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Supporting Information

Open Hollow Co-Pt clusters Embedded in Carbon Nanoflake Arrays for Highly Efficient Alkaline Water Splitting

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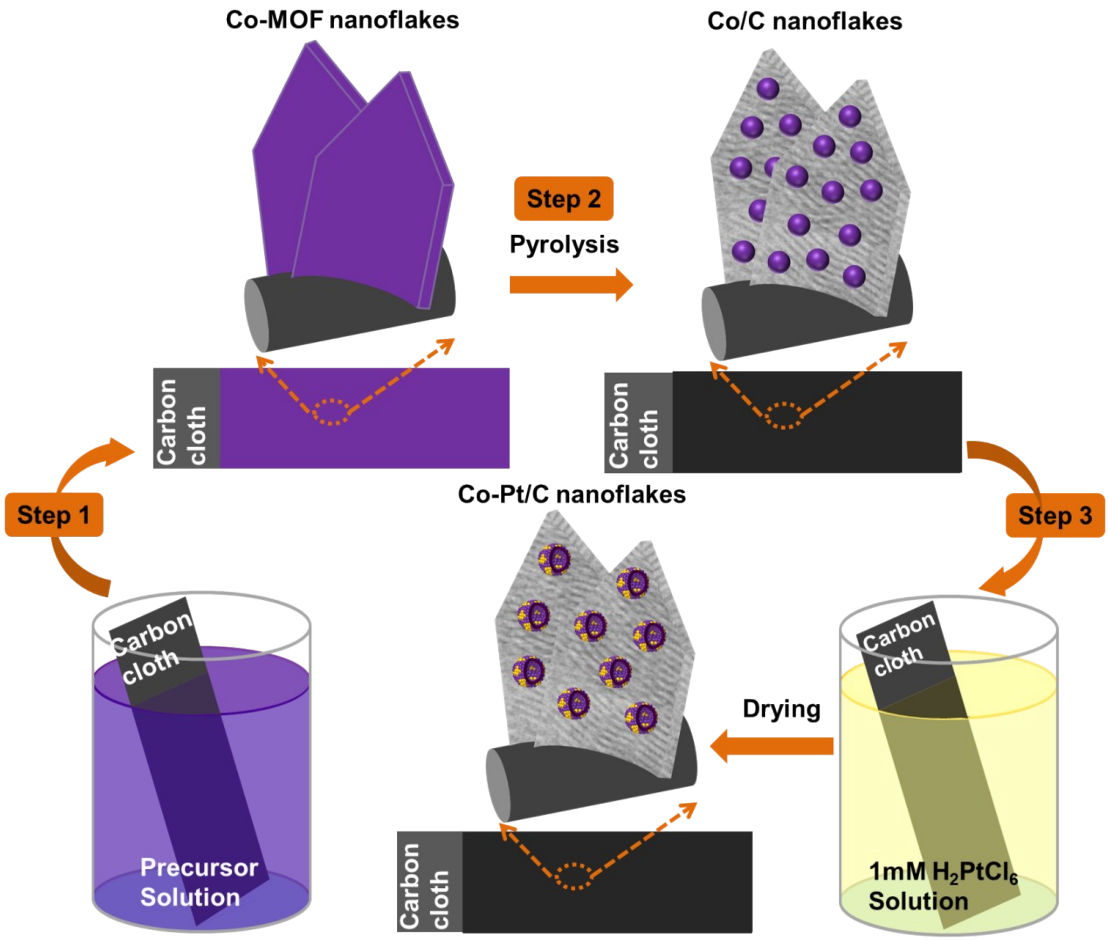

Schem. S1. Schematic illustration of the synthesis of Co-Pt/C nanoflake arrays grown on carbon cloth.

