Supplementary Material for

Fe-Ni-Co trimetallic oxides hierarchical nanosphere as high-performance bifunctional Electrocatalysts for Water electrolysis

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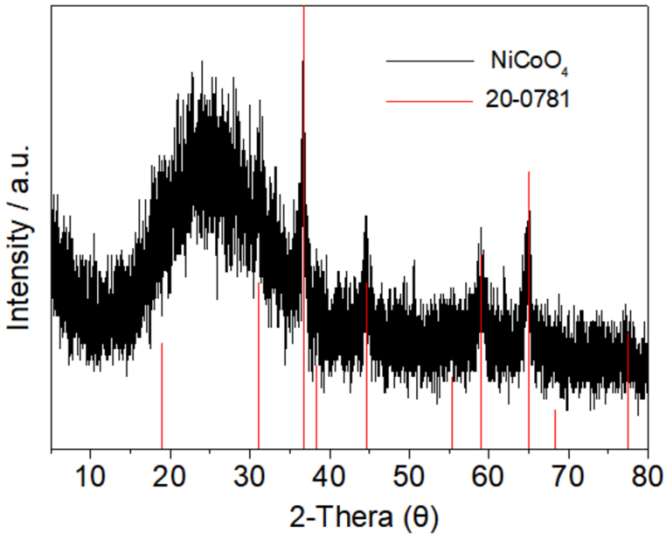


Fig. S1 XRD pattern of $NiCoO_4$.

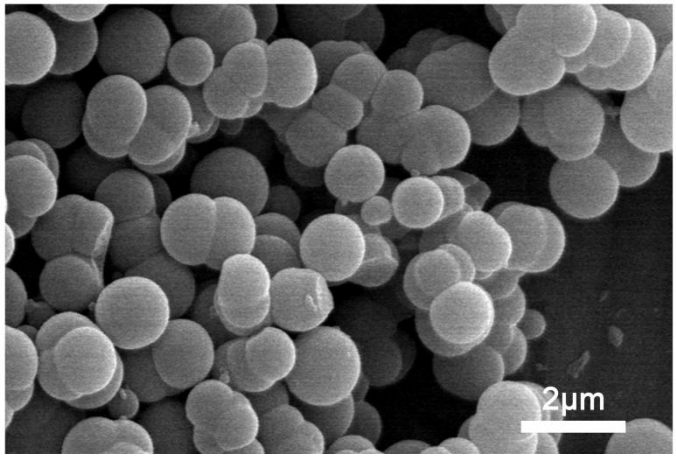
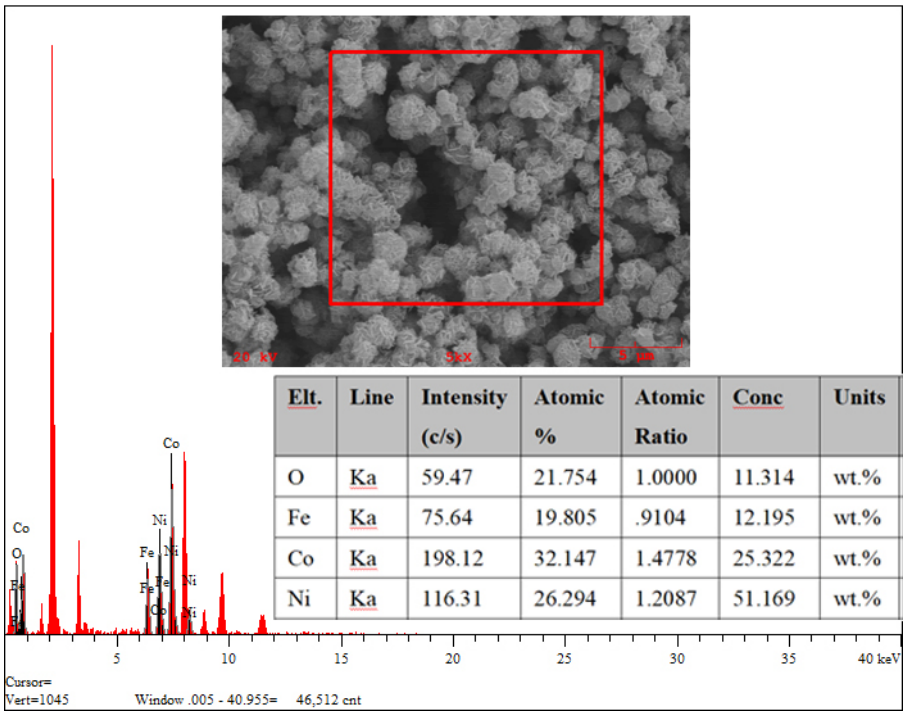


