Supporting Information

Three-dimensional nickel nanowires modified by amorphous Fe nanosheets as electrocatalyst for oxygen evolution reaction

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1.Materials

Nickel foam (Ni Foam, Kunshan Jiayisheng Electronics Co., Ltd.), nickel chloride ($NiCl_2$ $6H_2O$, 99%, Sinopharm Chemical Reagent Co., Ltd.), ferrous sulfate heptahydrate ($FeSO_4$ $7H_2O$, 99%, Sinopharm Chemical Reagent Co., Ltd.) boric acid (H_3BO_3, 99.5%, Sinopharm Chemical Reagent Co., Ltd.), sodium citrate ($Na_3C_6H_5O_7 \cdot 2H_2O$, 99%, Sinopharm Chemical Reagent Co., Ltd.), chloroplatinic acid (H_2PtCl_6, 98%, Sinopharm Chemical Reagent Co., Ltd.), hydration Hydrazine ($N_2H_4 \cdot H_2O$, 85%, Sinopharm Chemical Reagent Co., Ltd.), potassium hydroxide (KOH, 85%, Sinopharm Chemical Reagent Co., Ltd.), hydrochloric acid (HCl, 37%, Sinopharm Chemical Reagent Co., Ltd.), ruthenium dioxide (RuO_2, Aladdin) and ultrapure water (18.2 MU cm) without further treatment.

2. **Electrodeposition of Fe on NF.**

Nickel foam (NF) with dimensions of 2 x 3 cm was immersed in 3.0 M HCl solution and ultrasonicated for 10 min to remove surface oxides. 40 mL of the solution containing 0.5 M $FeSO_4 \cdot 7H_2O$ and 0.5 M H_3BO_3 was used as an electrolyte for Fe electrodeposition, which was carried out at -1V for 20 s. The obtained samples were labeled as Fe /NF, respectively.

3. Reaction mechanism

The formation of Fe/Ni NWs/NF is divided into two steps, namely the growth of nanowires, and the electrodeposition process. The growth of nanowires is a hydrothermal reaction, and $N_2H_4 \cdot H_2O$ is a reducing agent. $NiCl_2 \cdot 6H_2O$ is a nickel source to provide nickel ions; $Na_3C_6H_5O_7$ is a complexing agent, which is used to control the reaction rate. H_2PtCl_6 is a nucleating agent, which makes the reaction nucleate rapidly and lays a foundation for the formation of nanowires. The formation process of nanowires is carried out under the conditions of pH 12.5 at 80 oC with the assistance of the magnetic field. These conditions ensure that nanowires can grow slowly on the surface of nickel foam and are not easy to fall off. The reactions involved in nanowire growth are as follows:

$$Ni^{2+} + OH^- \rightarrow Ni(OH)_2\downarrow$$

$$2Ni(OH)_2 + N_2H_4 = 2Ni\downarrow + N_2\uparrow + 4H_2O$$

$FeSO_4 \cdot 7H_2O$ is the iron source in the electrodeposition process. Fe^{2+} is easily adsorbed on the cathode surface and preferentially deposited by discharge; Boric acid is a corrosion inhibitor, which can stabilize the pH of the electrodeposition solution and accelerate the deposition rate of iron. The following reaction occurred during the electrodeposition process.

$Fe^{2+} + 2e^{-} \rightarrow Fe\downarrow$

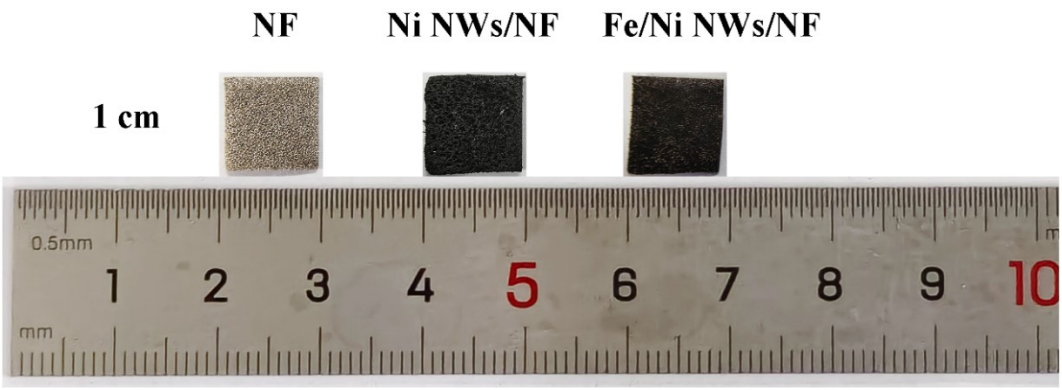

Figure S1. Picture of NF, Ni NWs/NF, Fe/Ni NWs/NF.