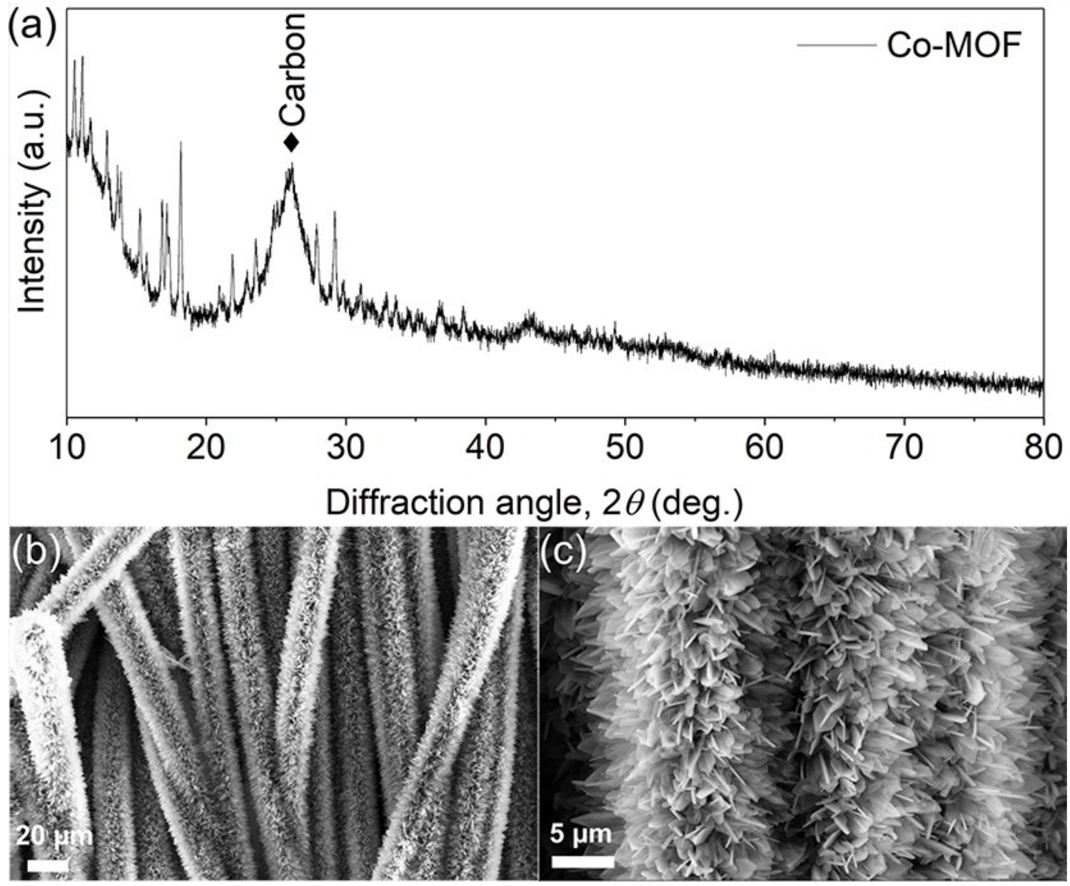

Fig. S1. XRD pattern and SEM images of Co-MOFs.

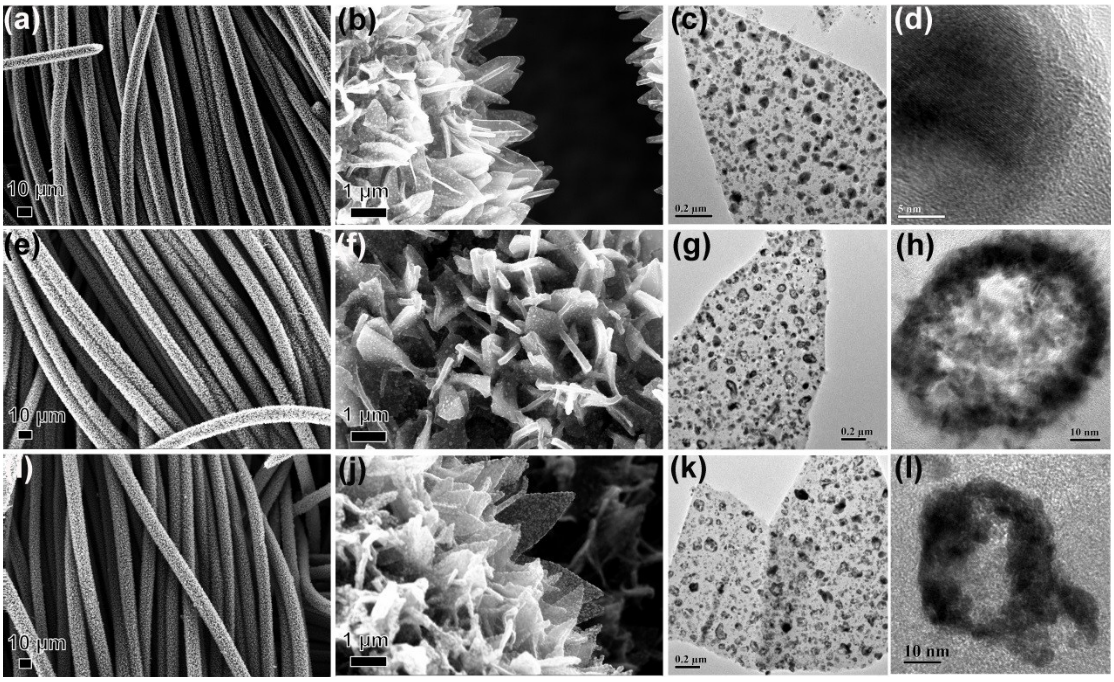

Fig. S2. SEM images and TEM images of Co/C (a-d), Co-Pt/C-5 (e-h) and Co-Pt/C-10 (i-l).