Fig. S2 The SEM image of NiCo precursor nanosphere.



Elt.	Line	Intensity (c/s)	Atomic %	Atomic Ratio	Conc	Units
O	Ka	59.47	21.754	1.0000	11.314	wt.%
Fe	Ka	75.64	19.805	.9104	12.195	wt.%
Co	Ka	198.12	32.147	1.4778	25.322	wt.%
Ni	Ka	116.31	26.294	1.2087	51.169	wt.%

Fig. S3 The half-quantitative SEM energy dispersive X-ray spectrum (SEM-EDX) of FeNiCo-15.

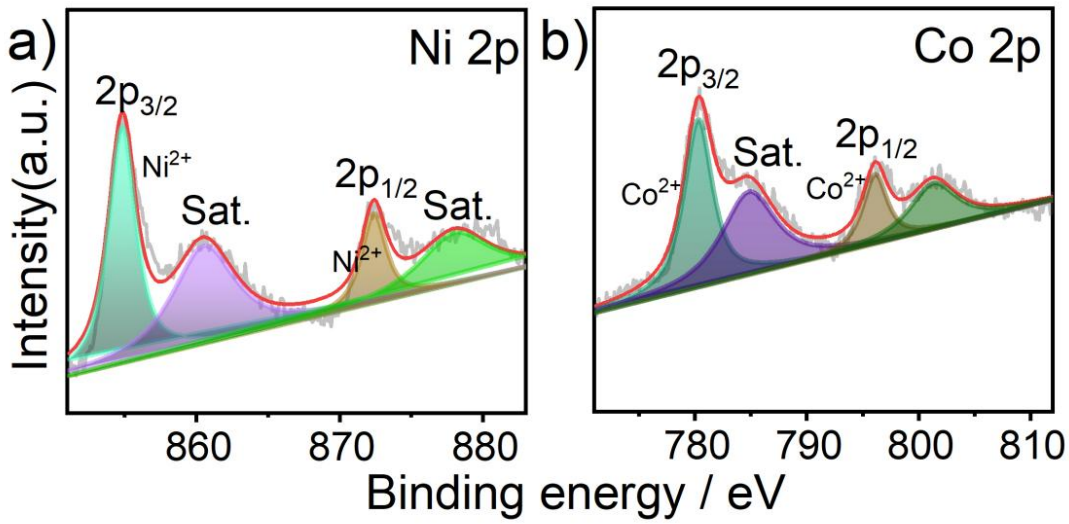


Fig. S4 a) Ni 2p, **b)** Co 2p XPS spectra of NiCo precursor.

