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Supporting Information

A Highly Active Oxygen Evolution Electrocatalyst Derived From Co/Ni-Succinic Acid Framework Under Mild Conditions

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S1. Materials and General Methods

The organic ligand H_2L was used as received from commercial sources without further purification. Powder X-ray diffraction (PXRD) was carried out on a Bruker D8-Focus Bragg-Brentano X-ray Powder Diffractometer equipped with a Cu sealed tube (λ = 1.54178 Å) at 40 kV and 40 mA. Thermogravimetry analysis (TGA) was conducted on a TGA-50 thermogravimetric analyzer. The morphology was observed with a Sigma HD Thermal field emission scanning electron microscope (SEM). The elemental composition of the samples were characterized by energy-dispersive X-ray spectroscopy (EDS, Oxford instruments X-Max). The X-ray photoelectron spectroscopy (XPS) spectras were collected by Thermo ESCALAB 250XI spectrometer.

S2. Syntheses

Synthesis of Co-MOF.

First of all, in the glass vial of 10mL, 0.55g $CoCl_2{\cdot}6H_2O$ and 0.41g succinic acid ligand were added.Then, 5mL water containing 0.13g KOH was added. After ultrasonic dissolving, it was placed in a quiet place and volatilized without stirring at room temperature for about a week to form a red polyhedral crystal, which was named Co-MOF. Yield (based on ligand): 95%.

Synthesis of Co/Ni_x-MOF.

The synthesis process is similar to Co-MOF, except for the mixing different ratio of $CoCl_2{\cdot}6H_2O$ and $NiCl_2{\cdot}6H_2O$. For example, $Co_{0.9}Ni_{0.1}$-MOF was synthesized via the utilization of 490mg $CoCl_2{\cdot}6H_2O$ and 30 mg $NiCl_2{\cdot}6H_2O$; $Co_{0.7}Ni_{0.3}$-MOF was

constructed by utilizing 380mg $CoCl_2 \cdot 6H_2O$ and 90 mg $NiCl_2 \cdot 6H_2O$. The similar XRD patterns illustrate the iso-structures of these materials. Yield (based on ligand): 91%.

Post-modification of different MOFs.

Because of the large crystal particles, which is not conducive to the post-modification process and the subsequent electrochemical test, the ball milling was carried out for 4 h. Then, the grilled samples was directly utilized for electrocatalytic measurements and post-modifications. 100 mg ball-milled Co0.9Ni0.1-MOF samples were weighed in a vial, a certain amount of $NaBH_4$ was utilized at 75℃ for 10 min with 0.1g $NaBH_4$, 3h with 0.3g $NaBH_4$, and 12h with 0.5g $NaBH_4$. Yield (based on pristine MOF): 65%.

S3. Electrochemical measurements and products analysis.

Electrochemical testing was carried out in 1M KOH electrolyte using standard CHI760E electrochemical workstation with three electrodes. Glass carbon electrode (GCE) with diameter of 3mm was used as the working electrode, Pt network as the counter electrode, and Hg/HgO electrode as the reference electrode.

Preparation of catalyst dispersion solution. 5mg catalyst was dispersed in the mixed solution of 0.955mL ethanol and 0.005 ml5% Nafion, and ultrasonic treatment was conducted for 30min to form uniform dispersion solution. Then, The 10μL catalyst drops onto the polished GCE. To evaluate OER performance, a linear scan voltammetry curve (LSV) with a scan rate of 5mVs is obtained, from which the Tafel slope is obtained. Electrochemical impedance spectroscopy (EIS) in the range of

100000 ~0.1Hz was analyzed. When the current density was 10mA cm^{-2}, the stability of the catalyst was tested by chronopotentiometry method.