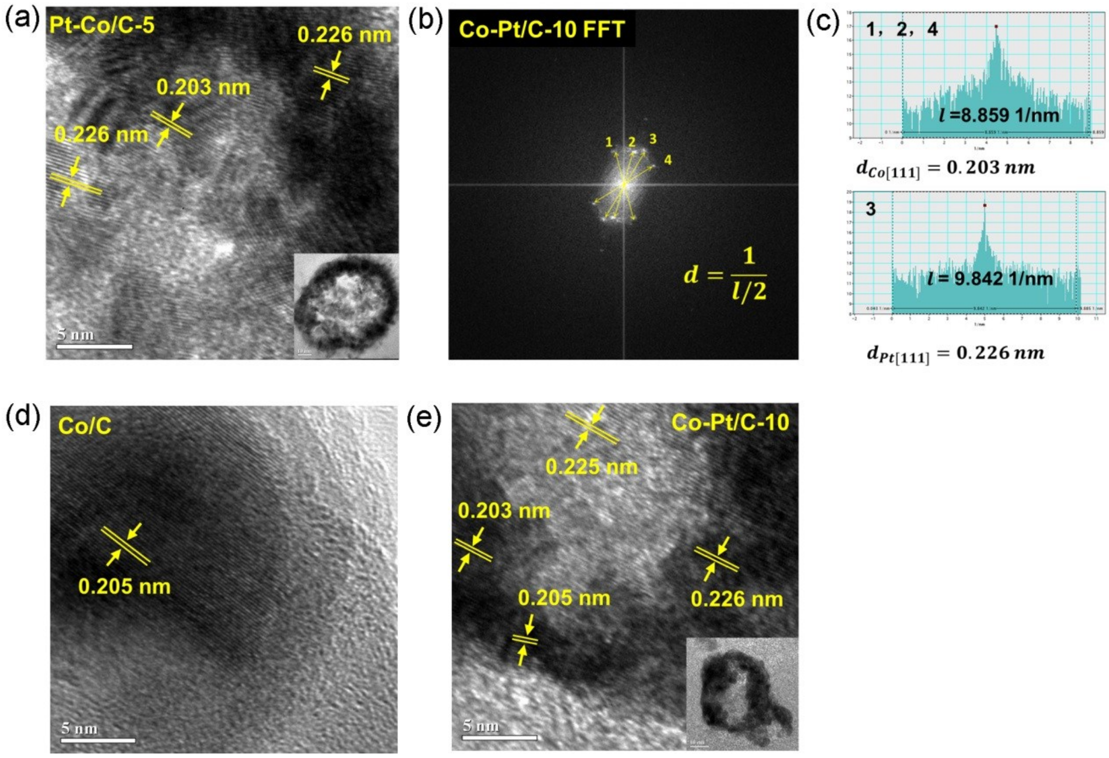

Fig. S3. (a-c) HRTEM image and the associated fast Fourier transform (FFT) images of Co-Pt/C-5. HRTEM image of (d) Co/C and (e) Co-Pt/C-10.

The HRTEM images and the associated fast Fourier transform (FFT) clearly show that the Co(111) plane with the interplanar distances of 0.203 nm and Pt(111) plane with the interplanar distances of 0.226nm co-exist in Co-Pt/C-5 and Co-Pt/C-10, but only the Co(111) plane can be observed in Co/C, which confirms that the Co nanoparticles turned into the Co-Pt bimetallic open hollow clusters embedding in carbon after the replacement reaction.