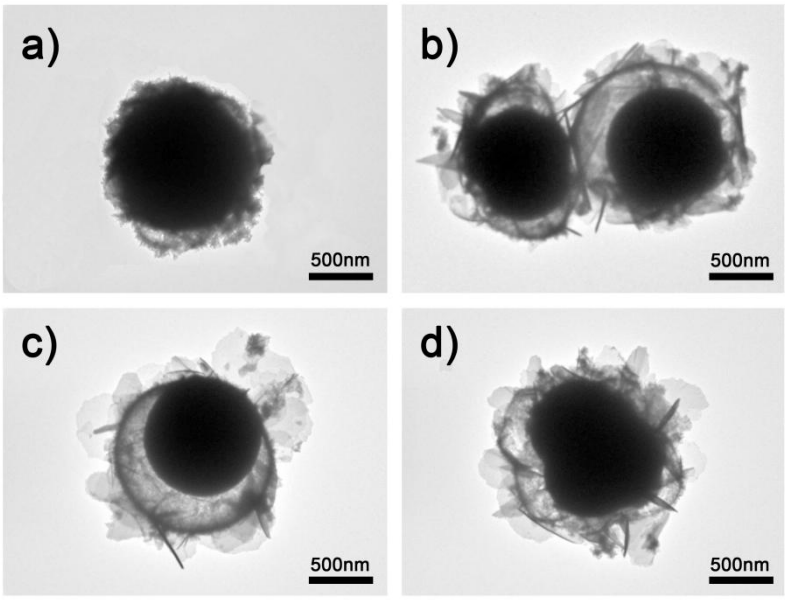


Fig. S5 The TEM images of **a)** NiCo, **b)** FeNiCo-10, **c)** FeNiCo-15 and **d)** FeNiCo-20.

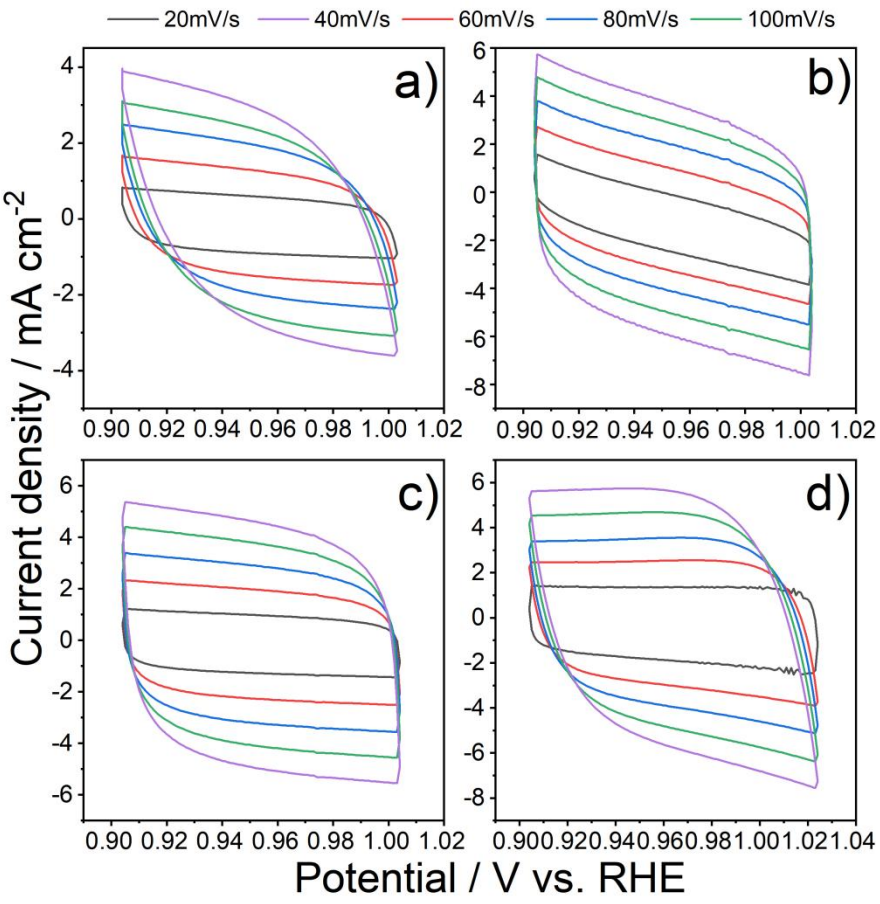


Fig. S6 The cyclic voltammograms curves of catalytic **a)** NiCo, **b)** FeNiCo-10, **c)** FeNiCo-15 and **d)** FeNiCo-20 toward to OER.