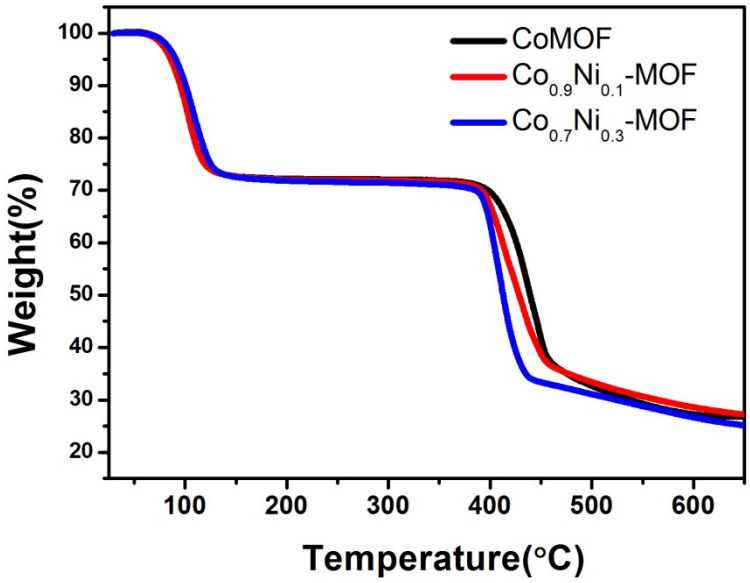


Figure S1. TGA curves for different samples

Table S1. ICP-OES values for different samples

Sample Name	Co (mg/mg Cat)	Ni (mg/mg Cat)	Co:Ni
Co-MOF	0.235	-	-
$Co_{0.9}Ni_{0.1}$-MOF	0.264	0.0109	1:0.041
$Co_{0.7}Ni_{0.3}$-MOF	0.232	0.03660	1:0.150

Table S2. The cost of the starting materials

materials	Price (dollar/1KG)
$Co(NO_3)_2 \cdot 6H_2O$	84.6
Succinic Acid	15.7
$NaBH_4$	342.6