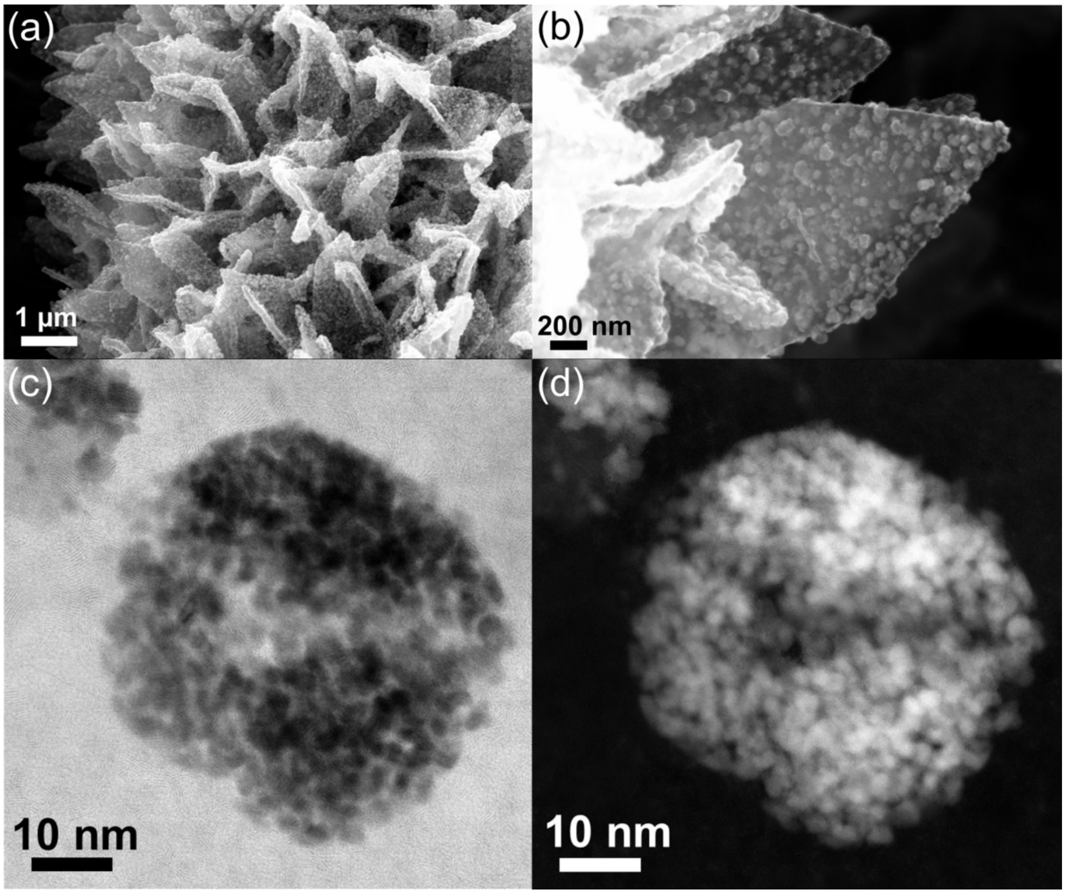

Fig. S4. SEM images and STEM images of Co-Pt/C-20.

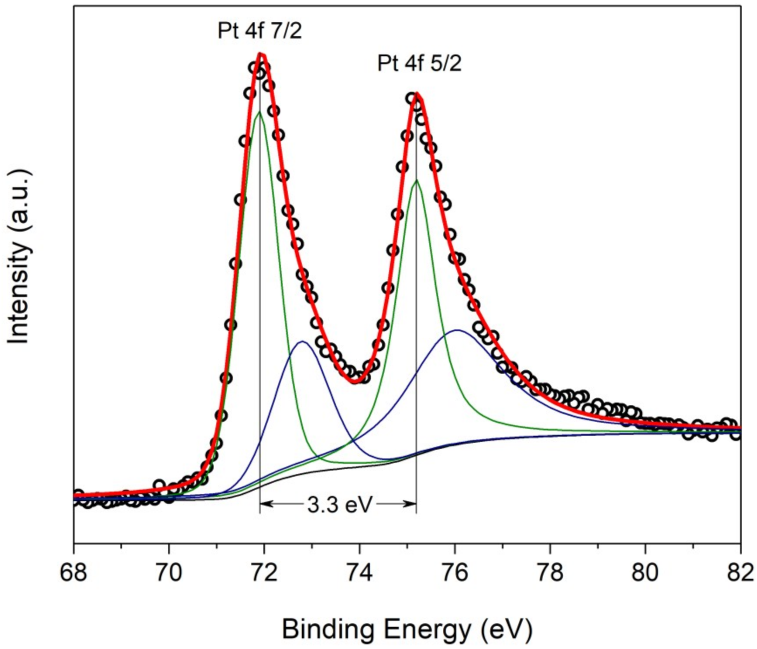

Fig. S5 High-resolution Pt 4f XPS spectra of Co-Pt/C-10.

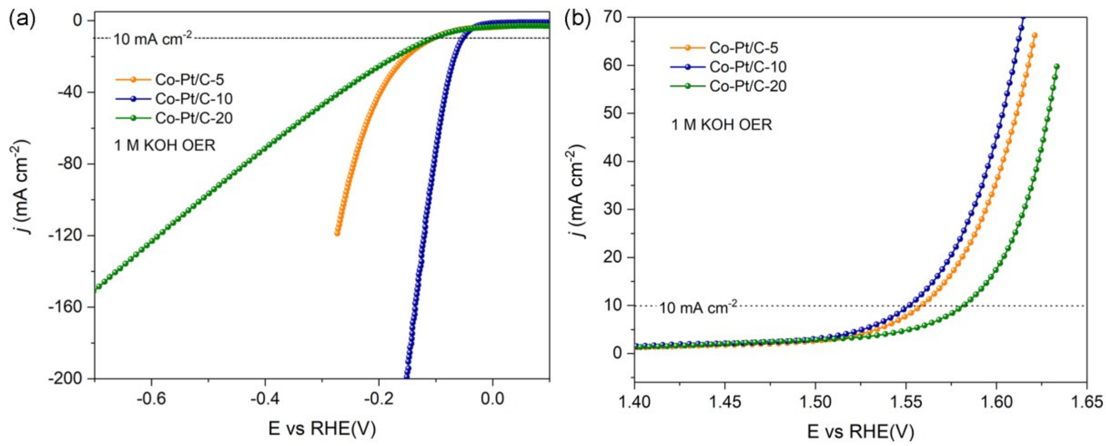

Fig. S6. LSV curves of Co-Pt/C-5, Co-Pt/C-10, Co-Pt/C-20 for (a) HER and (b) OER.

