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Construction of Hierarchical NiCu-based Bimetallic Electro catalysts for Promoting the Electrooxidation of Biomass Derivative

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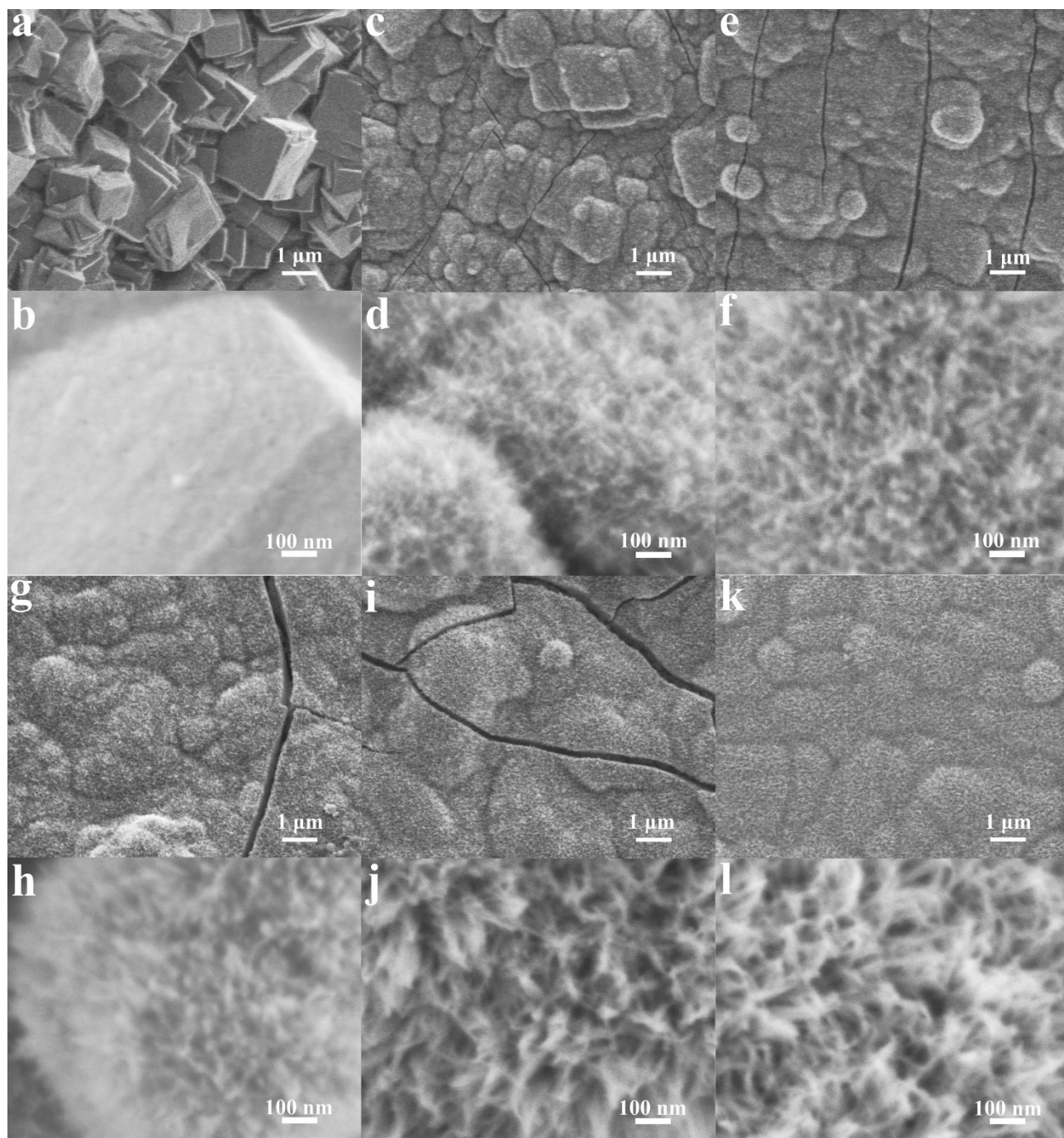
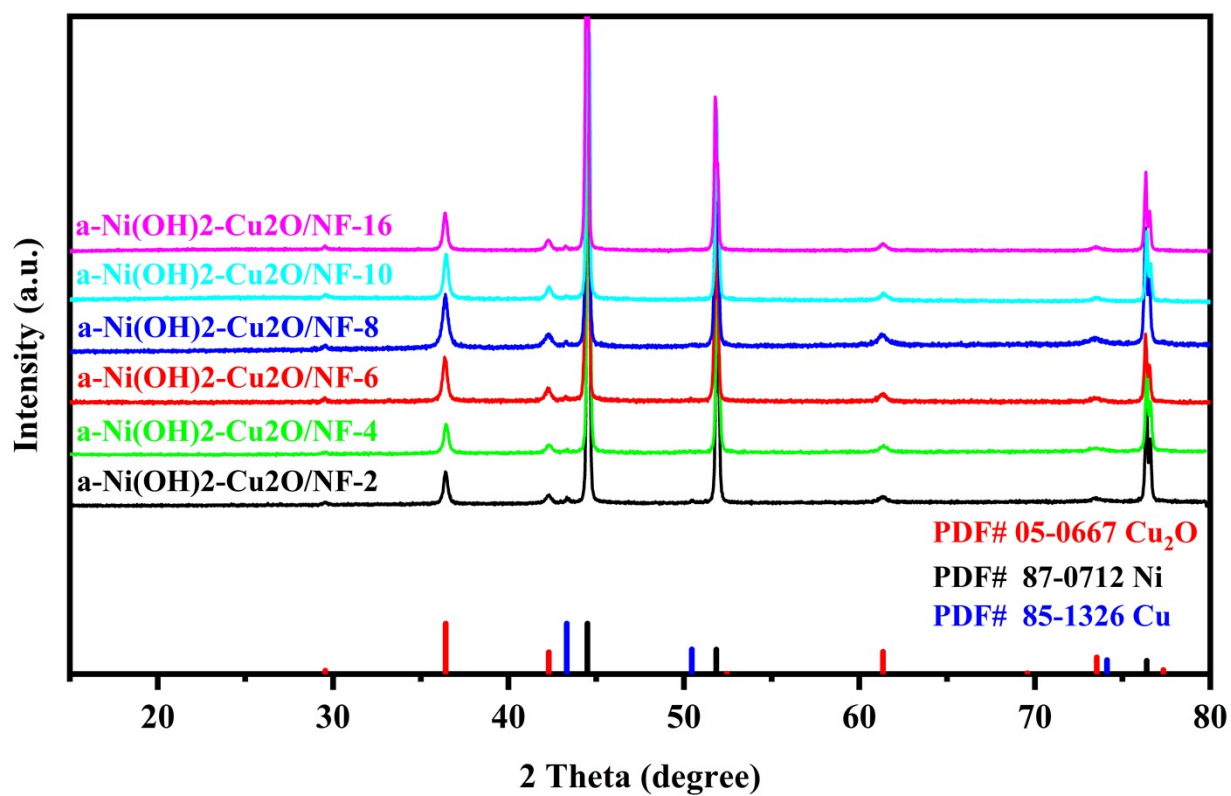