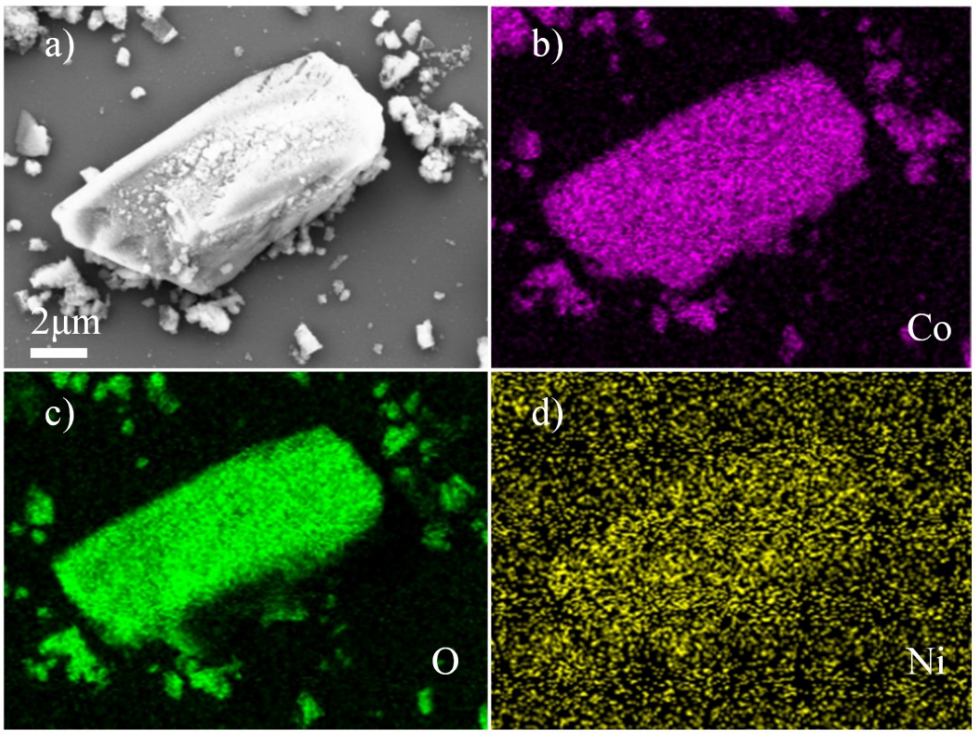


Figure S2. SEM and EDX images for $Co_{0.9}Ni_{0.1}$-MOF

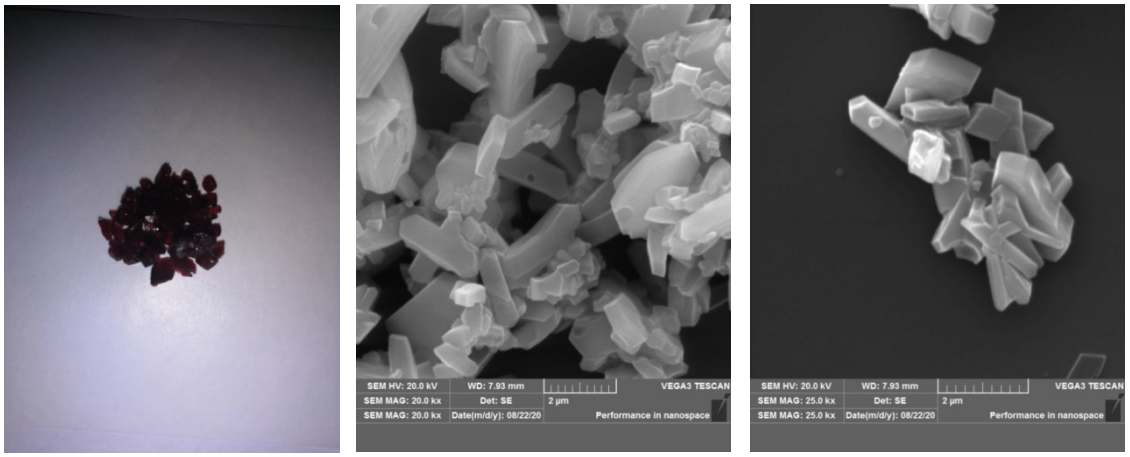


Figure S3. photo and SEM images for $Co_{0.9}Ni_{0.1}$-MOF

