Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Facile synthesis of CeO_2-decorated W@Co-MOF heterostructures as a highly active and durable electrocatalyst for overall water splitting

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Materials and Reagents

The cobalt nitrate hexahydrate ($Co(NO_3)_2 \cdot 6H_2O$), Cerium nitrate hexahydrate ($Ce(NO_3)_3 \cdot 6H_2O$) and sodium carbonate ($NaNO_3$) were obtained from Sinopharm Chemical Reagent Co. Ltd. The 2-aminoterephthalic acid (2-NH_2-BDC) and Sodium metatungstate ($Na_6W_{12}O_{39} \cdot xH_2O$) were purchased from Sigma-Aldrich Co. ltd. The potassium hydroxide (KOH) and N,N dimethylformamide (DMF) were purchased from Shanghai Maclean Biochemical Technology Co., ltd. Besides, ultrapure water (18.2 MΩ) was utilized throughout the whole experiment. The purity of all reagents more than 99%.

Materials characterization

The morphologies and microstructures of the prepared products were tested by scanning electron microscope (SEM, JSM-6360LA, Japan) and transmission electron microscopy (TEM, JEM-2010, Japan). The X-ray diffraction (XRD) was used to identify the crystal phases of products on the Max-2000 (Rigaku Co., Ltd., Japan) and X-ray photoelectron spectroscopy (XPS) can be used to analyze the elemental chemical states of the catalyst materials on the AXIS-Ultra DLD (Shimazu, Japan). The surface pore size adsorption instrument was used to calculate the specific surface area and pore size distribution of the material.

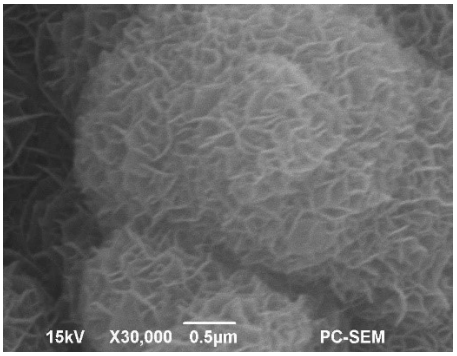

Fig. S1. The SEM images of Co-MOF/NF.