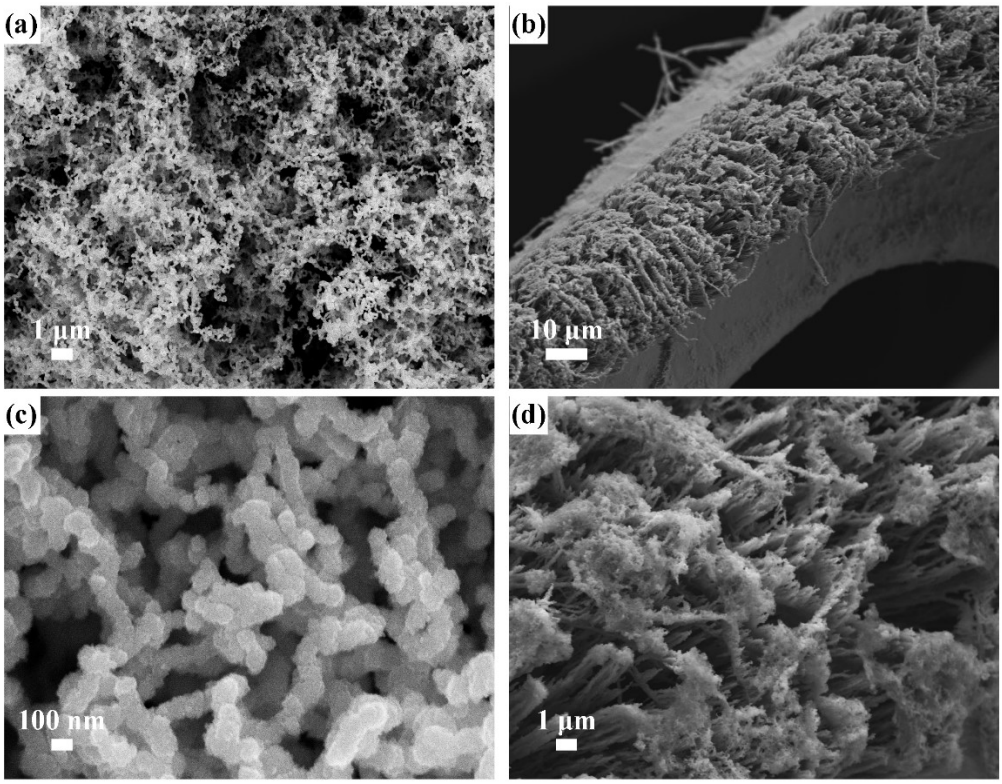

Figure S2. SEM images of (a,c)Ni/NF without magnetic field;and (b,d) reverse side of Ni NWs/NF with magnetic field.