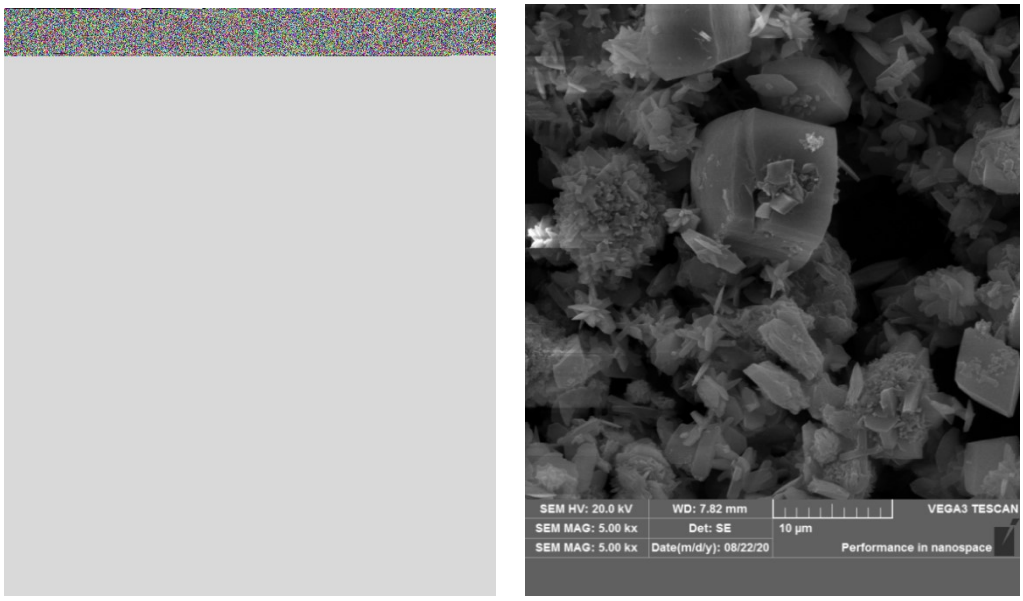


Figure S4. photo and SEM images for $Co_{0.7}Ni_{0.3}$-MOF

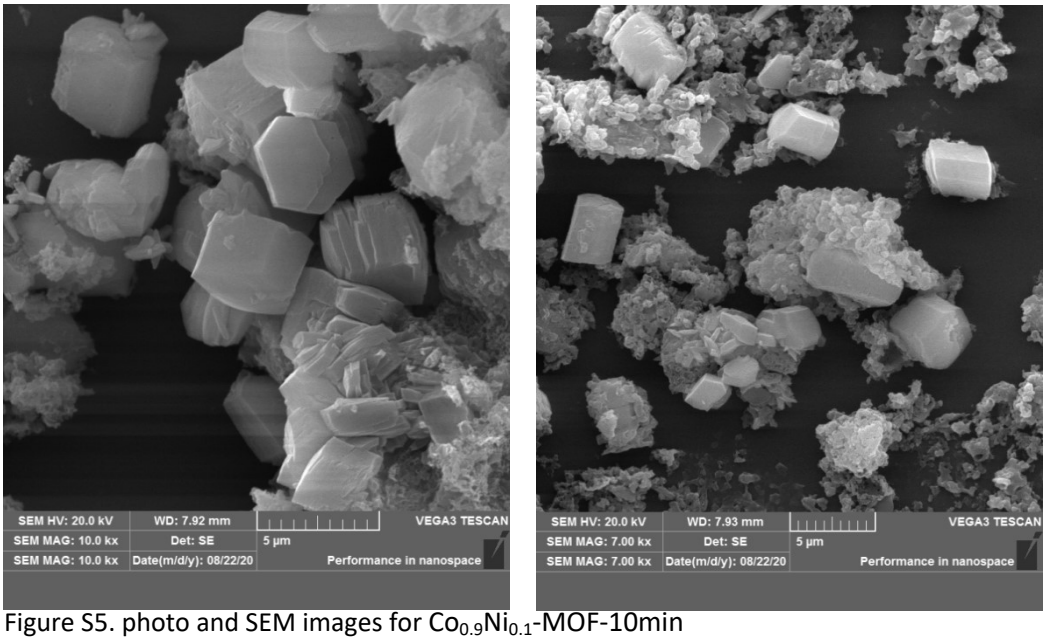


Figure S5. photo and SEM images for $Co_{0.9}Ni_{0.1}$-MOF-10min

