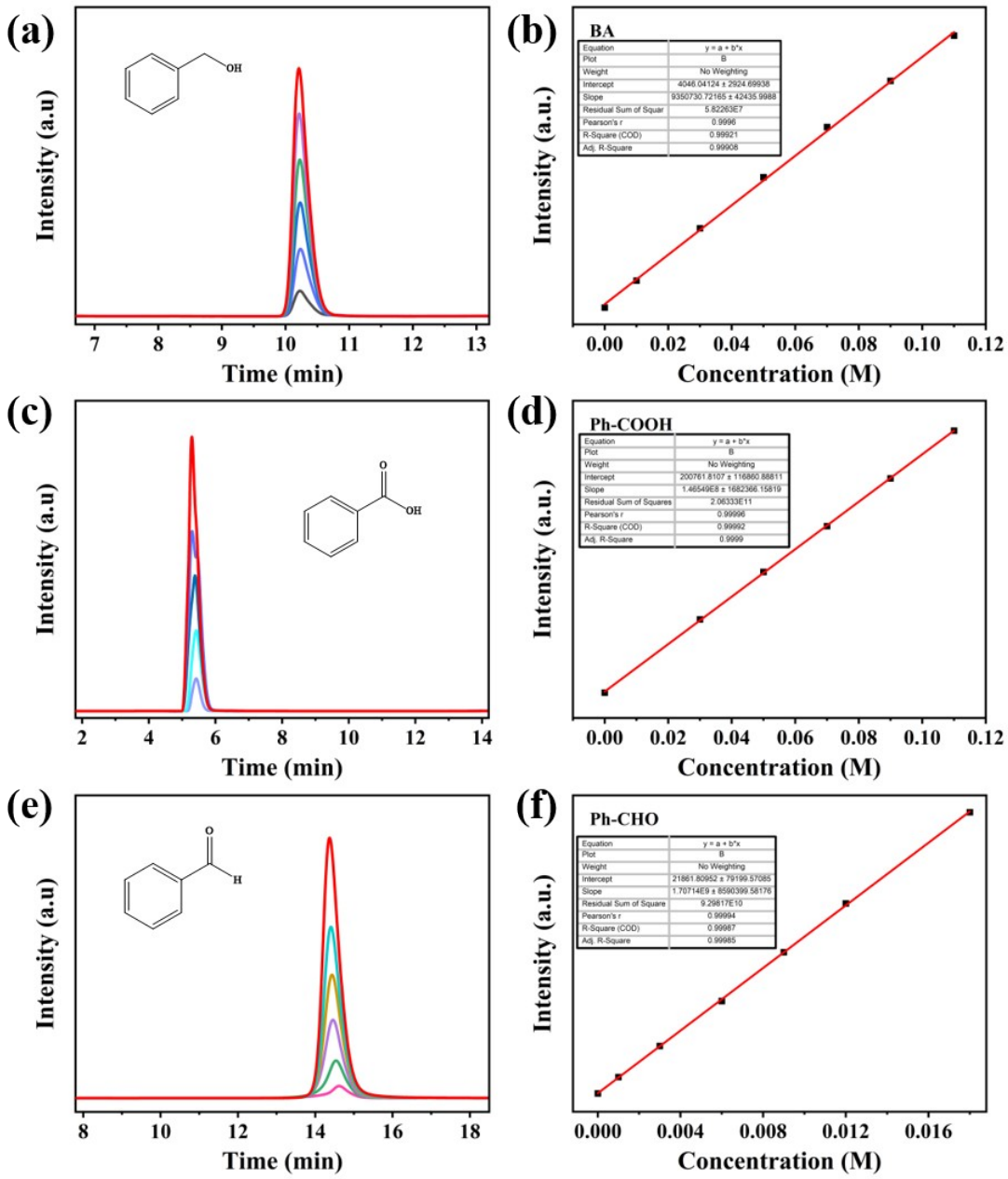

Figure S9. HPLC chromatogram of standard samples at different concentrations: (a) benzyl alcohol, (c) benzoic acid, (e) benzaldehyde. Calibration of the HPLC for (b) benzyl alcohol, (d) benzoic acid, (f) benzaldehyde.