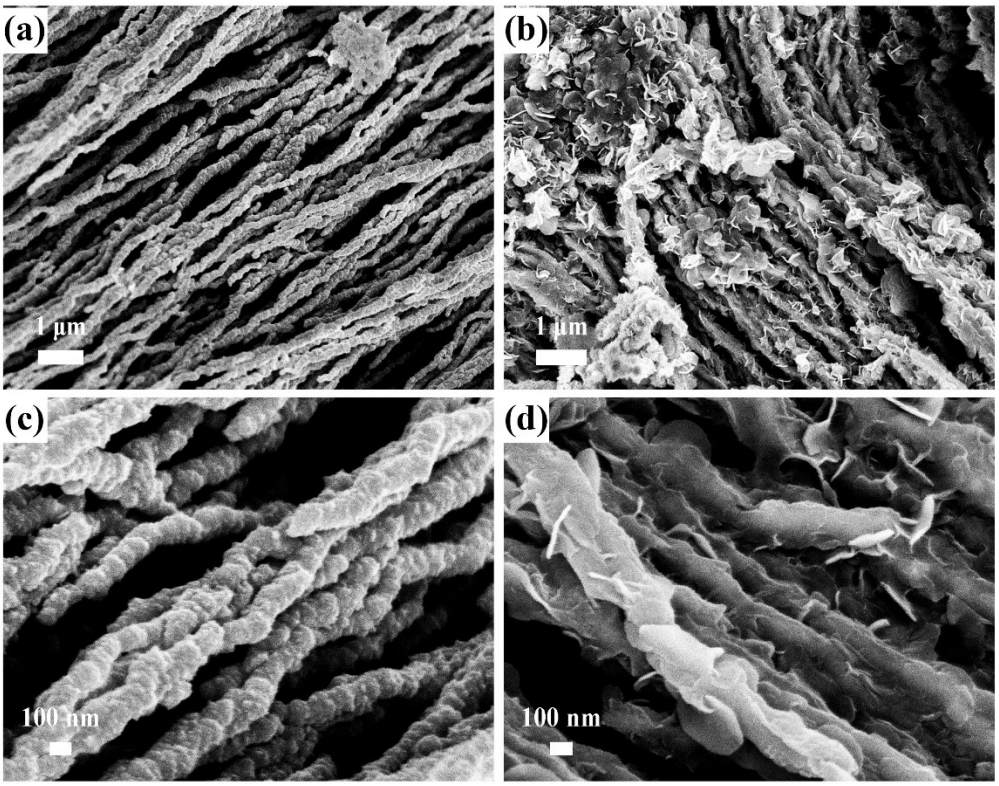

Figure S3. SEM images of different deposition time(a,c)10 s, (b,d)30 s.

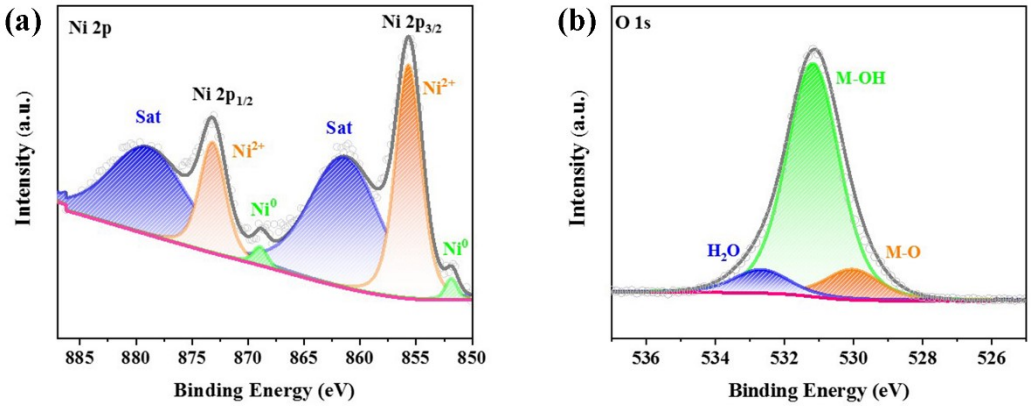

Figure S4. the deconvoluted high-resolution XPS spectra of (a) Ni 2p (Ni NWs/NF) and (b) O 1s (Fe/Ni NWs/NF).

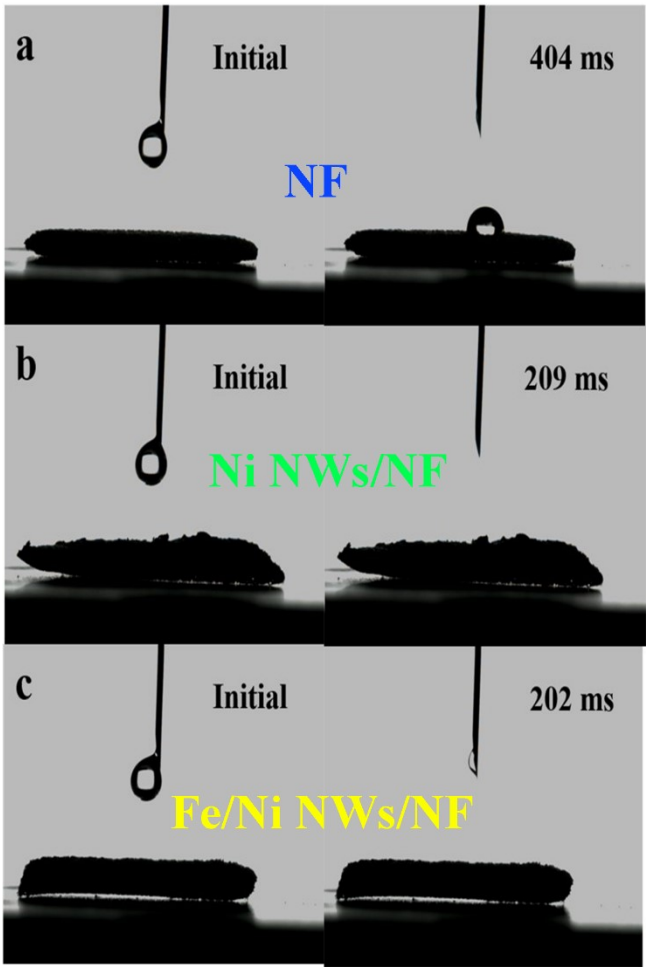

Figure S5. Contact Angle test for different samples.