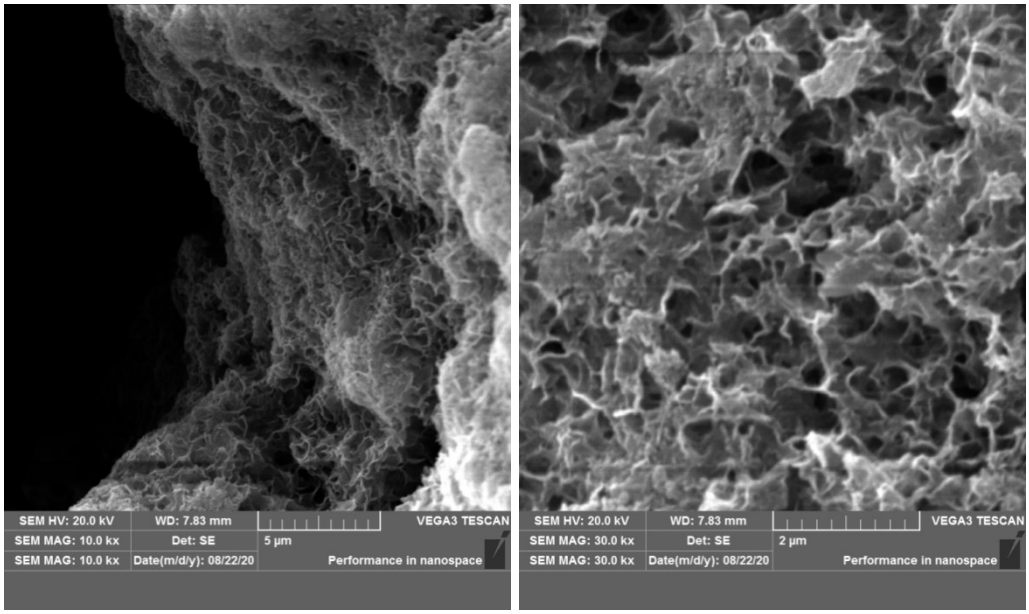


Figure S6. photo and SEM images for $Co_{0.9}Ni_{0.1}$-MOF-3h

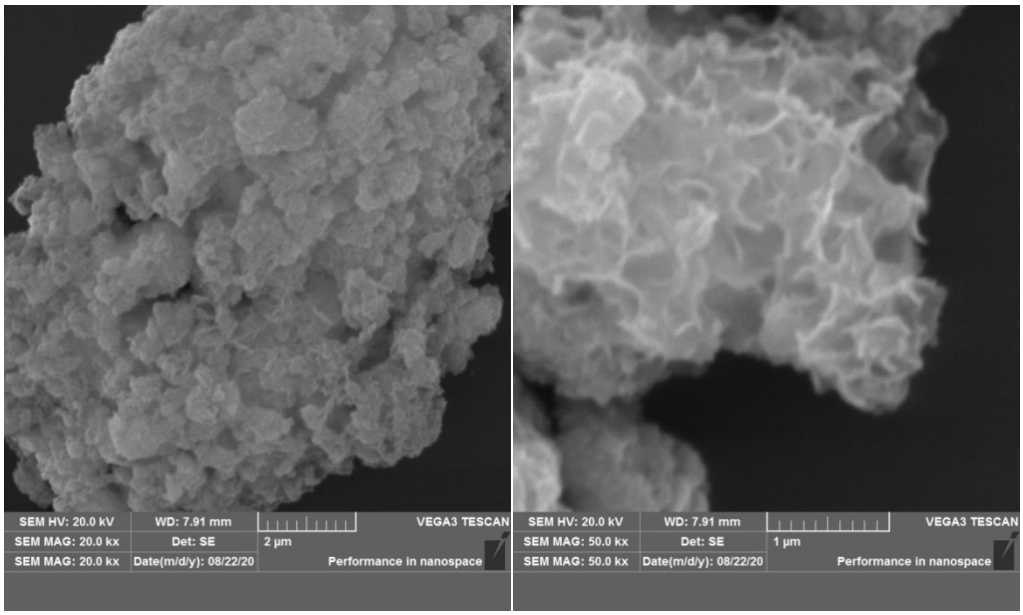
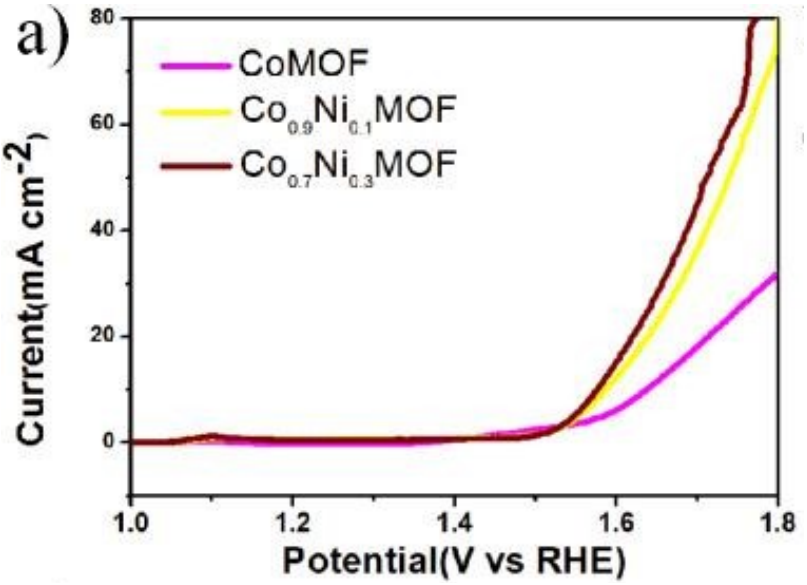
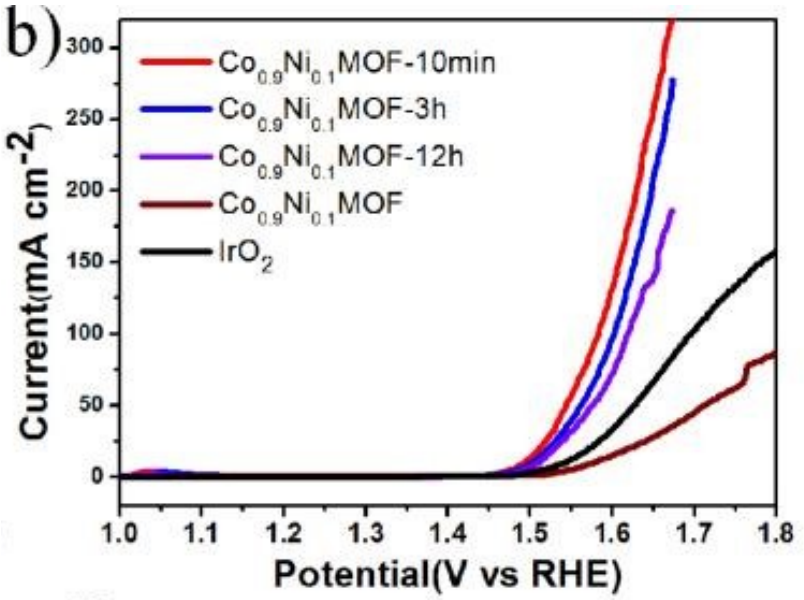


