Supporting Information for

Self-Sacrificial templated-directed synthesis of ultrathin 0D/2D $FeNi_3$-NC/$NiFeO_x$ Schottky junction as hydrogen evolution reaction electrode for alkaline seawater electrolysis

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1、Electrochemical measurement details

1.1 Preparation of alkaline seawater

Natural seawater is collected from Beishan Bay Beach in Shantou City, Guangdong Province (116.769°E, 23.315°N). The preparation method for alkaline seawater involves creating 1M KOH by using the supernatant of natural seawater after it has settled as deionized water.

1.2 Reparation of Pt/C, RuO_2 and Ni(R) electrodes

10 mg 20wt.%Pt/C, 400μl ultra-pure water, 540μl ethanol and 60μl Nafion were mixed together for 0.5 hours to form a homogeneous ink. Then, the ink was dripped onto the IF and allowed to dry naturally at room temperature to obtain Pt/C electrodes. The preparation method for the RuO_2 electrode is the same as described above. 10 mg raney nickel, 400μl ultra-pure water, 540μl ethanol and 60μl Nafion were mixed together for 0.5 hours to form a homogeneous ink. The ink was dripped onto the NF and allowed to dry naturally at room temperature to obtain the raney nickel catalyst electrodes.

1.3 Electrochemical measurements

Electrochemical measurements were performed on an electrochemical workstation (Shanghai Chenhua CHI660e) with an electrolytic cell. A three-electrode system was used, with a mercury/mercury oxide electrode serving as the reference electrode, a stone mill rod as the counter electrode, and the synthesized sample as the working electrode. 1M KOH + natural seawater was used as the electrolyte, and the pH value of the electrolyte was measured using a pH meter. Before all electrochemical tests were prepared, the working electrode was activated through 50 cycles of cyclic voltammetry (CV) scanning in the range of 0.1 to -0.7 V vs. RHE. Additionally, a linear sweep voltammetry (LSV) curve was obtained at a sweep rate of 5 mV s^{-1}. The double layer capacitance (Cdl) is determined by utilizing cyclic voltammetry to measure the disparity in current density. The open circuit potential is ±0.05 V vs. RHE at intervals of 10 mV s^{-1} from 10 mV s^{-1} to 50 mV s^{-1}. Electrochemical impedance spectroscopy (EIS) is tested in the frequency range from 0.01 to 100,000 Hz with an amplitude of 5 mV.

1.4 The substrates and $FeNi_3$, $NiFeO_x$ material complement the details

Iron foam: The thickness is 1.2mm, the purity is 99.9%, from Kunshan Jiayisheng Electronics Co., LTD.

Nickel foam: The thickness is 0.5mm, the purity is 99.9%, from Suzhou Kesheng and metal Materials Co., LTD.

$FeNi_3$: Customized by Kunshan Jiayisheng Electronics Co., LTD.

$NiFeO_x$: It is obtained by NiFe LDH in argon at 5°C per minute to 280°C, and then at 5°C per minute to 400°C.

1.5 Details of SEM, TEM, or XPS instruments

Scanning electron microscope(SEM)：Sigma SEM produced by the German Carl Zeiss Group，electron gun acceleration voltage is 5kV.

Transmission electron microscope(TEM): JEM-2100F model TEM manufactured by Japan JEOL LTD, electron gun acceleration voltage is 300kV.

X-ray Photoelectron Spectroscopy(XPS): The ESCALAB Xi+ model XPS, manufactured by Thermo Fisher Scientific in the United States, the source gun type used is Al K Alpha.