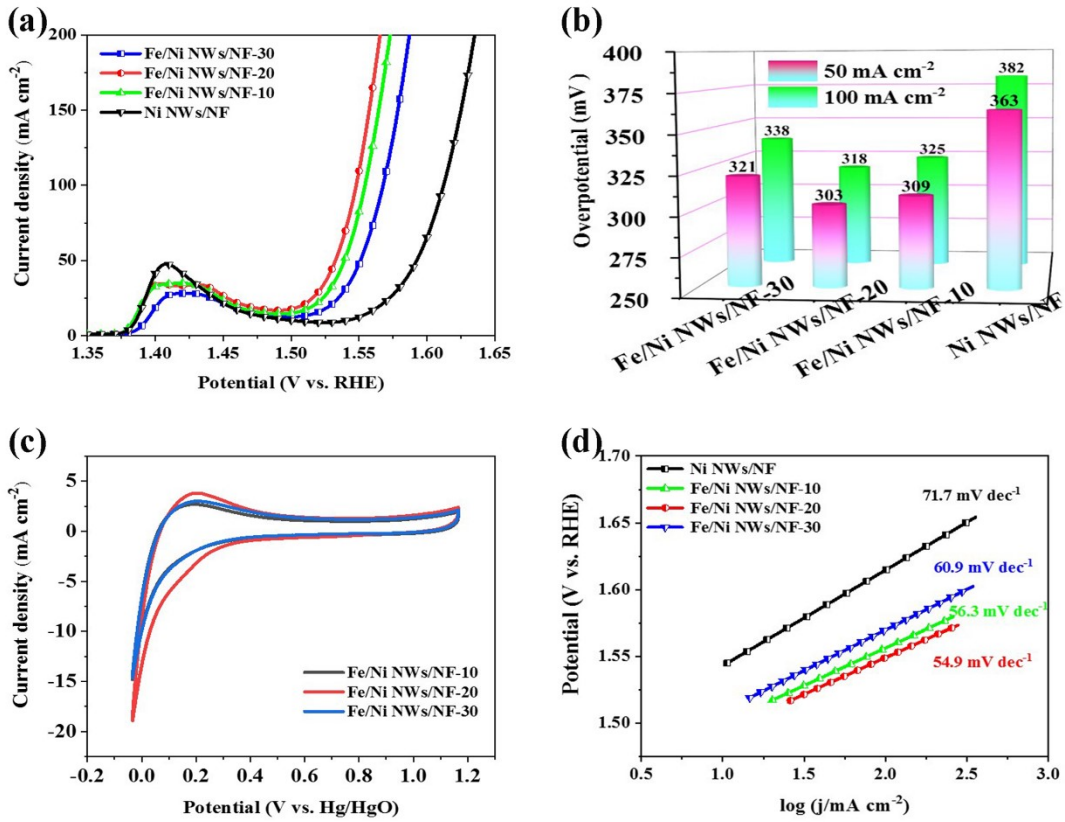

Figure S6. (a) OER LSVs of Ni NWs/NF, Fe/Ni NWs/NF-10, Fe/Ni NWs/NF-20 ,Fe/Ni NWs/NF-30 electrodes in 1.0 M KOH at a scan rate of 5 $mV.s^{-1}$; (b) their Overpotential at 50 mA cm^{-2} and 100 mA cm^{-2}; (c) their Cyclic voltammetry; (d)their Tafel plots

Table S1. Fitting values of Fe/ Ni NWs/NF, Ni NWs/NF, Fe/NF, NF electrochemical composition in Nyquist

Samples	R_s(ohm)	R_{ct}(ohm)
NF	1.06	121.10
Ni NWs/NF	1.05	17.07
Fe/NF	1.08	15.63

Fe/ Ni NWs/NF	1.06	0.82

Table S2. The metal content of Fe/Ni NWs/NF

Test elements	Weight of sample(mg)	Elements content of sample
Ni	40.2	99.57%
Fe	40.2	0.11%