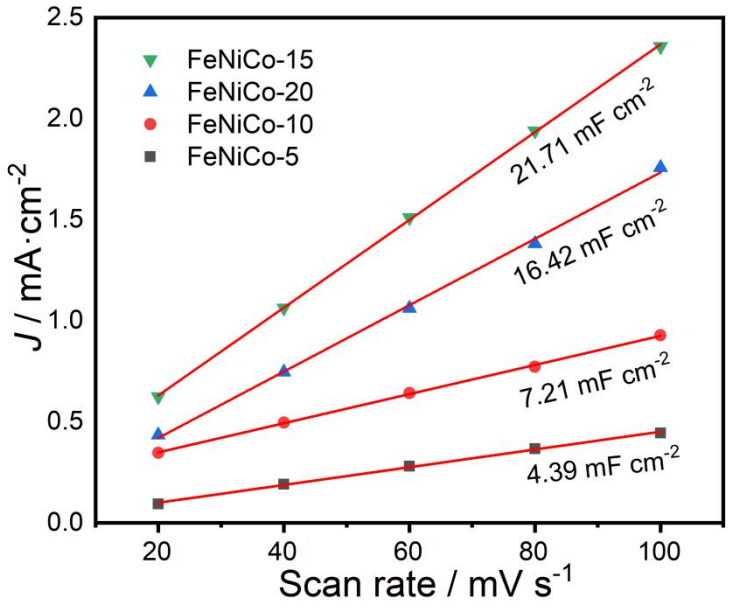


Fig. S7 C_{dl} for FeNiCo-5, FeNiCo-10, FeNiCo-15 and FeNiCo-20 toward to OER.

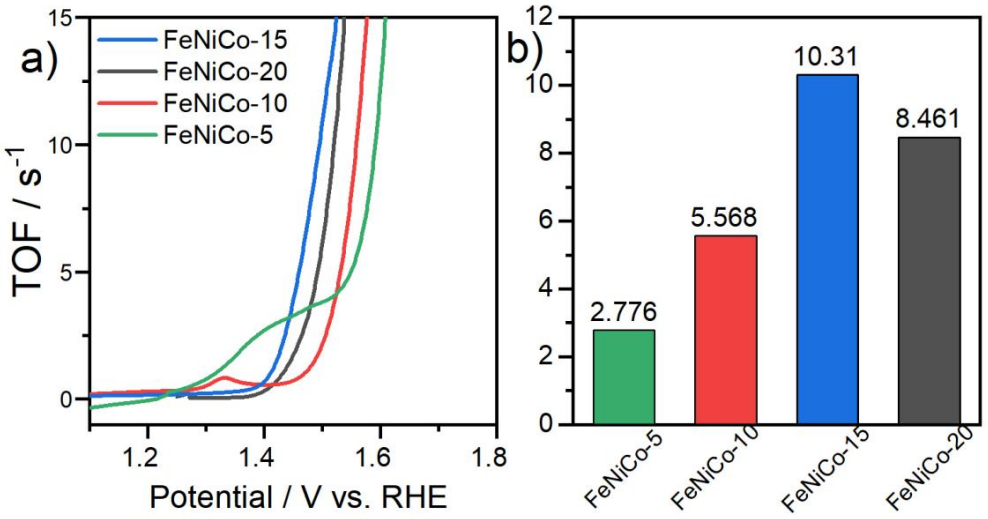


Fig. S8 a) The TOF curve of FeNiCo-15, FeNiCo-20, FeNiCo-10 andFeNiCo-5, **b)** TOF at 350 mV toward to OER.