2、Additional figures and table

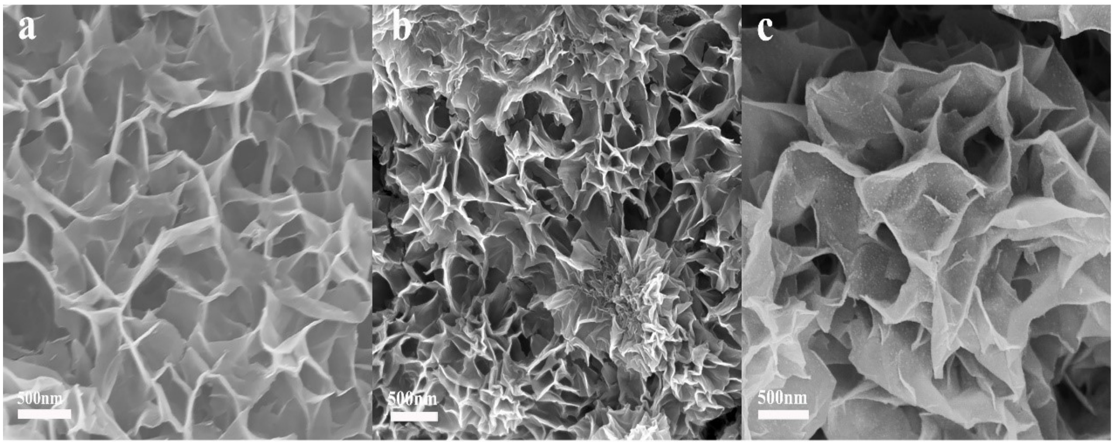

Figure S1. SEM image of NiFe-LDH（a），MOF/NiFeO$_x$（b）and FeNi$_3$-NC/NiFeO$_x$(c).

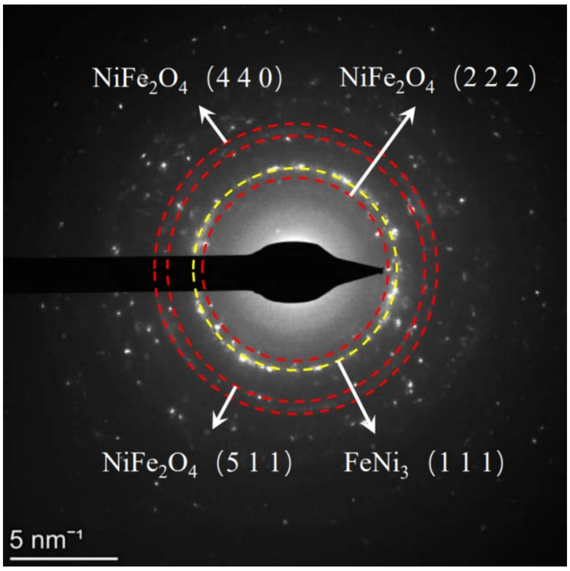

Figure S2. The selected-area electron diffraction (SAED) of FeNi$_3$-NC/NiFeO$_x$.

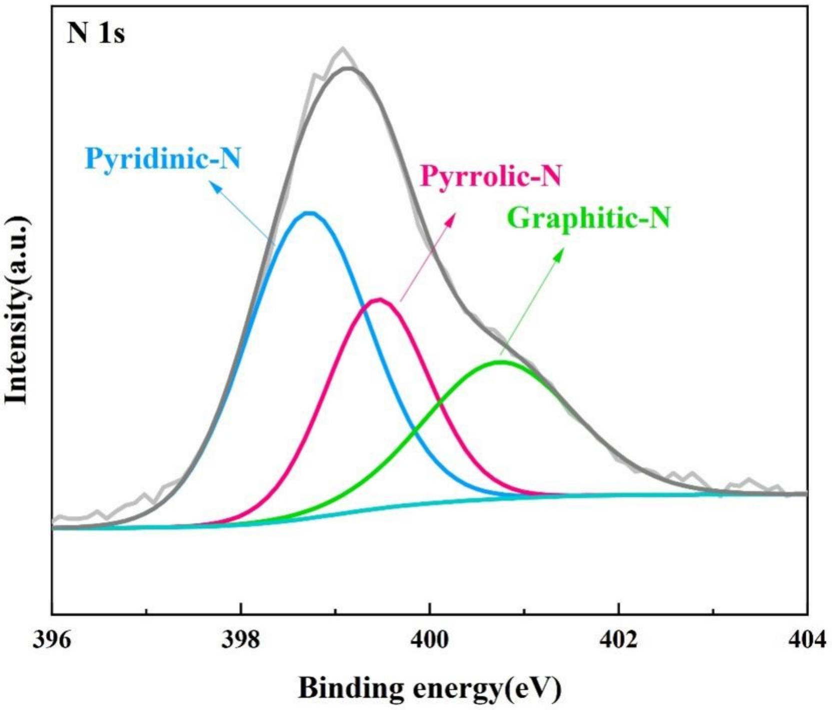

Figure S3. XPS spectra of N 1s in $FeNi_3$-NC/$NiFeO_x$.