Figure S7. photo and SEM images for $Co_{0.9}Ni_{0.1}$-MOF-12h


a)
CoMOF
Co0.9Ni0.1MOF
Co0.7Ni0.3MOF
Current(mA cm-2)
Potential(V vs RHE)


b)
Co0.9Ni0.1MOF-10min
Co0.9Ni0.1MOF-3h
Co0.9Ni0.1MOF-12h
Co0.9Ni0.1MOF
IrO2
Current(mA cm-2)
Potential(V vs RHE)

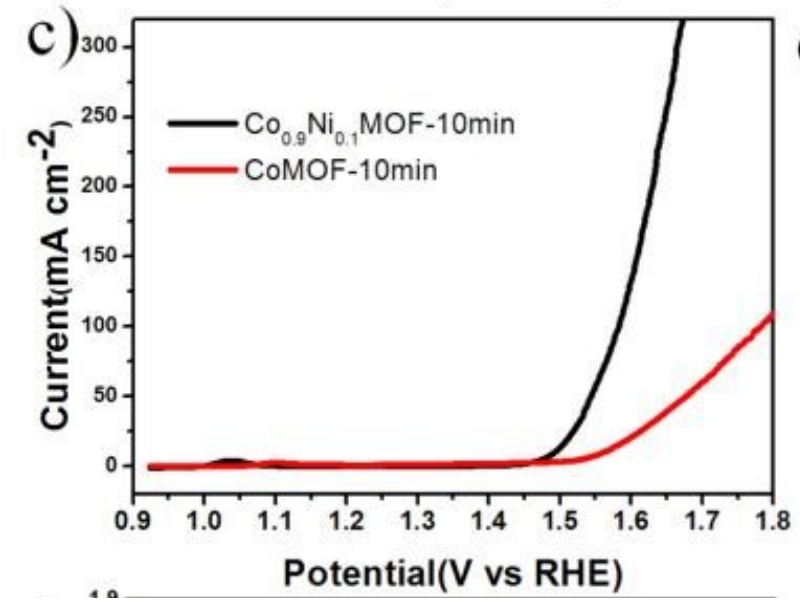

c)
Co0.9Ni0.1MOF-10min
CoMOF-10min
Current(mA cm-2)
Potential(V vs RHE)

Figure S8. The enlarged OER results (a) and LSV plots (b, c) of different samples; EIS spectra (d) of different samples