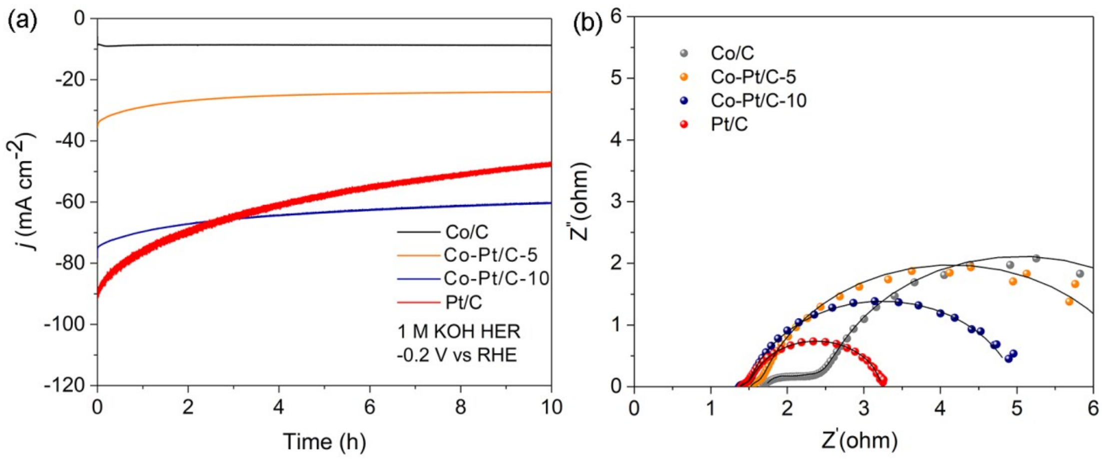

Fig. S7. (a) Stability test curves at -0.2 V for HER in an N_2-saturated 1 M KOH solution. (b) Nyquist plots for HER in an N_2-saturated 1 M KOH solution.

Table S1. Series resistance and charge transfer resistance from Nyquist plots for HER.

Samples	Co/C	Co-Pt/C-5	Co-Pt/C-10	Pt/C
Series resistance	1.71	1.52	1.38	1.40
Charge transfer resistance	5.01	4.98	3.50	1.68

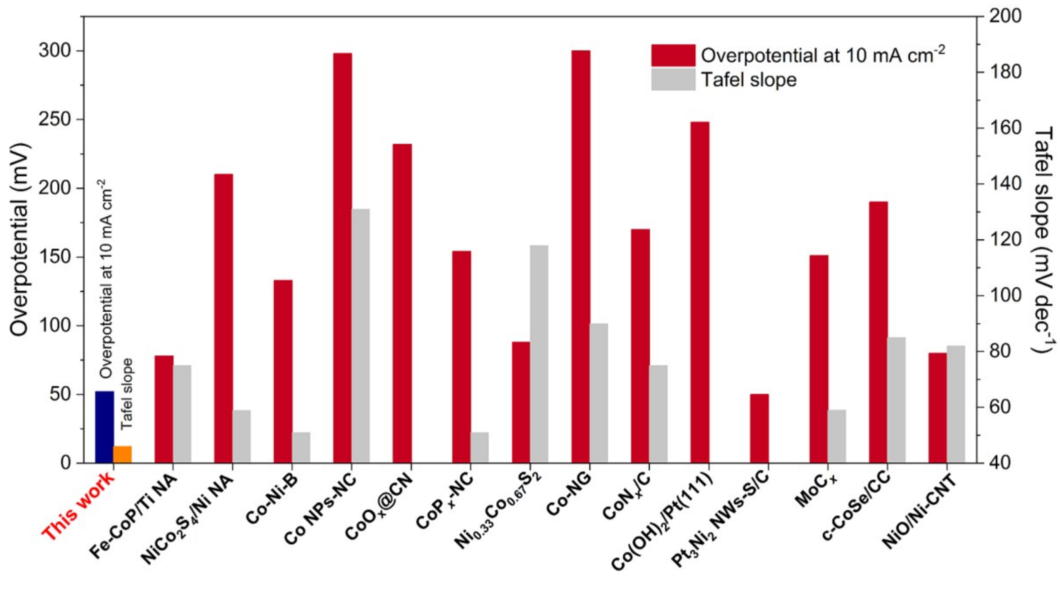

Fig. S8. Comparison of HER performances of some typical Co based and MOF derived electrocatalysts in alkaline electrolyte.

Sources:

Fe-CoP/Ti NA: Fe-doped CoP nanoarray on Ti foil [1]

$NiCo_2S_4$/Ni NA: $NiCo_2S_4$nanowire array supported on Ni foam [2]

Co–Ni–B[3]

Co NPs-NC: Co nanoparticles embedded in N-rich carbon [4]
CoO_x@CN: Cobalt Oxide/nitrogen-doped Carbon Hybrids [5]
CoP_x-NC: MOF derived CoP_x NPs embedded in nitrogen-doped carbon matrices [6]
$Ni_{0.33}Co_{0.67}S_2$: $Ni_{0.33}Co_{0.67}S_2$ nanowires [7]
Co-NG: Atomic cobalt on nitrogenitrogen-doped graphene [8]
CoN_x/C: Molecular Co–N_x centres in porous carbon [9]
$Co(OH)_2$/Pt(111) [10]
c-CoSe/CC: cubic phase $CoSe_2$ on carbon cloth [11]
Pt_3Ni_2 NWs-S/C: Pt-Ni sulfide interface nanowires [12]
MoC_x: MoC_x nano-octahedrons derived by MOF [13]
NiO/Ni-CNT: nickel oxide/nickel heterostructures on carbon nanotube [14]