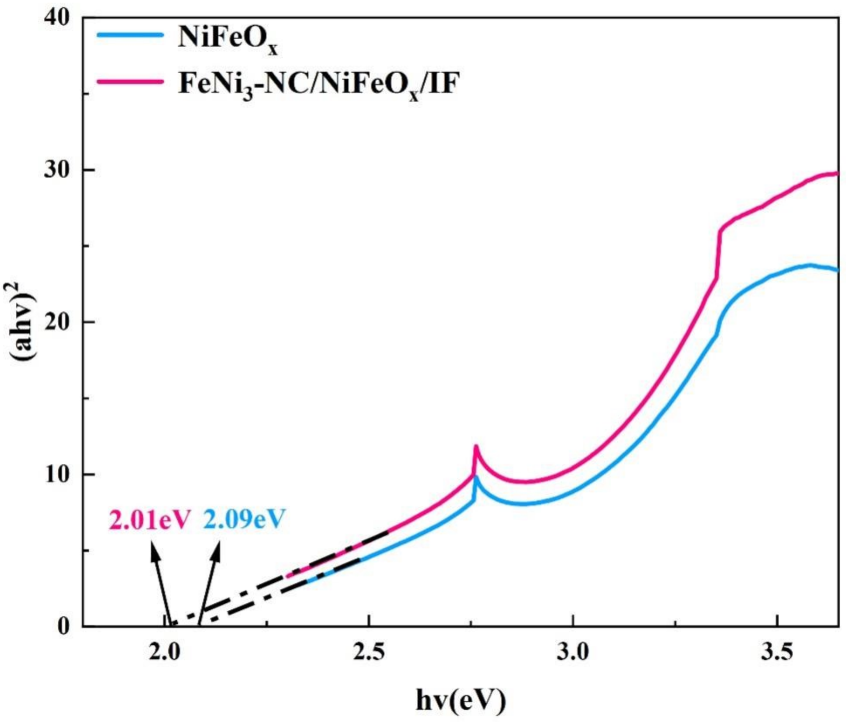

Figure S4. Tauc plot of NiFeO$_x$ FeNi$_3$-NC/NiFeO$_x$.

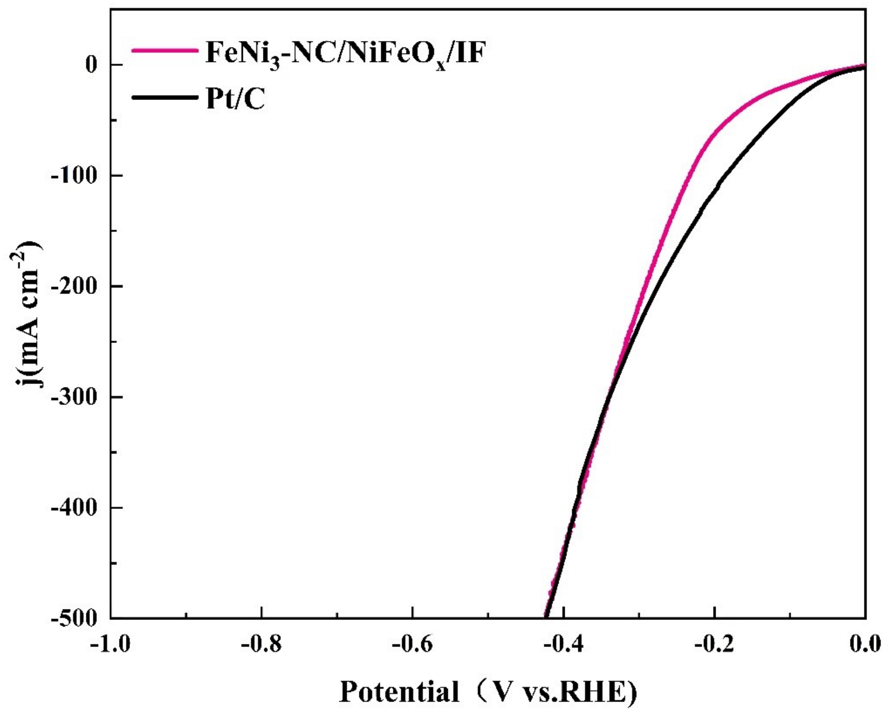

Figure S5. LSV curves of $FeNi_3$-NC/$NiFeO_x$ and Pt/C.