Figure S1. (a, b) SEM images of a-Ni(OH)₂-Cu₂O/NF-2. (c, d) SEM images of a-Ni(OH)₂-Cu₂O/NF-4. (e, f) SEM images of a-Ni(OH)₂-Cu₂O/NF-6. (g, h) SEM images of a-Ni(OH)₂-Cu₂O/NF-8. (i, j) SEM images of a-Ni(OH)₂-Cu₂O/NF-10. (k, l) SEM images of a-Ni(OH)₂-Cu₂O/NF-16.

Figure S2. XRD patterns of a-Ni(OH)₂-Cu₂O/NF-x.

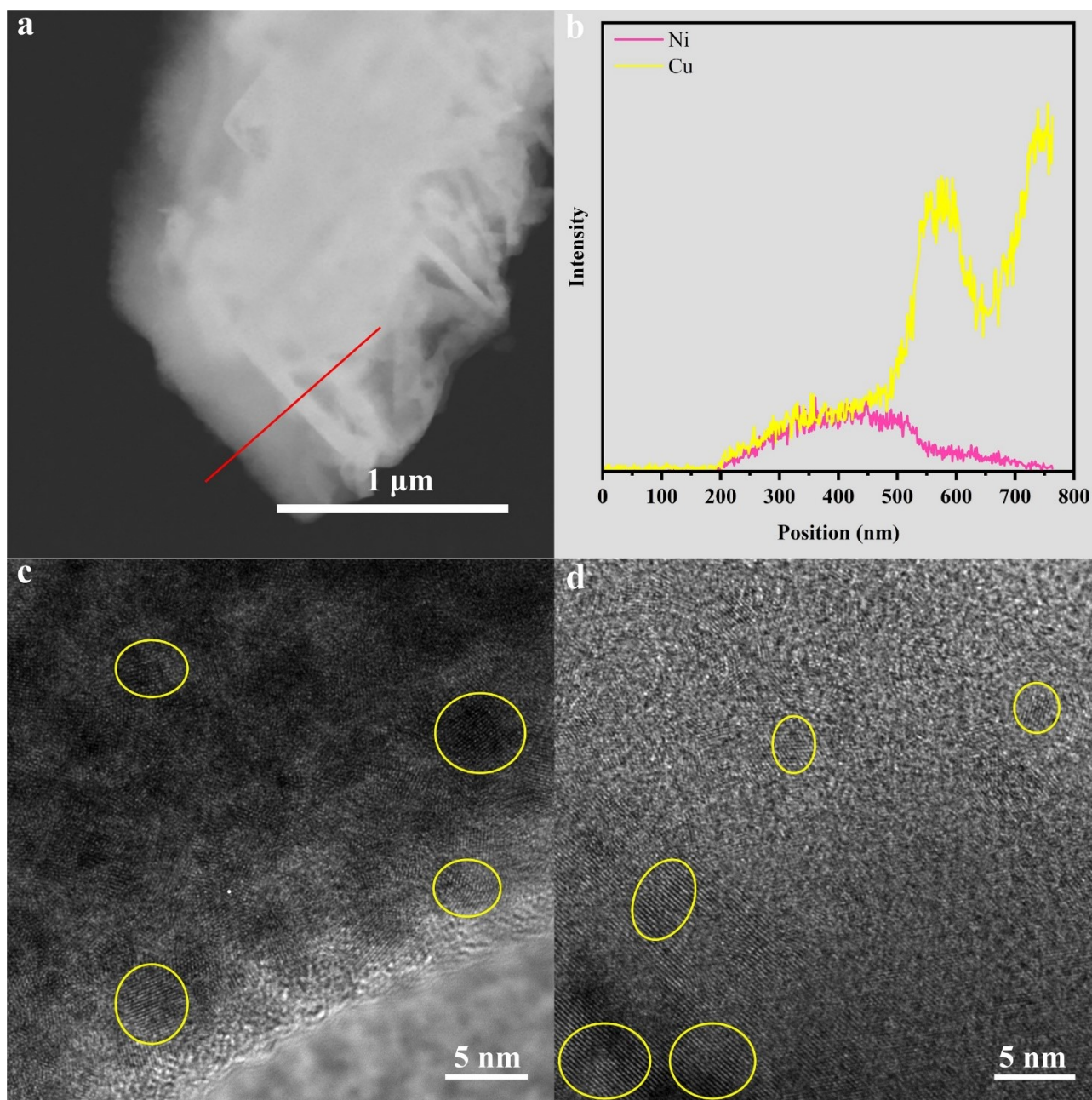


Figure S3. (a, b) TEM line-scan analysis of a-Ni(OH)₂-Cu₂O/NF-6. (c, d) HR-TEM of a-Ni(OH)₂-Cu₂O/NF-6.