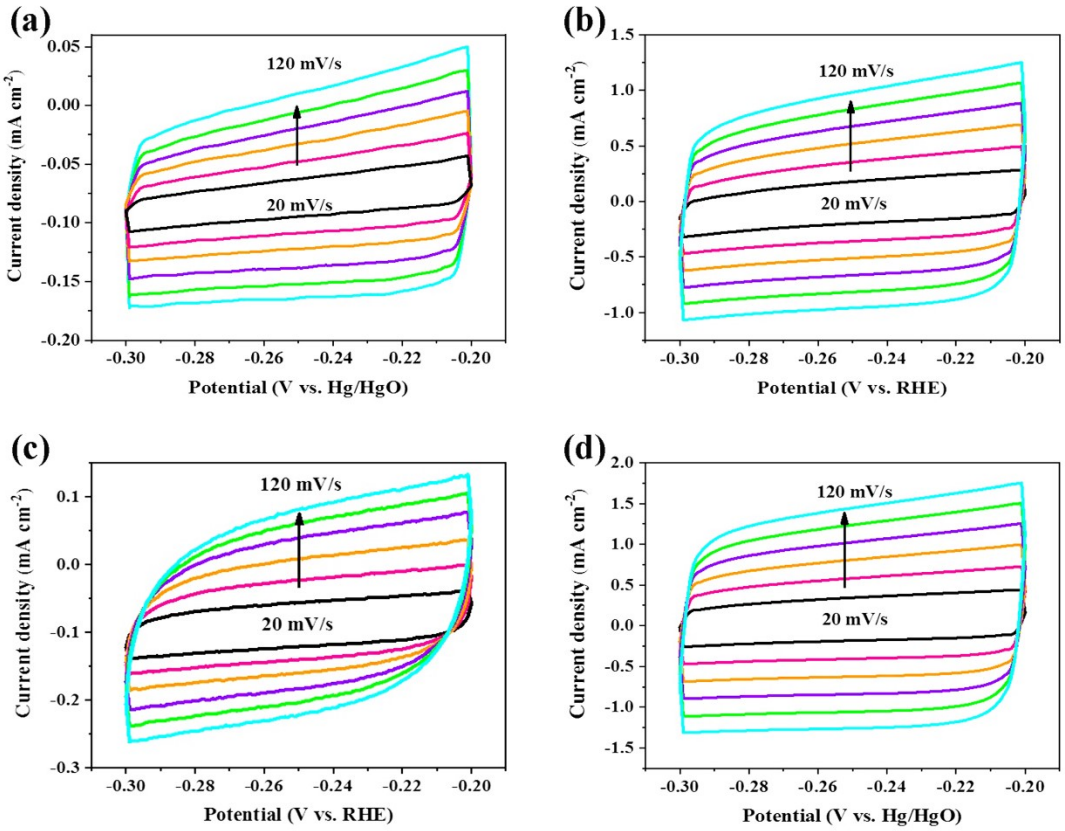

Figure S7. Cyclic Voltammetry plots of (a) NF; (b)Ni NWs/NF; (c)Fe/NF;(d)Fe/Ni NWs/NF.

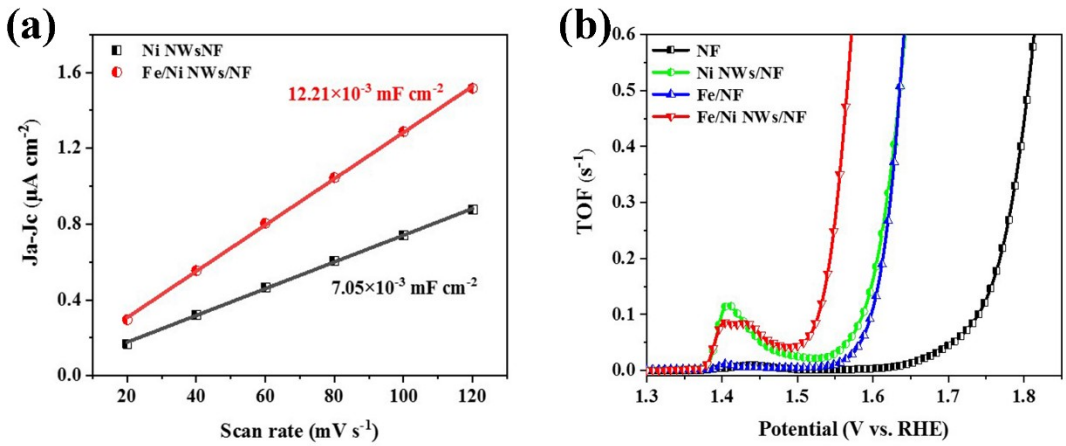

Figure S8. (a) Specific activity of Fe/Ni NWs/NF and Ni NWs/NF; (b)TOF value of NF, Ni NWs/NF,Fe/NF and Fe/Ni NWs/NF.