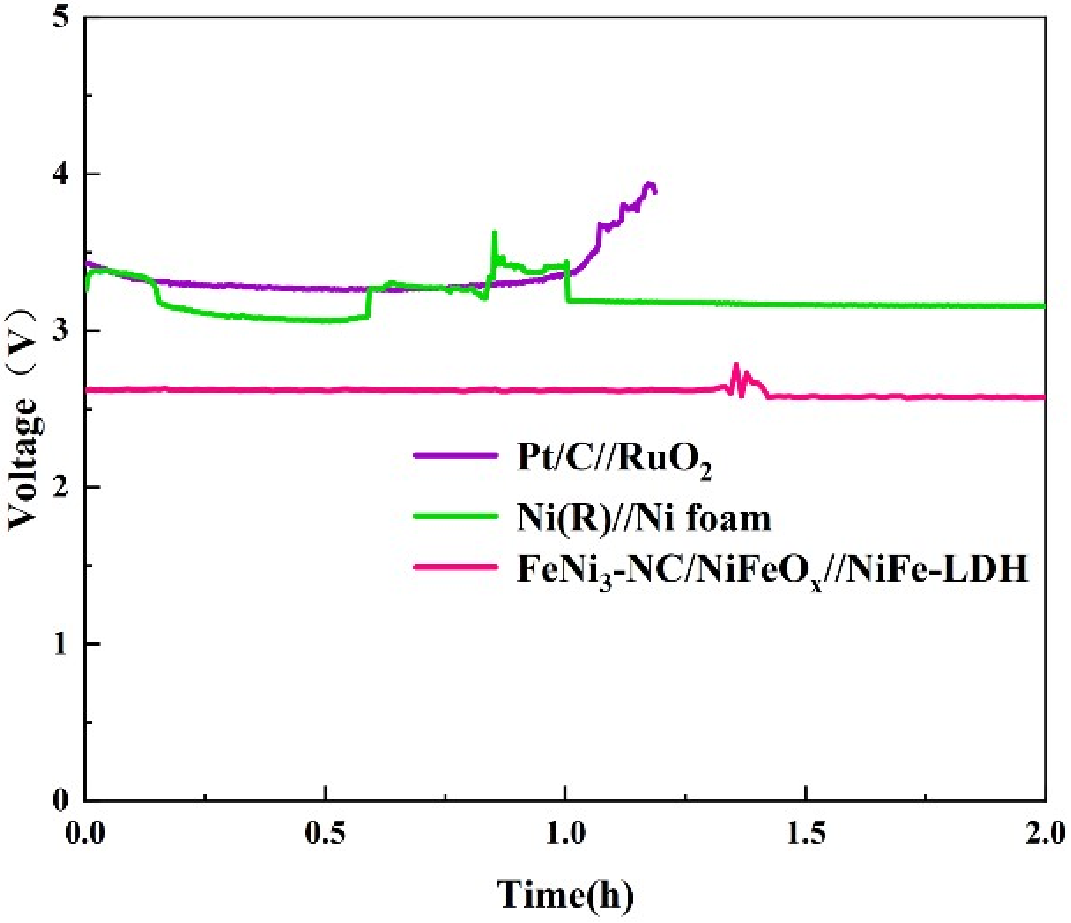

Figure S6. Stability comparison of locally enlarged FeNi$_3$-NC/NiFeO$_x$ | | NiFe-LDH, Pt/C | | RuO$_2$ and Ni (R) | | Ni foam at 500mA cm^{-2}.

Table S1. This work compares the performance of various HER catalysts in an alkaline solution.

Catalyst	η(mV) @ j (mA cm^{-2})	Stability (h) @ j (mA cm^{-2})	Electrolyte	Ref.
$FeNi_3$-NC/$NiFeO_x$	65@10 232@100	500@500	Alkaline seawater	This work
Ni-SA/NC	139@10		Alkaline seawater	[1]
NiFeP-NS-HER	83@10	500@100	alkaline simulated seawater	[2]
NiCo@C/MXene	49@10	140@500	Alkaline seawater	[3]
Ni_2P-Fe_2P	252@100	36@100	Alkaline seawater	[4]
CoP_x@FeOOH	117@10	80@500	Alkaline seawater	[5]
NiCoP/NiCo-LDH	213@50	50@15	alkaline simulated seawater	[6]
Co-Fe_2P	221@100	22@100	alkaline simulated seawater	[7]
NiFe-LDH/(NiFe)S_x	169@10	15@10	1M KOH	[8]
CoNiN@NiFe-LDH	150@10	50@20	1M KOH	[9]
S-NiFeOOH	176@10	70@500	1M KOH	[10]
NiFe-LDH@Mo-NiS_2-NiS	120@10	20@10	1M KOH	[11]
NiFeNb-0.25/NF	207@10	40@10	1M KOH	[12]

Reference:

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