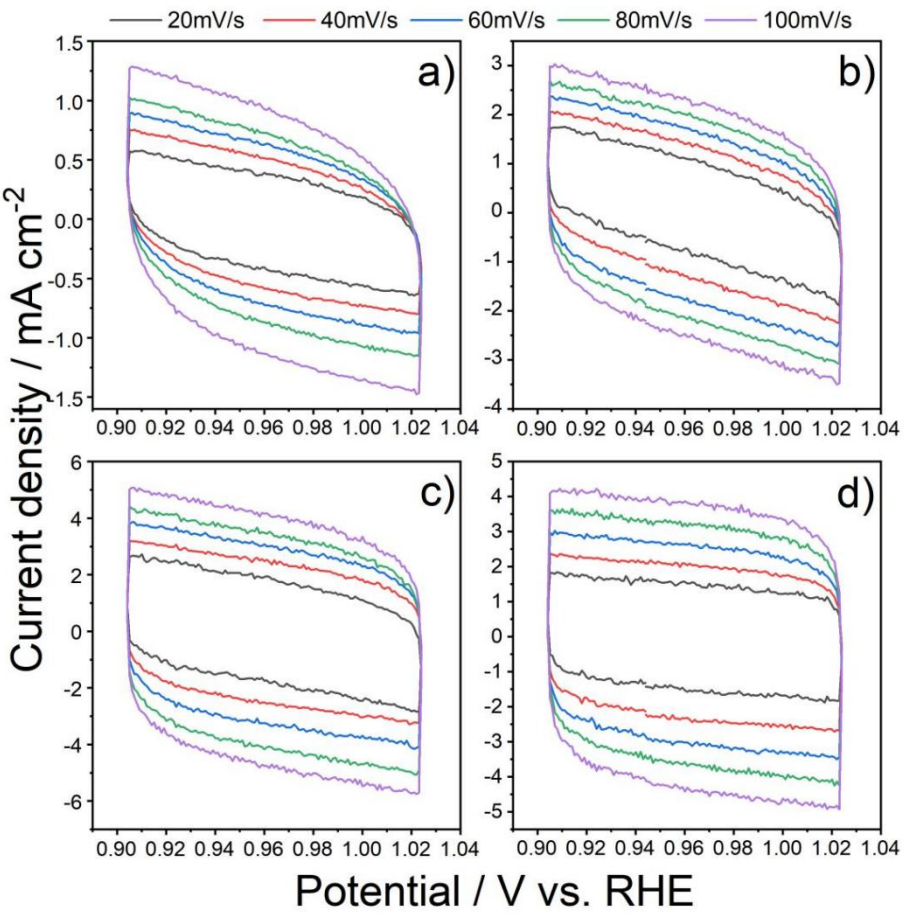


Fig. S9 The cyclic voltammograms curves of catalytic **a)** NiCo, **b)** FeNiCo-10, **c)** FeNiCo-15 and **d)** FeNiCo-20 toward to HER.

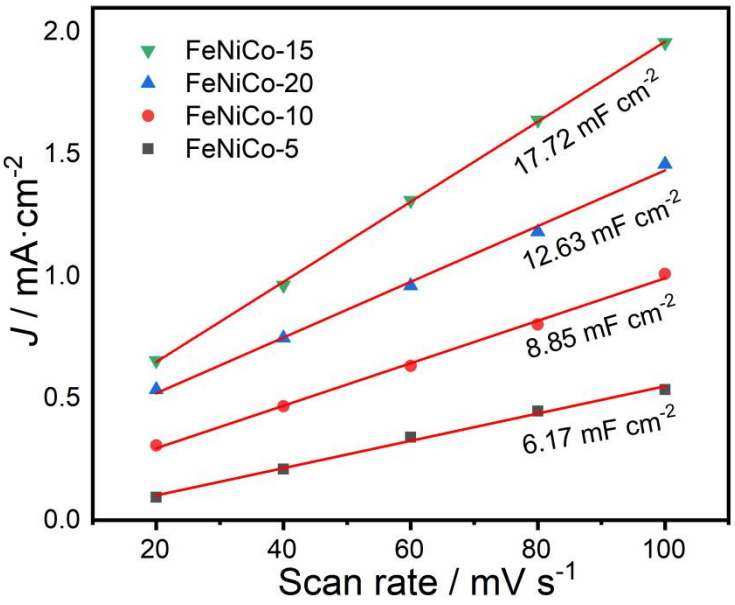


Fig. S10 C_{dl} for FeNiCo-5, FeNiCo-10, FeNiCo-15 and FeNiCo-20 toward to HER.