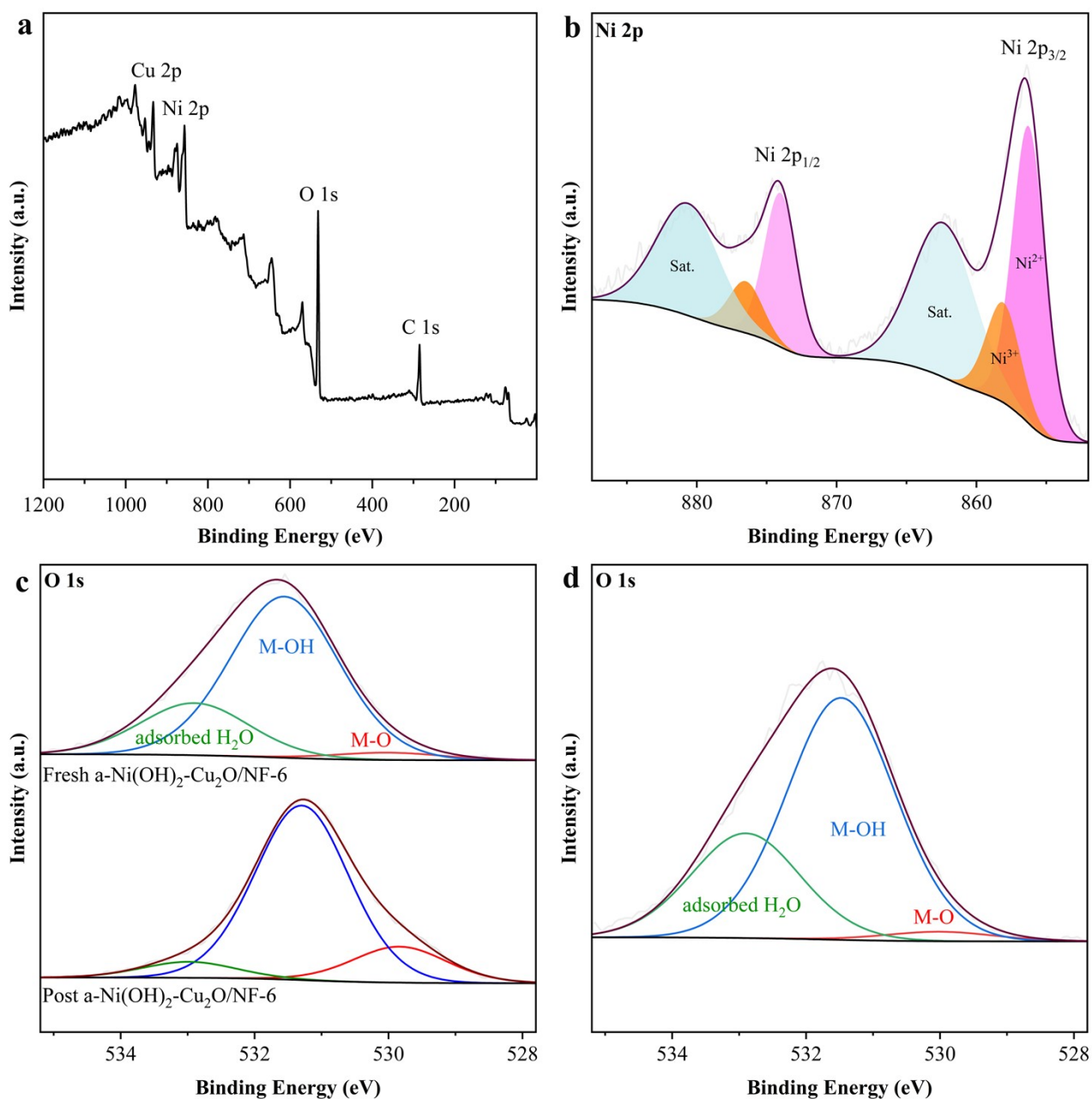


Figure S4. (a) XPS survey spectra of a-Ni(OH)₂-Cu₂O/NF-6. (b) High-resolution XPS spectra of Ni 2p for Ni(OH)₂. (c) High-resolution XPS spectra of O 1s for fresh a-Ni(OH)₂-Cu₂O/NF-6 and post a-Ni(OH)₂-Cu₂O/NF-6. (d) High-resolution XPS spectra of O 1s for Ni(OH)₂.