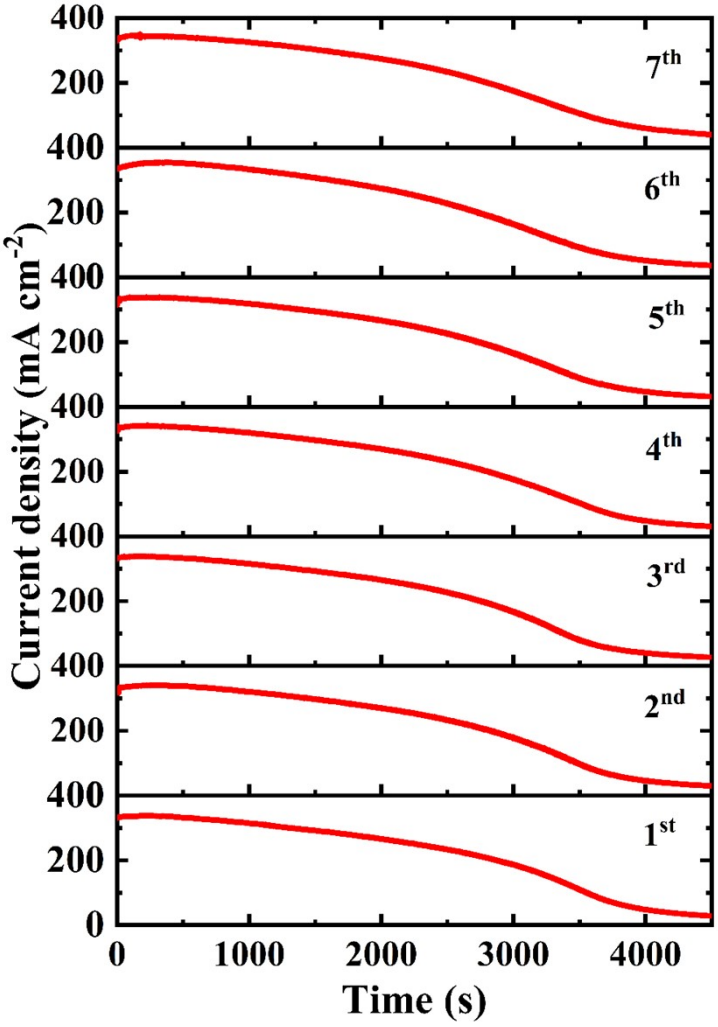

Figure S10. The i-t curves of BA oxidation at a constant potential of 1.52 V (vs. RHE) for the seven successive cycles.

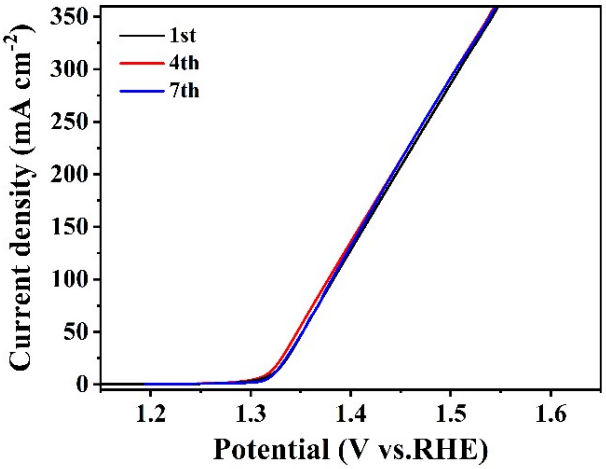

Figure S11. The LSV curves of N-Mo-Ni/NF without iR correction.