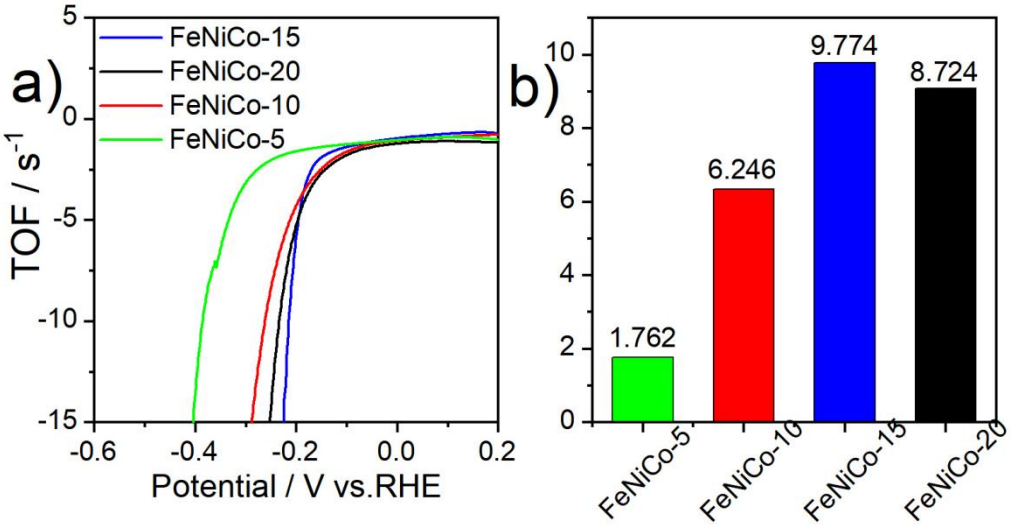


Fig. S11 a) The TOF curve of FeNiCo-15, FeNiCo-20, FeNiCo-10 andFeNiCo-5, **b)** TOF at 350 mV toward to HER.

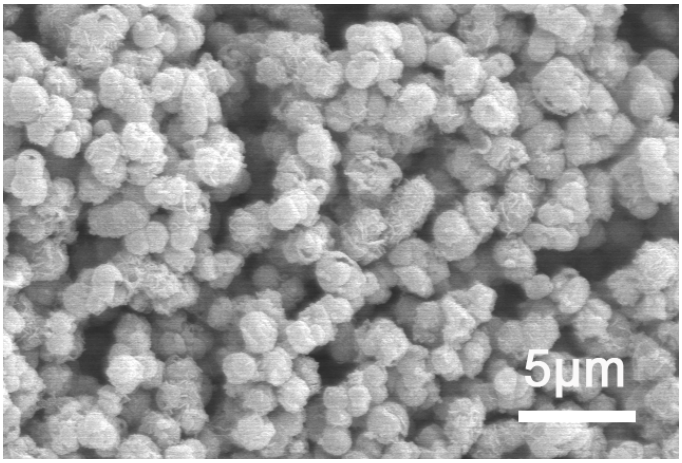


Fig. S12 SEM images of FeNiCo-15 after electrochemical test.