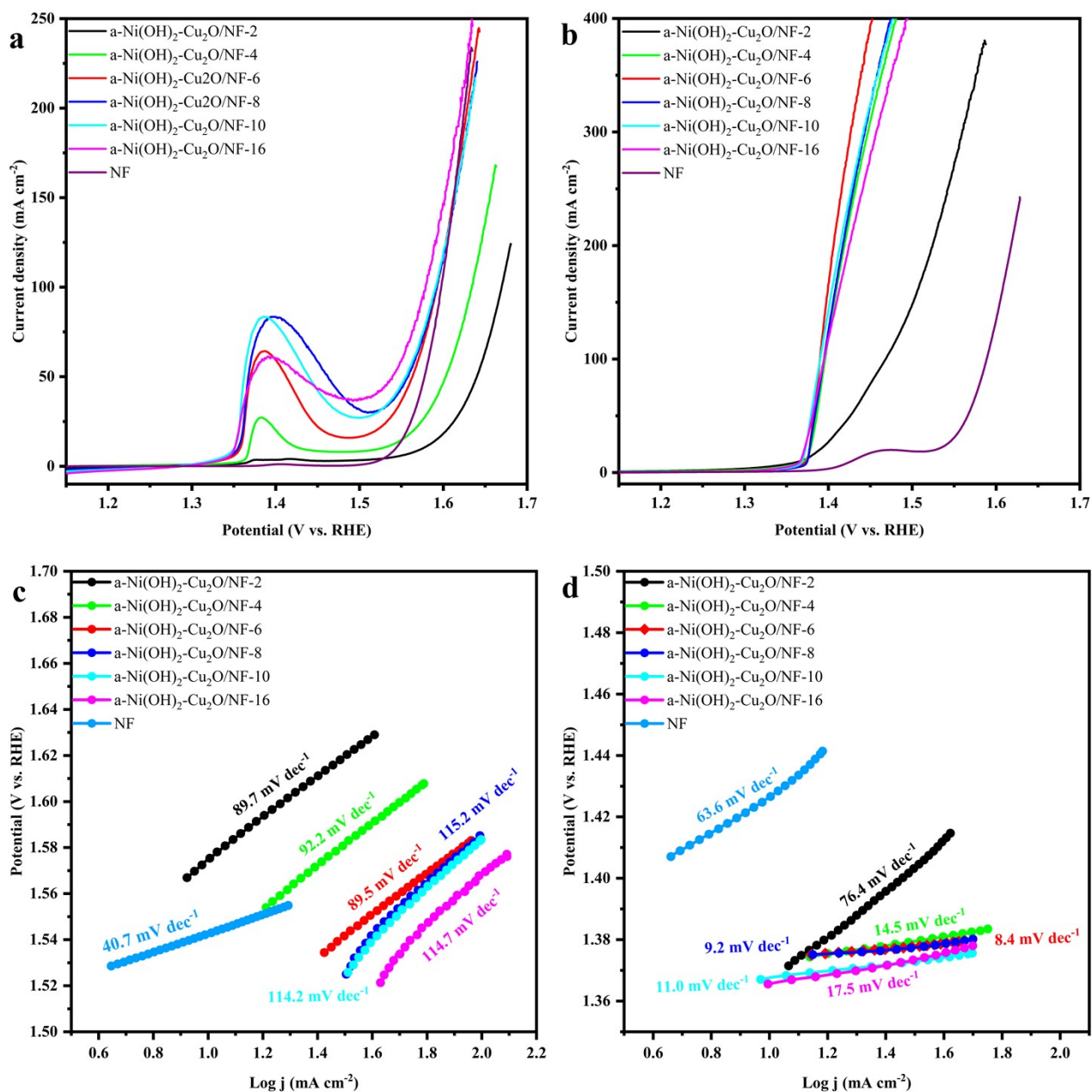


Figure S5. (a) LSV curves of a-Ni(OH)₂-Cu₂O/NF-x and NF at a scan rate of 5 mV s⁻¹ in 1 M KOH. (b) LSV curves of a-Ni(OH)₂-Cu₂O/NF-x and NF at a scan rate of 5 mV s⁻¹ in 1 M KOH with 50 mM HMF. (c) Tafel plots of a-Ni(OH)₂-Cu₂O/NF-x and NF for OER. (d) Tafel plots of a-Ni(OH)₂-Cu₂O/NF-x and bare NF for HMFEOR.