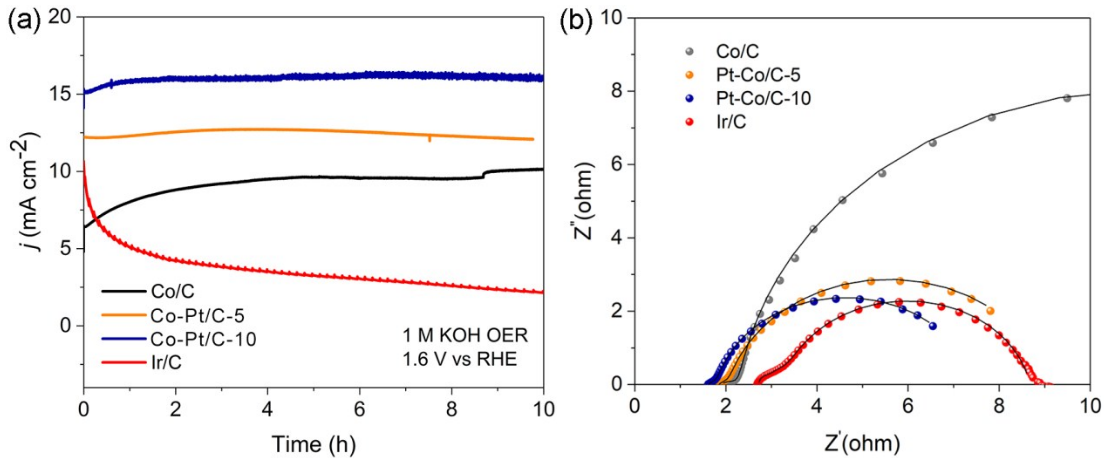

Fig. S9. (a) Curves of stability test at 1.6 V for OER in an O_2-saturated 1 M KOH solution. (b) Nyquist plots for OER in an O_2-saturated 1 M KOH solution.

Table S2. Series resistance and charge transfer resistance from Nyquist plots for OER.

Samples	Co/C	Co-Pt/C-5	Co-Pt/C-10	Pt/C
Series resistance	1.95	1.84	1.61	2.73
Charge transfer resistance	17.8	7.01	5.60	5.34