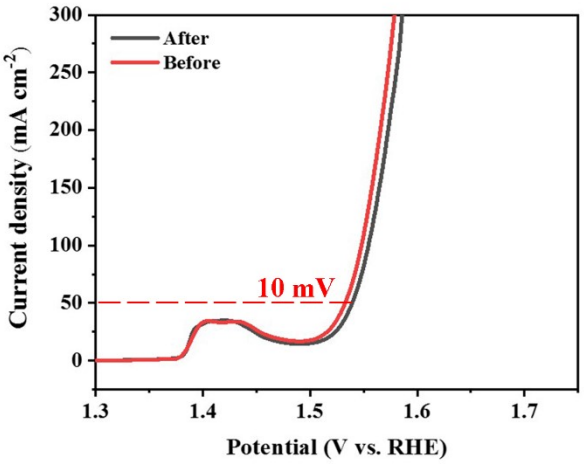

Figure S9. OER LSVs of Fe/Ni NWs/NF before and after stability test

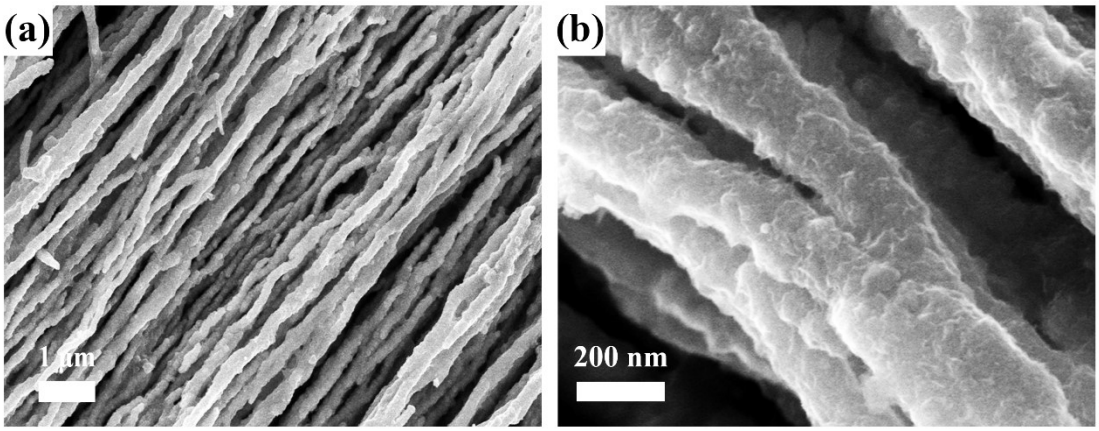

Figure S10. SEM image of Fe/Ni NWs/NF after stability test.

Table S3. The samples prepared were compared with those in the literature.

Catalysts	Overpotential (mV) at 10/100 mA cm^{-2}	Tafel slope ($mV\ dec^{-1}$)	Electrolyte	Ref
Fe/Ni NWs/NF	318/100	55.8	1 M KOH	This work
$Ni_{0.83}Fe_{0.17}(OH)_2$	245/10	61	1 M KOH	[1]
NiFe LDH/GC	347/10	67	1 M KOH	[2]
Fe^{2+}-NiFe-LDH-EO6 h@NF	285/100	48	1 M KOH	[3]
FeCoOH	320/100	/	1 M KOH	[4]
Ag NW@$Ni(OH)_2$ NS	290/100	58.1	1 M KOH	[5]
Fe-BDC/$Co(OH)_2$	268/10	41	1 M KOH	[6]
$Ni_{0.8}Fe_{0.2}$–AHNA	190/10	34.7	1 M KOH	[7]
NiFeOOH/NiFe/Ni	240/100	50	1 M KOH	[8]
Ni_2P/NiFeP/NF	270/100	35	1 M KOH	[9]
ANC-Fe_1Ni_2	266/10	39	1 M KOH	[10]
FeCo/NF	220/10	40	1 M KOH	[11]

Reference:

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