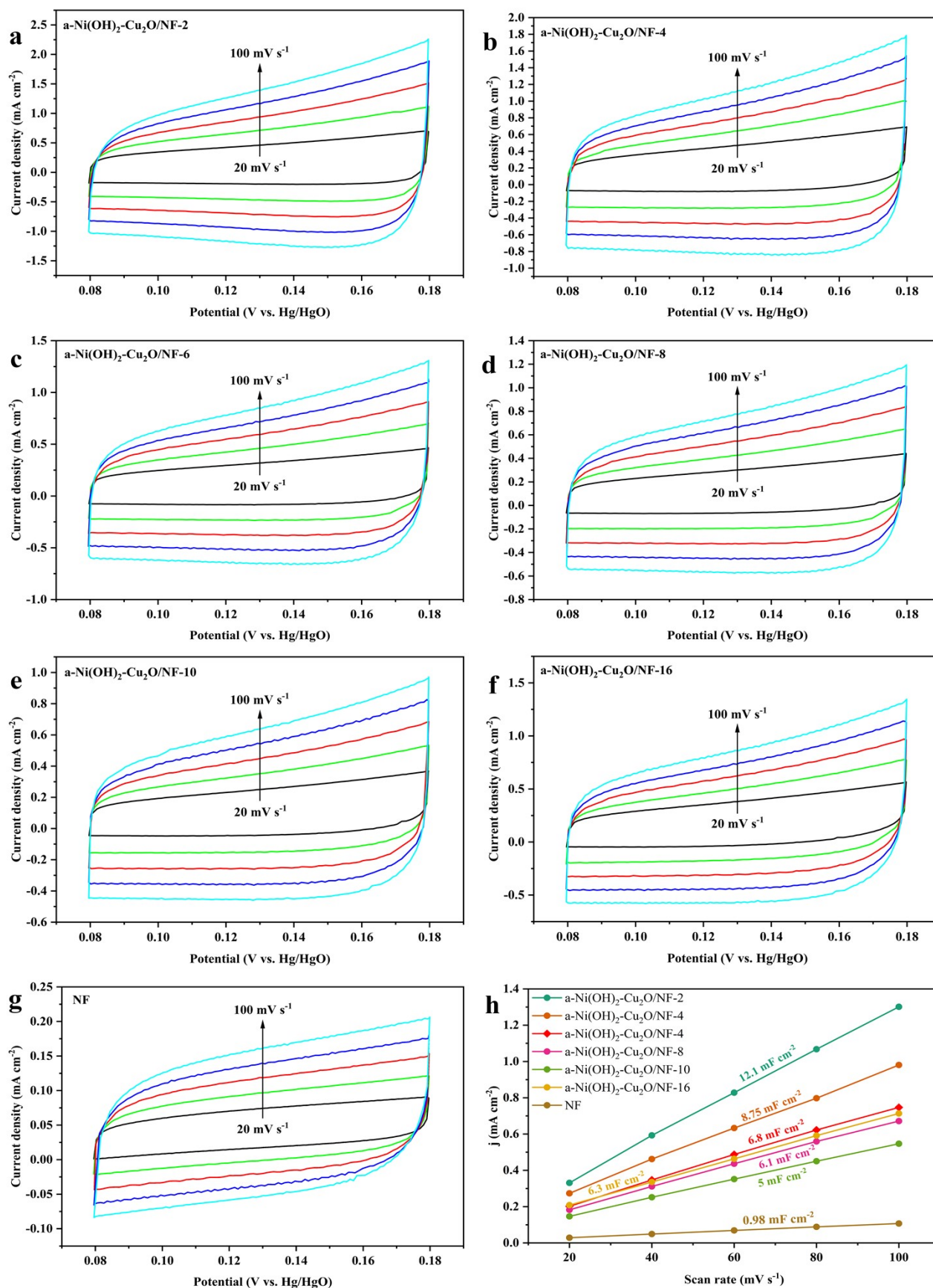


Figure S6. (a-g) CV curves of a-Ni(OH)₂-Cu₂O/NF-x and NF with 50 mM HMF at different scan rates. (h) calculated double layer capacitive of a-Ni(OH)₂-Cu₂O/NF-x and bare NF.

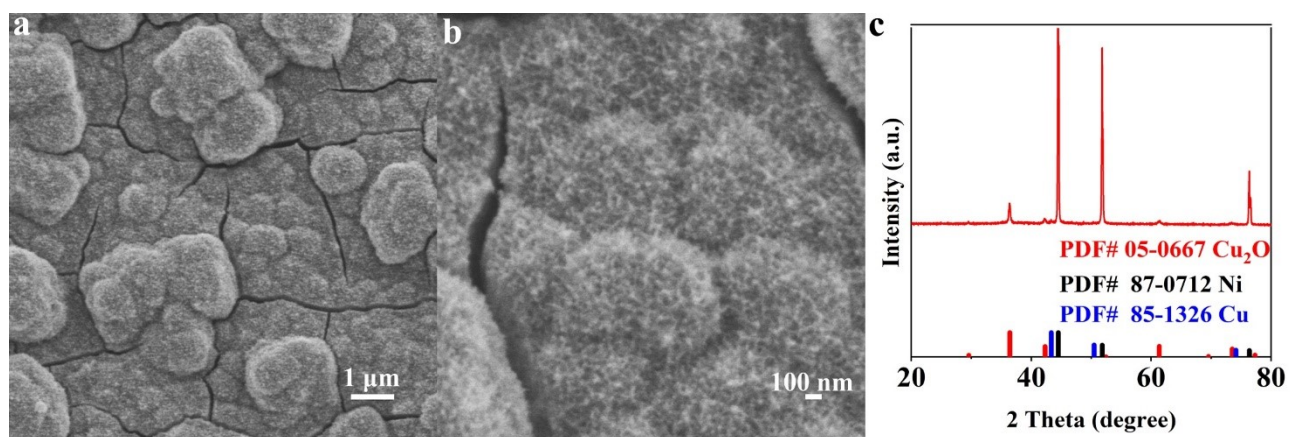


Figure S7. (a, b) SEM images of a-Ni(OH)₂-Cu₂O/NF-6 after LSV for HMFEOR, (c) XRD pattern of a-Ni(OH)₂-Cu₂O/NF-6 after LSV for HMFEOR