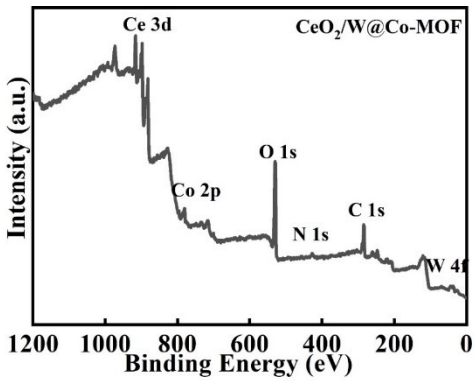

Fig. S2. XPS full spectrum image of CeO_2/W@Co-MOF/NF

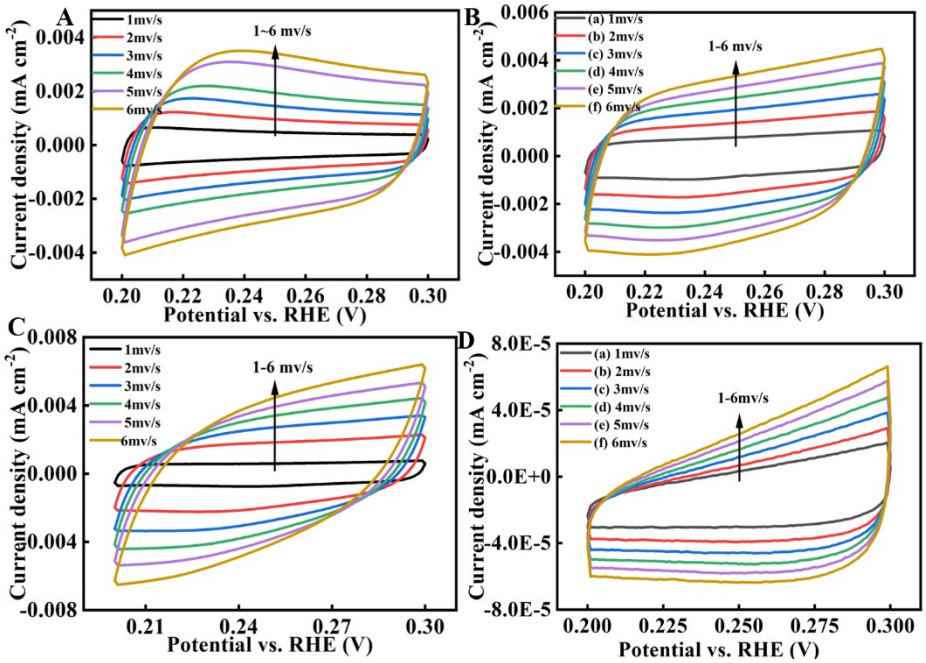

Fig. S3. CV curves of various electrodes in the potential window from 0.05 to 0.15 V (vs. RHE) at 1, 2, 3, 4, 5 and 6 mV s^{-1}: (A) Co-MOF/NF, (B) W@Co-MOF/NF, (C) CeO_2/W@Co-MOF/NF and (D) CeO_2/NF.

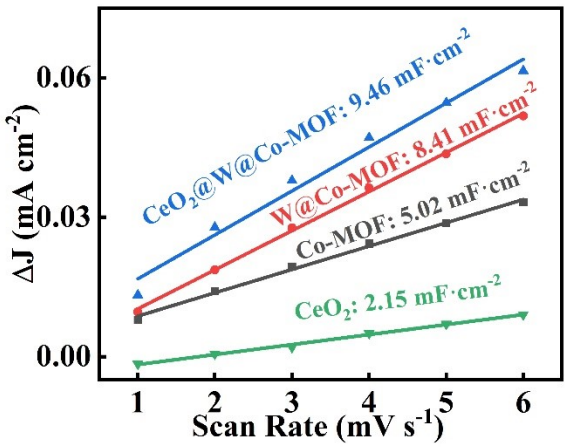

Fig. S4. Double-layer capacitances (C_{dl}) of the four samples derived from the cyclic voltammograms.

Table S1. Comparison of OER activity at 10 mA cm^{-2} and stability of various MOF-based catalysts.

Catalyst	η_{10}/mV	Tafel slope/ mV dec^{-1}	Electrolyte	Reference
CeO_2/W@Co-MOF/NF	**239**	**29.39**	**1M KOH**	**This work**
Ce/Cu-MOF/GO	386	98.1	1M KOH	[1]
Co/CoS_2@NC	349	237.8	1M KOH	[2]
Co/CoP@HOMC	260	151	1M KOH	[3]
Hollow CoS_2–MoS_2	266	104	1M KOH	[4]
FeCo-P	240	38.24	1M KOH	[5]
Fe-Co-Ni MOF	254	51.3	1M KOH	[6]
$(Ni_2Co_1)_{0.925}Fe_{0.075}$-MOF	257	41.3	1M KOH	[7]
Co-BPDC/Co-BDC-3	335	72.1	1M KOH	[8]
Co-Ni@HPA-MOF	320	58	1M KOH	[9]
$BaTiO_3$@MOF-Fe/Co	247	38.4	1M KOH	[10]

Table S2. Comparison of HER activity at 10 mA cm^{-2} and stability of various Co-based MOFs catalysts.

Catalyst	η_{10}/mV	Tafel slope/ mV dec^{-1}	Electrolyte	Reference
CeO_2/W@Co-MOF/NF	**87**	**32.25**	**1M KOH**	**This work**
Co-Fe-P/CeO_2	320	69.7	1M KOH	[11]
Co/CoS_2@NC	188	54.9	1M KOH	[2]
Co/CoP@HOMC	120	78	1M KOH	[3]
FeCo-P	131	89.9	1M KOH	[5]
NiCo-MOF-P	195	105	1M KOH	[12]
MXene@Ce-MOF	220	149.9	1M KOH	[13]
Fe-MOF@MoS_2	118	68	1M KOH	[14]

Table S3. Comparison of overall water splitting at 10 mA cm^{-2} and stability of various Co-based MOFs catalysts.

Catalyst	Volatage/ V	Electrolyte	Reference
CeO_2/W@Co-MOF/NF	**1.54**	**1M KOH**	**This work**
NiFe-MOF-5	1.57	1M KOH	[15]
Fe-Co-Ni-MOF	1.60	1M KOH	[6]
FeCo-P	1.47	1M KOH	[16]
CoNiP/NF	1.62	1M KOH	[17]
FeCoMnNi-MOF-74/NF	1.62	1M KOH	[18]
Co,Fe-MOF-74/Co/CC	1.65	1M KOH	[19]

Notes and references

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