Supporting Information

Regular pentagonal folded La doped CoNiOOH@FeSe@NiSe/NF nanosheet array for high efficiency alkaline electrocatalytic oxygen evolution reaction

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1.1. Physical characterization

The physical and chemical properties of the catalyst materials were characterized by the following instruments. In order to verify the morphology and elemental composition of the catalyst material, field emission scanning electron microscopy (FE-SEM, Carl Zeiss Ultra Plus, Germany) and transmission electron microscopy (TEM, JEOL JEM 2100). The elemental mapping of the sample was characterized by energy dispersive X-ray spectroscopy (EDX, Oxford, England) with the equipped Aztec-X-80. Chemical composition and elemental composition were analyzed by X-ray powder diffractometer K (XRD, Rigaku D/Max-2400) with Cu Kα radiation source and X-ray photoelectron spectroscopy (XPS) analysis was performed on an analytical instrument (Thermo Scientific K-Alpha) with monochromatic Al Kα radiation source. The purpose of this study is to investigate the hydrophilic and gasophobic characteristics of this material, therefore, Contact Angle Analyzer (SL 200 KB) was used to test its contact angle (CA).

1.2. Electrochemical measurements

The electrochemical testing in this study is conducted using the standard three-electrode system. (CHI760e, CH instrument, Shanghai, China) at room temperature. The standard three-electrode system was used for electrochemical testing. The graphite electrode was used as the counter electrode, and all samples to be tested could be used as self-supported working electrodes. The Hg/HgO electrodes were used as reference electrodes in alkaline media. All the potentials were converted into the reversible hydrogen electrode (vs. RHE) by the Nernst equation:

$$E\ (RHE) = E\ (Hg/HgO) + 0.059\ pH + 0.098$$

$$E\ (RHE) = E\ (Ag/AgCl) + 0.059\ pH + 0.197$$

La-CNOOH@NFSe/NF (2×1 cm^2) was used as a self-supported working electrode for electrochemical tests in 1.0 M KOH solutions. The OER catalytic activity of each electrode was measured by linear sweep voltammetry (LSV) at a sweep rate of 5 mV s^{-1}. To analyze the performance of OER, the Tafel plot of the linear region is derived by fitting the Tafel equation ($\eta = a + b \log j$), wherein η represents the overpotential, b signifies the Tafel slope, and j designates the current density. CV curves were obtained by cyclic voltammetry in the sweep rate range of 20 to 120 mV s^{-1}, and the double-layer capacitance (C_{dl}) was calculated. Under the condition of a current density of 10 mA cm^{-2} and a duration of 24 hours, the electrochemical stability is examined using a chronopotentiometry curve. Meanwhile, electrochemical impedance spectroscopy (EIS) measurements were performed in the frequency range of 100 kHz to 0.01 Hz.

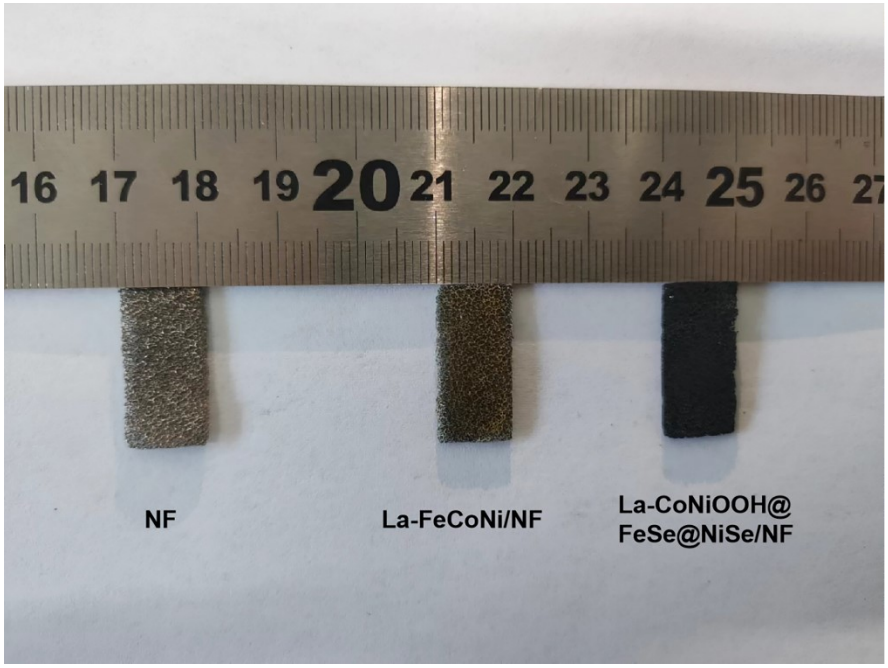

Fig. S1 Process diagram and surface variation of blank NF (left), La-FeCoNi/NF (middle), and La-CoNiOOH@FeSe@NiSe/NF (right).