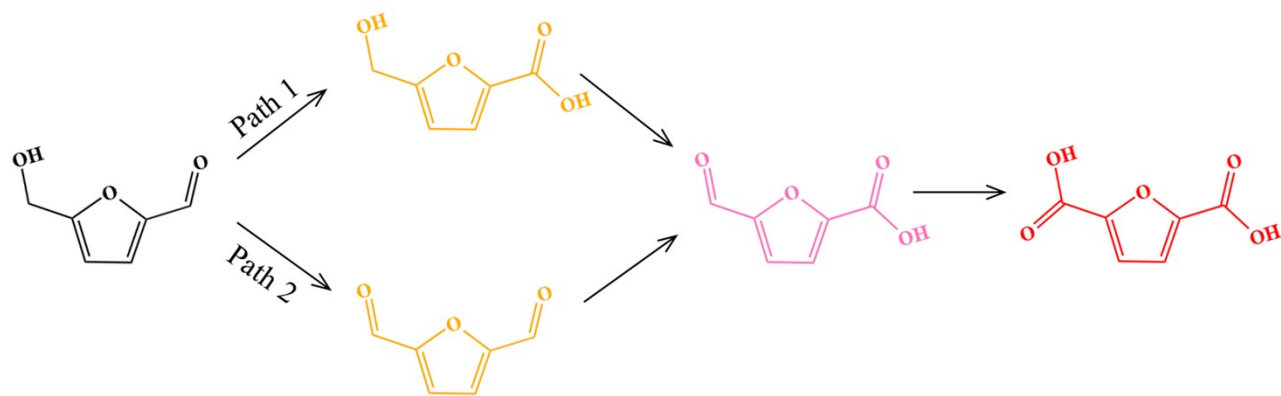


Figure S8. Two possible reaction routes for HMFEOR.