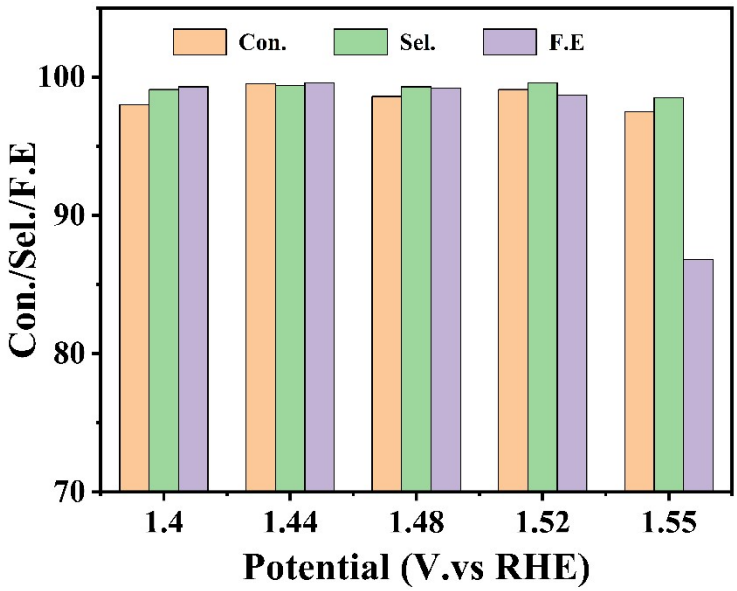

Figure S12. The conversion, selectivity, and Faradaic efficiencies for oxidation of benzyl alcohol at different applied potentials using N-Mo-Ni/NF electrode.