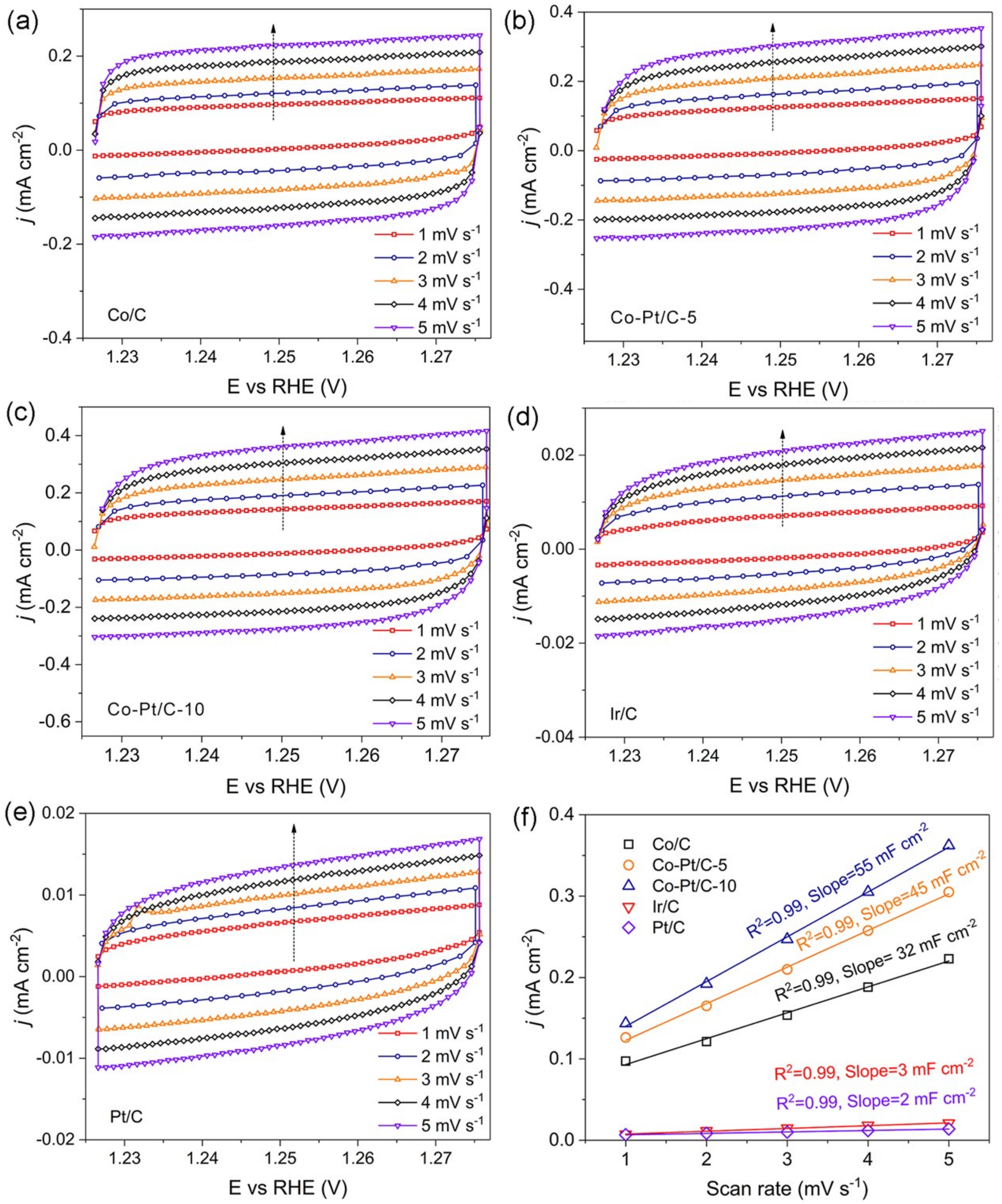

Fig. S10. CV curves at scan rates from 1 mV/s to 5mV/s, where no redox peaks are observed in this voltage range, and plots of electrochemical double-layer capacitance.

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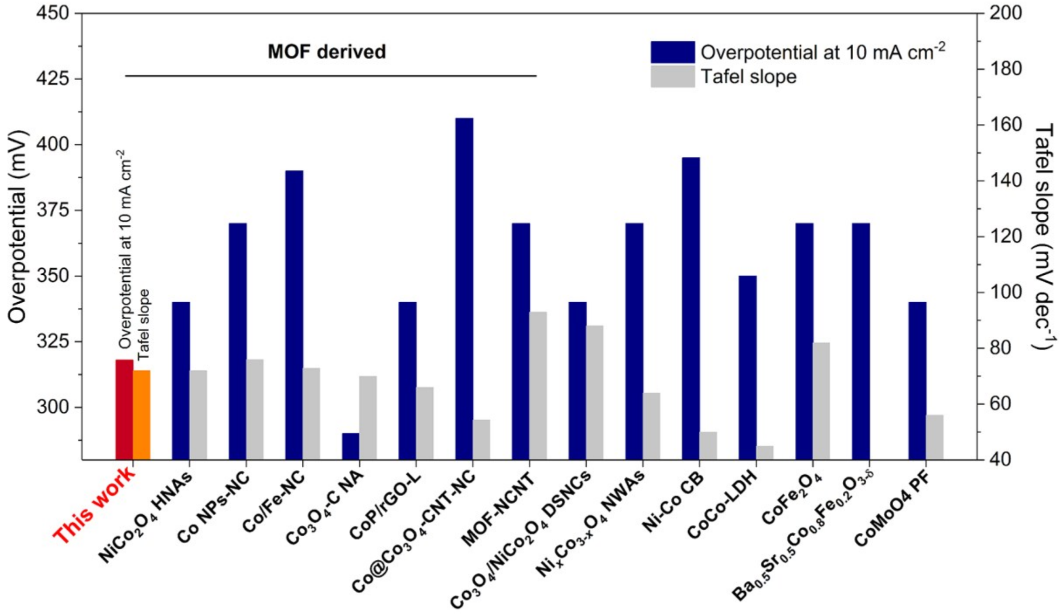

Fig. S11. Comparison of OER performances of some typical Co based and MOF derived electrocatalysts.

Sources:

$NiCo_2O_4$ HNAs: $NiCo_2O_4$ hollow nanoarray [15]

Co NPs-NC: Co NPs embedded in porous N-rich carbon [4]

Co/Fe-NC: Spindle-like Co/Fe metal oxides in nitrogen-doped porous carbon [16]

Co_3O_4-C NAs: Co_3O_4-C nanoarray [17]

CoP/rGO-L: layered CoP/rGO composite [18]

Co@Co_3O_4-CNT-NC: Co@Co_3O_4 encapsulated in CNTgrafted nitrogen-doped carbon polyhedral [19]

MOF-NCNT: MOF derived nitrogen-doped carbon nanotube [20]

Co_3O_4/$NiCo_2O_4$ DSNCs: Co_3O_4/$NiCo_2O_4$ double-shelled nanocages [21]

$Ni_xCo_{3-x}O_4$ NWAs: $Ni_xCo_{3-x}O_4$ nanowire array [22]

Ni-Co CB: Ni-Co cubes [23]

CoCo-LDH: CoCo layered double hydroxides [24]

$CoFe_2O_4$ [2]]

$Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ [26]

$CoMoO_4$ PF: $CoMoO_4$ porous flowers [27]