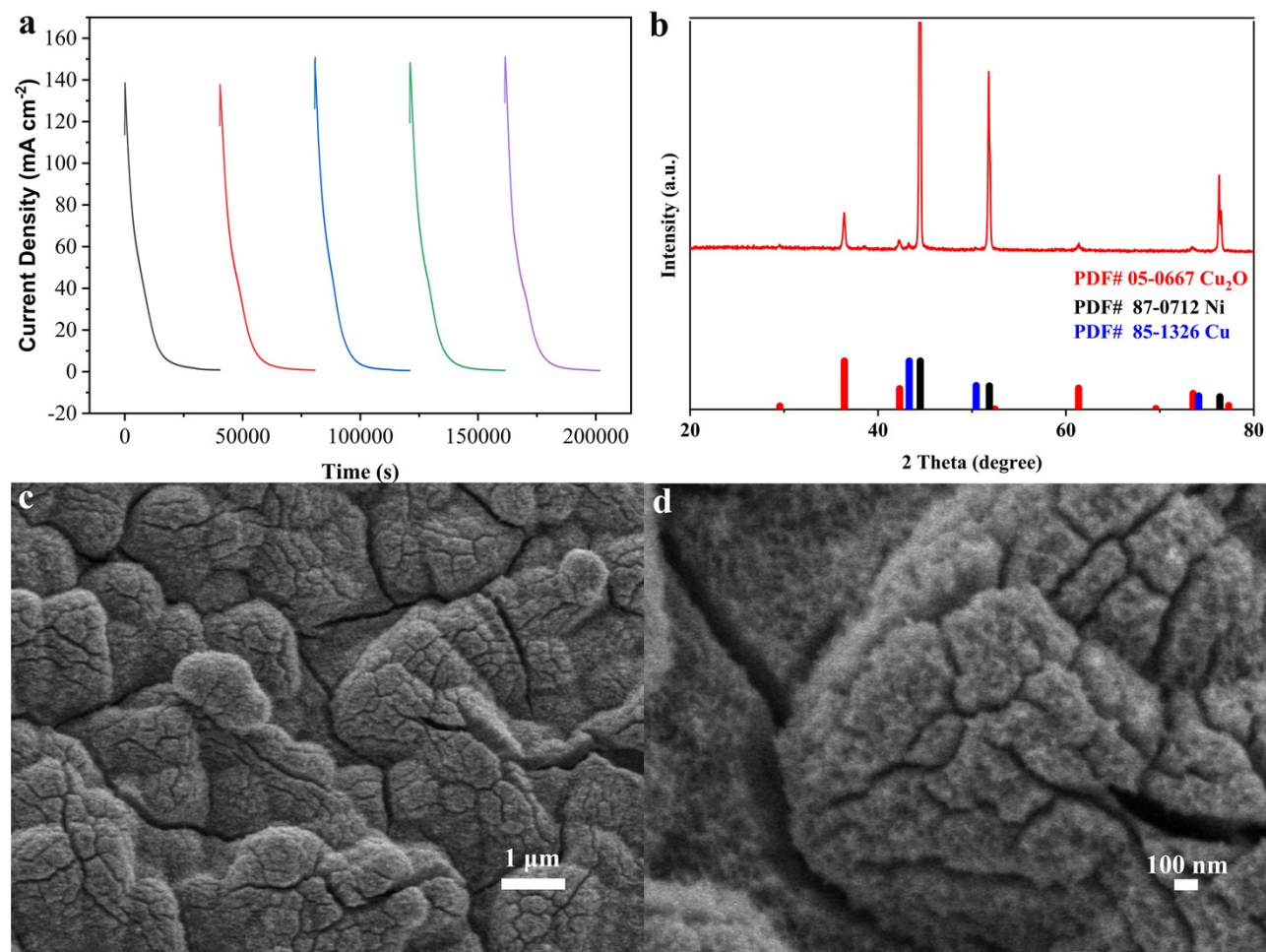


Figure S9. (a) i-t curve for a-Ni(OH)₂-Cu₂O/NF-6 at 1.424 V_{RHE} for five successive cycles in 1M KOH with 100 mM HMF. (b) XRD pattern of a-Ni(OH)₂-Cu₂O/NF-6 after five successive cycles in 1M KOH with 100 mM HMF. (c, d) SEM images of a-Ni(OH)₂-Cu₂O/NF-6 after LSV for HMFEOR

Electrocatalysts	Potential (versus RHE) and current	C_{HMF} (mM)	Ref.
CoCu	1.38 V (16.71 mA cm ⁻²)	50	[1]
Pt/Ni(OH) ₂	1.5 V (37.31 mA cm ⁻²)	50	[2]
NiFe-1	1.478 V (500 mA cm ⁻²)	50	[3]
NiFe-LDH	1.5 V (~180 mA cm ⁻²)	50	[4]
P-HEOs	1.5 V (~55 mA cm ⁻²)	50	[5]
CF-Cu(OH) ₂	1.82 V (198.2 mA cm ⁻²)	100	[6]
Vo-NiO	1.5 V (~60 mA cm ⁻²)	100	[7]
NiCu NTs	1.424 V (~136 mA cm ⁻²)	20	[8]
CF-CuO/CeO ₂	1.92 V (~125 mA cm ⁻²)	10	[9]
CuMn ₂ O ₄ -NH ₃ -40	1.31 V (20 mA cm ⁻²)	10	[10]
Ni _{0.9} Cu _{0.1} (OH) ₂	1.52 V (10 mA cm ⁻²)	5	[11]
CuNi(OH) ₂	1.45 V (9.2 mA cm ⁻²)	5	[12]
NF@Mo-Ni _{0.85} Se	1.5 V (~115 mA cm ⁻²)	10	[13]
Ni ₃ N@C	1.38 V (50 mA cm ⁻²)	10	[14]
Ni _x B	1.45 V (100 mA cm ⁻²)	10	[15]