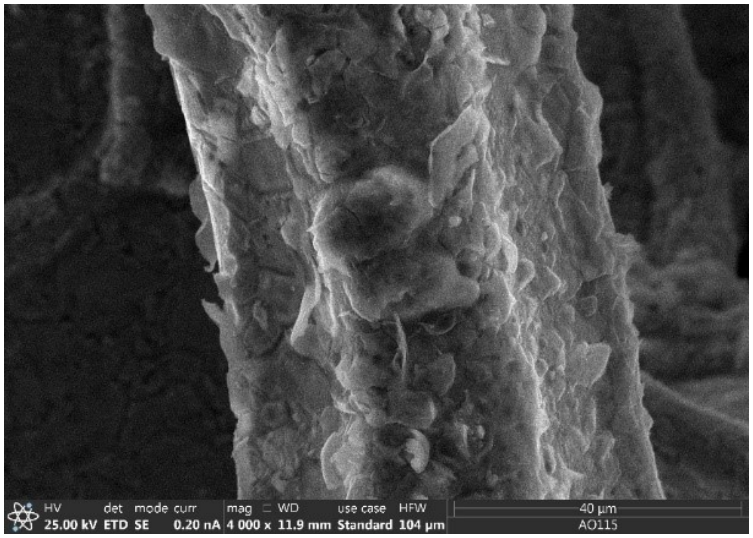

Figure S13. SEM images of N-Mo-Ni/NF after BOR

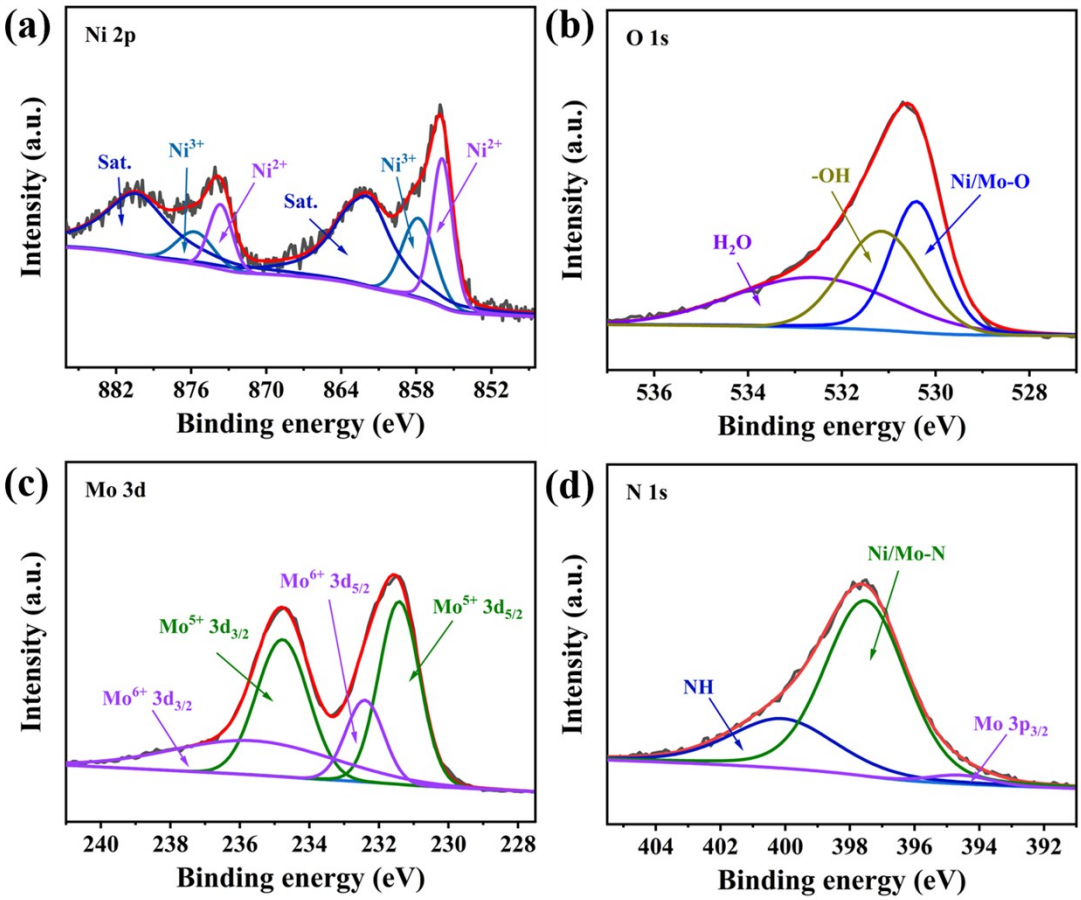

Figure S14. XPS spectra of Ni 2p (a), O 1s (b), Mo 3d (c) and N 1s (d) for obtained N-Mo-Ni/NF electrode after seven chronoamperometric tests.

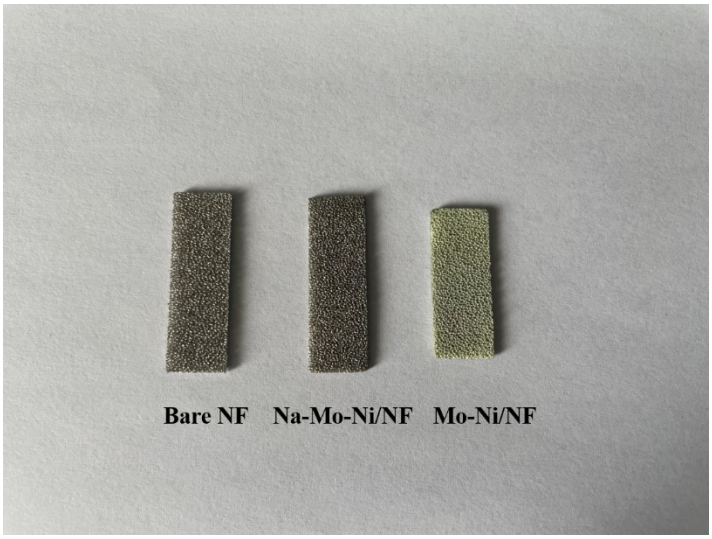

Figure S15. Optical photograph of bare NF, Na-Mo-Ni/NF and Mo-Ni/NF.

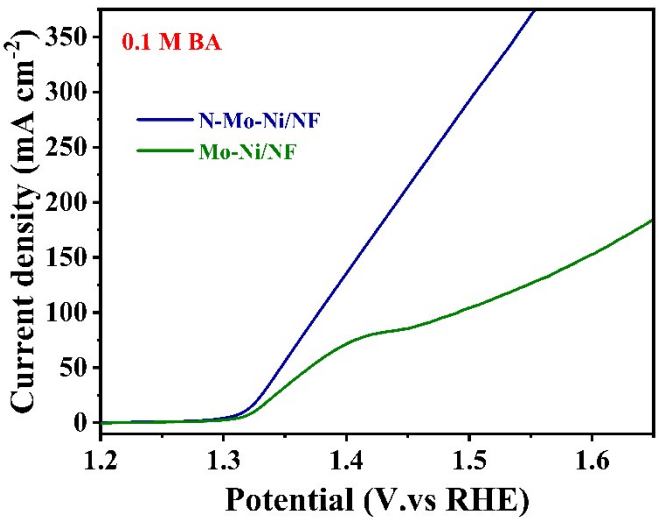

Figure S16. The LSV curves of Mo-Ni/NF and N-Mo-Ni/NF for benzyl alcohol oxidation without iR correction.