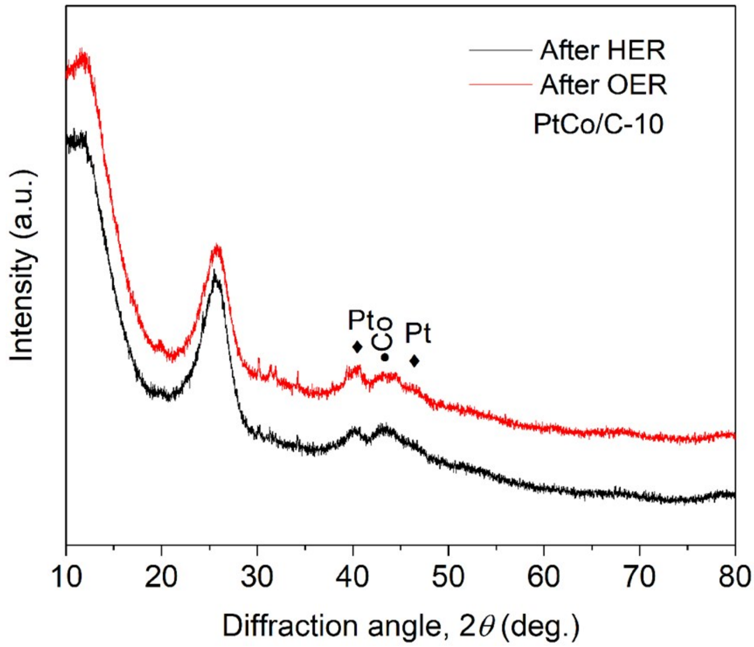

Fig. S12. XRD patterns of Co-Pt/C-10 after the stability test of HER and OER, respectively.

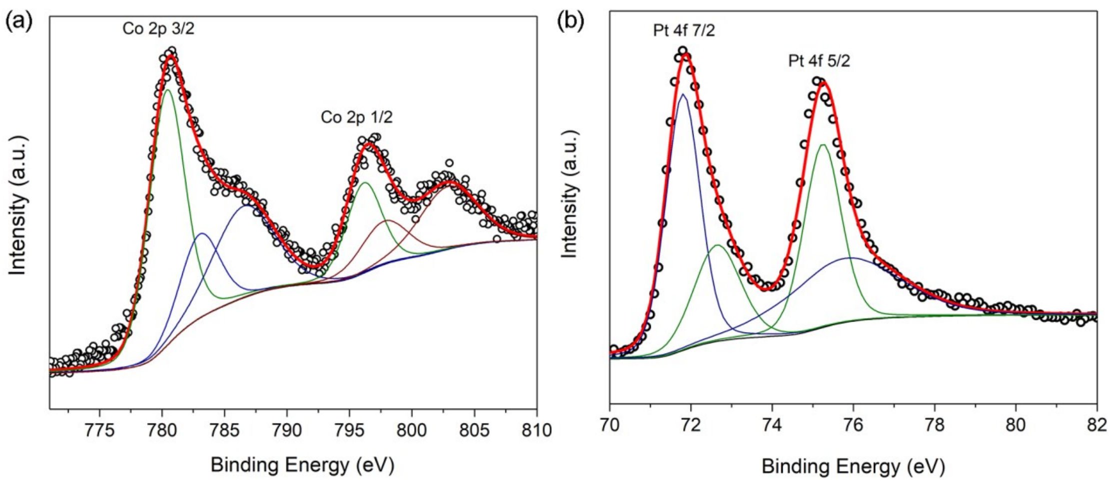

Fig. S13. High-resolution (a) Co 2p and (b) Pt 4f XPS spectra of Co-Pt/C-10 after HER stability test.

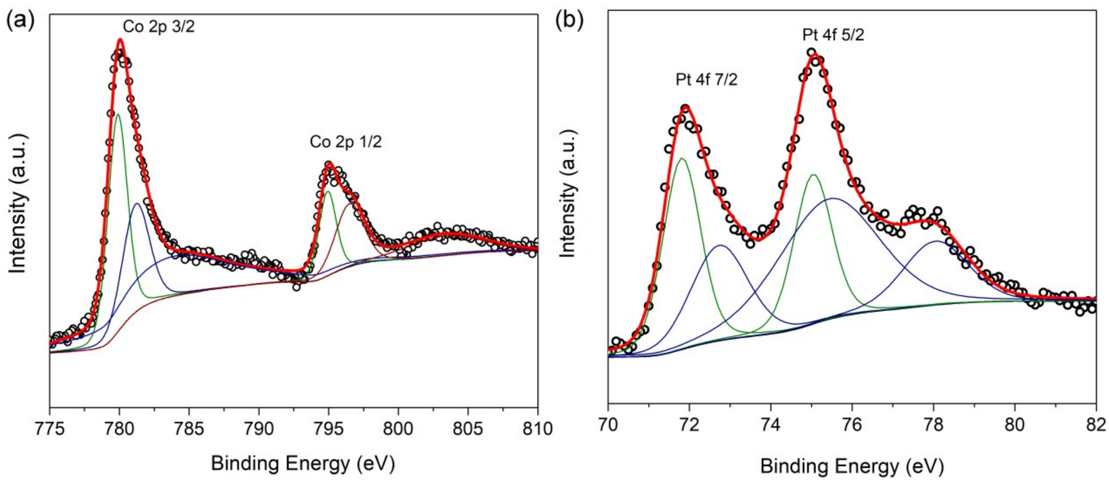

Fig. S14. High-resolution (a) Co 2p and (b) Pt 4f XPS spectra of Co-Pt/C-10 after OER stability test.

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