Ni ₃ S ₂ /NF	1.55 V (~25 mA cm ⁻²)	10	[16]
a-Ni(OH) ₂ -Cu ₂ O/NF-6	1.38 V (50 mA cm ⁻²)	50	This work
a-Ni(OH) ₂ -Cu ₂ O/NF-6	1.45 V (400 mA cm ⁻²)	50	This work

Table S1. The comparison of current density for a-Ni(OH)₂-Cu₂O/NF-6 and previous reported electrocatalysts.

Electrocatalysts	Oxidation potential (versus RHE)	C _{HMF} (mM)	n _{HMF} (mmol)	Charge transferred	Ref.
Vo-NiO	1.42 V	100	10	6680 C	[7]
NiCu NTs	1.424 V	20	4	2300 C	[8]
Ni ₃ S ₂ -MoS ₂ /NF	1.45 V	20	3	1735 C	[17]
MoO ₂ -FeP@C	1.424	10	2	1160 C	[18]
Co ₉ S ₈ -Ni ₃ S ₂ @NSOC/NF	1.4 V	10	2	1160 C	[19]
Ni _x Se _y -NiFe LDH@NF	1.423 V	10	1.86	1080 C	[20]
Ni ₃ N@C	1.45 V	10	1.8	1044 C	[14]
Co _{0.4} NiS@NF	1.45 V	10	1.1	578 C	[21]
NiSe@NiO _x	1.423 V	10	0.6	348 C	[22]
t-Ni ₁ Co ₁ -MOF	1.4 V	10	0.5	290 C	[23]
a-Ni(OH) ₂ -Cu ₂ O/NF-6	1.424 V	100	7.5	~4300 C	This work

Table S2. The comparison of charge transferred in stable test for a-Ni(OH)₂-Cu₂O/NF-6 and previous reported electrocatalysts.

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