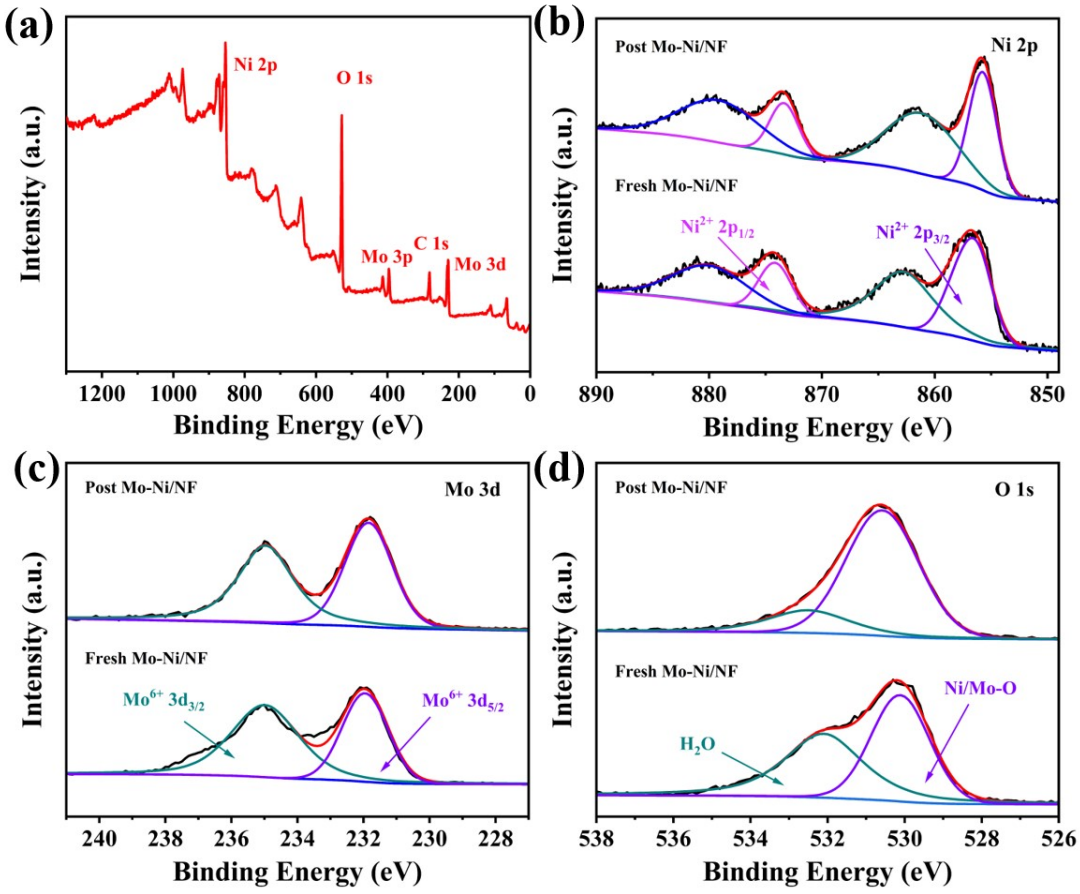

Figure S17. (a) XPS survey spectrum of Mo-Ni/NF electrode. XPS spectra of Ni 2p (b), O 1s (c), Mo 3d (d) before (Fresh Mo-Ni/NF) and after (Post Mo-Ni/NF) benzyl alcohol oxidation.