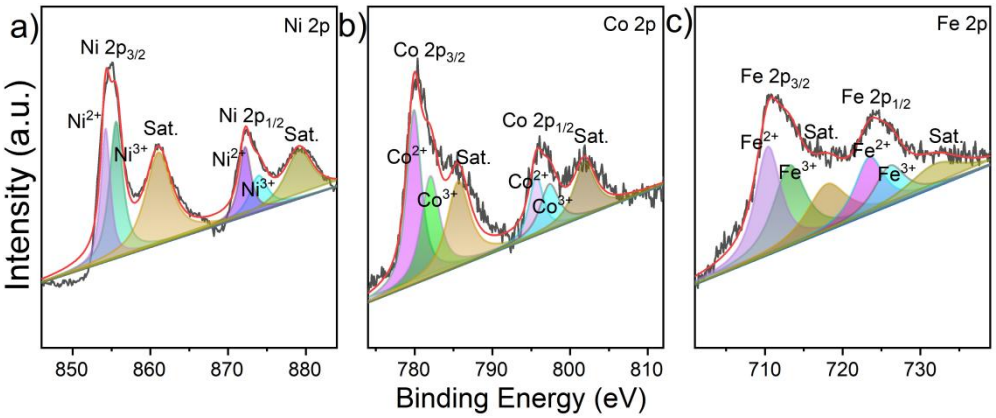


Fig. S13 The XPS spectrum of Fe^{3+}-$NiCo_2O_4$ nanospheres catalyst after OER

Table S1. The detailed parameters of NiCo, FeNiCo-5, FeNiCo-10, FeNiCo-15,FeNiCo-20 and IrO_2 toward the OER.

	NiCo	FeNiCo-5	FeNiCo-10	FeNiCo-15	FeNiCo-20	IrO_2
Atom ratio	1/1	Fe:Co:Ni= 6:45:49	Fe:Co:Ni= 12:42:46	Fe:Co:Ni= 22:37:42	Fe:Co:Ni= 32:32:36	
Overpotential at 10 mA cm^{-2}	373 mV	303 mV	263 mV	204 mV	216 mV	271 mV
anodic peak position	1.41 V vs. RHE	--	--	--	--	--
Rct	1.5 Ω cm^2	1. 4Ω cm^2	1. 4Ω cm^2	1. 2Ω cm^2	1.3 Ω cm^2	--
Cdl	3.62 mF cm^{-2}	4.39 mF cm^{-2}	7.21 mF cm^{-2}	21.71 mF cm^{-2}	16.42 mF cm^{-2}	--
TOF(350 mV)	--	2.776 s^{-1}	5.568 s^{-1}	10.31 s^{-1}	8.461 s^{-1}	--

Table S2. The detailed parameters of NiCo, FeNiCo-5, FeNiCo-10, FeNiCo-15,FeNiCo-20 and Pt/C toward the HER.

	NiCo	FeNiCo-5	FeNiCo-10	FeNiCo-15	FeNiCo-20	Pt/C
Overpotential at 10 mA cm^{-2}	306 mV	289 mV	262 mV	178 mV	205 mV	16 mV
anodic peak position	1.41 V vs. RHE	--	--	--	--	--
Rct	1.7 Ω cm^2	1.6 Ω cm^2	1.4 Ω cm^2	1.1 Ω cm^2	1.2 Ω cm^2	--
Cdl	4.04 mF cm^{-2}	6.17 mF cm^{-2}	8.85 mF cm^{-2}	17.72 mF cm^{-2}	12.63 mF cm^{-2}	--
TOF(350 mV)	--	1.762 s^{-1}	6.246 s^{-1}	9.774 s^{-1}	8.724 s^{-1}	--

Table S3. The comparisons of the catalytic activities of OER and HER on FeNiCo-15 with the recently reported catalysts in 1.0 M KOH media.

Catalysts	Overpotential at 10 mA cm^{-2} for OER(mV vs RHE)	Overpotential at 10 mA cm^{-2} for HER(mV vs RHE)	Electrolyte concentration (pH)	Ref.
FeNiCo-15	204	178	14	This work
NiCo	373	306		
Ni/NiO@G-SH	270	----	14	7
$Ni/Ni(OH)_2$	310	168	14	8
1-D CoHCF /CFP	420	----	14	11
$NiC_{0.2}$NS/Ni/CF	228	121	14	12
NCO-0.1	297	143	14	14
NiFe-PBA	263	169	14	15
$NiCo_2O_4$	420	----	14	16
FeP	---	69	0	22
Fe-$NiMoO_4$	217	217	14	25
Ni-Fe-S	223	115	14	26
CoM-P-3DHFLMs	292	----	14	33
Ni_4Cu_2@C	280	137	14	34
ECT-S-$Co_{0.37}Ni_{0.26}Fe_{0.37}O$	232	----	14	37
$FeNi_3N$-Ni_3S	230	181	14	38
Co@NCNTAs	280	----	14	39
Co–Fe–P–Se	270	----	14	41