Table S1. The mass of Mo in per 5mg x-N-Mo-Ni/NF electrode

	0.02-N-Mo-Ni/NF	0.04-N-Mo-Ni/NF	0.06-N-Mo-Ni/NF	0.08-N-Mo-Ni/NF	0.1-N-Mo-Ni/NF
Mo/mg	0.051	0.117	0.186	0.196	0.210

Table 2. Impedance fitting results of as-prepared N-Mo-Ni/NF comparing with Ni foam electrodes.

	Rs/Ω cm^{-2}	Rct/Ω cm^{-2}
Ni foam	0.52	0.14
N-Mo-Ni/NF	0.51	0.68

Table S3**.** Comparison of the catalytic performance of the N-Mo-Ni/NF and the stand-of-the-art non-noble catalysts towards benzyl alcohol electrochemical oxidation in 1.0 M KOH.

Electrocatalyst	Electrolyte	Potential @ Current density	con . (%)	FE (%)	Ref.
N-Mo-Ni/NF	0.1M BA	1.338@100	99.1	98.7	**This work**
Ni-2D-O-SA-CNT	0.1M BA	0.6V@77[a]	-	-	[1]
NiO-NS_s/NF	0.06 M BA	>1.5@90[b]	-	-	[2]
hp-Ni	0.01 M BA	>1.35@10	-	98%	[3]
Ni-MOF@CNT	0.5 M BA	>1.4V@25	-	-	[4]
Ni_3N@C	0.02M BA	>1.35@25	-	-	[5]
h-$Ni(OH)_2$	0.04 M BA	>1.4@40	99.99	98.62	[6]
MoO_2-FeP	0.01 M BA	>1.37@20	-	-	[7]
CuO-NRs	0.01 M BA	>1.4@10	90	97	[8]
A-Ni-CoH/NF	0.1M BA	1.35@100	99.6	93.5	[9]
Mo-Ni/MoO_2/Ni	0.1M BA	1.35@15	-	60	[10]
NC@CuCo	0.015 M BA	1.25@10	97.5	81.3	[11]

Ni-OH/NF	0.1M BA	1.33@100	84.5	99	[12]
NiCo/AC	0.1M BA	1.31@10	-	-	[13]
NiO/Ni_3S_2	0.2M BA	1.391@50	99.11	94	[14]

[a] V vs Hg/HgO
[b] the potential is over 1.5 V (vs. RHE) when the currently density is 90 mA cm^{-2}

Table S4. Comparison of the chemical-assisted hydrogen evolution reaction performance between the N-Mo-Ni/NF and some other reported non-noble catalysts.

Electrocatalyst	Electrolyte	product	Potential @ Current density	Ref.
O-NiMoP/NF	1 M KOH 0.5 M urea	N_2	1.41@100	[15]
$P\text{-}CoNi_2S_4$	1 M KOH 0.5 M urea	N_2	1.367@100	[16]
$Ni(OH)_2/NiO\text{-}C/WO_3$ HAs	1 M KOH 0.5 M urea	N_2	1.381@100	[17]
$Rh_{SA}\text{-}S\text{-}Co_3O_4$	1 M KOH 0.5 M urea	N_2	1.37@100	[18]
$Ni(OH)_2$/NF	1.0 M KOH 0.5 M MeOH	formate	1.36@100	[19]
Co_xP@NiCo-LDH	1.0 M KOH 0.5 M MeOH	formate	1.34@100	[20]
Co_3FePx@NF	1 M KOH 0.1 M glucose	-	1.36@100	[21]
Co@NPC	1 M KOH 0.1 M glucose	lactic acid	1.46@10	[22]
Ni_2P-UNMs/NF	1 M KOH 0.125 M benzylamin	benzonitrile	1.34@10	[23]
NiO_x/MWCNTs-Ox	1 M KOH 1 M glycerol	Oxalate	1.31@10	[24]
$CoSe_2$/CC	1.0 M KOH 1.0 M glycerol	formate	1.42@100	[25]
N-Mo-Ni/NF	1.0 M KOH 0.1M BA	Benzoic acid	1.338@100	This work

Table S5. The mass of Mo in per 5mg N-Mo-Ni/NF electrode in different testing phases determined by ICP-OES analysis.

	Pristine electrode	three LSV tests	seven chronoamperometric tests
Mo mass/mg	0.186	0.013	0.010

Uncategorized References

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