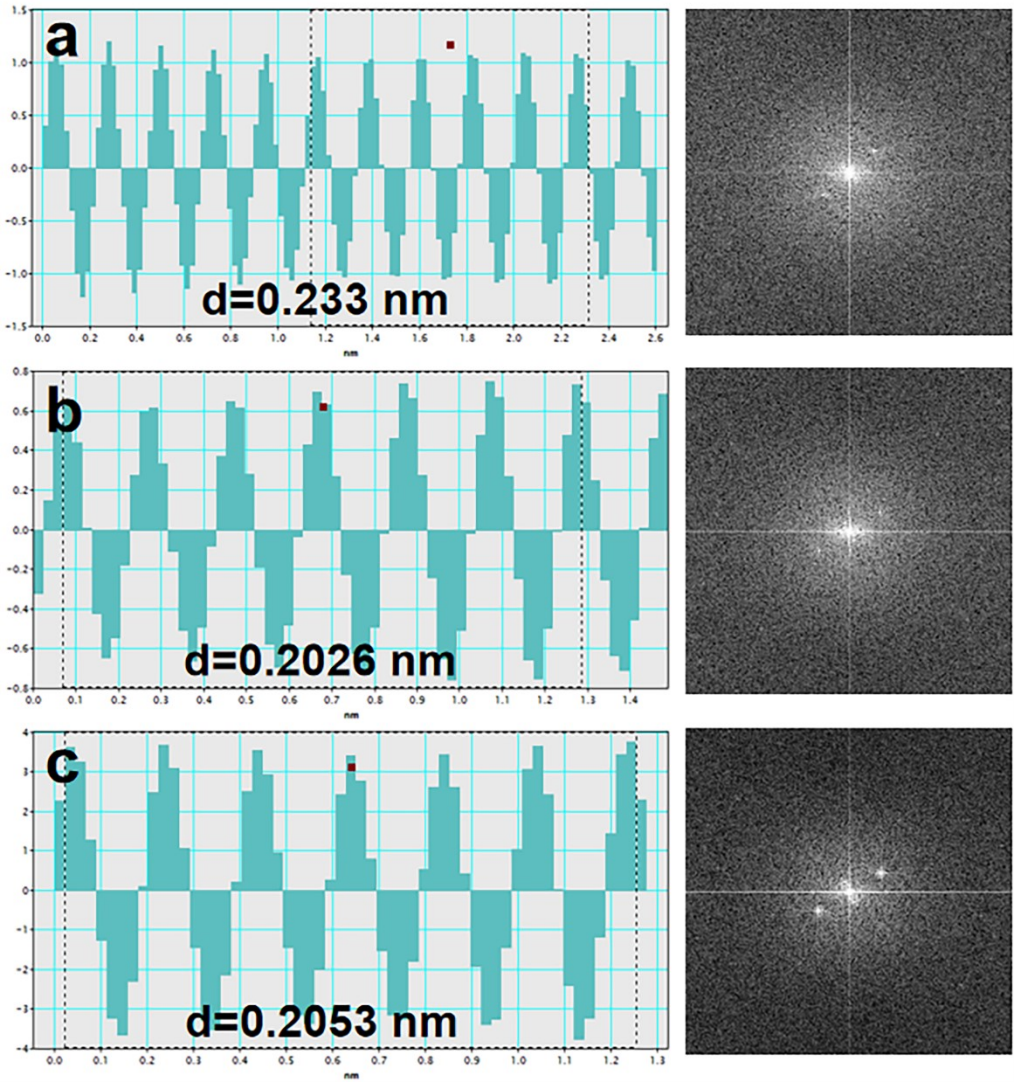

Fig. S2 The lattice spacing measured by the Fourier transform of FeSe, CoNiOOH, NiSe.

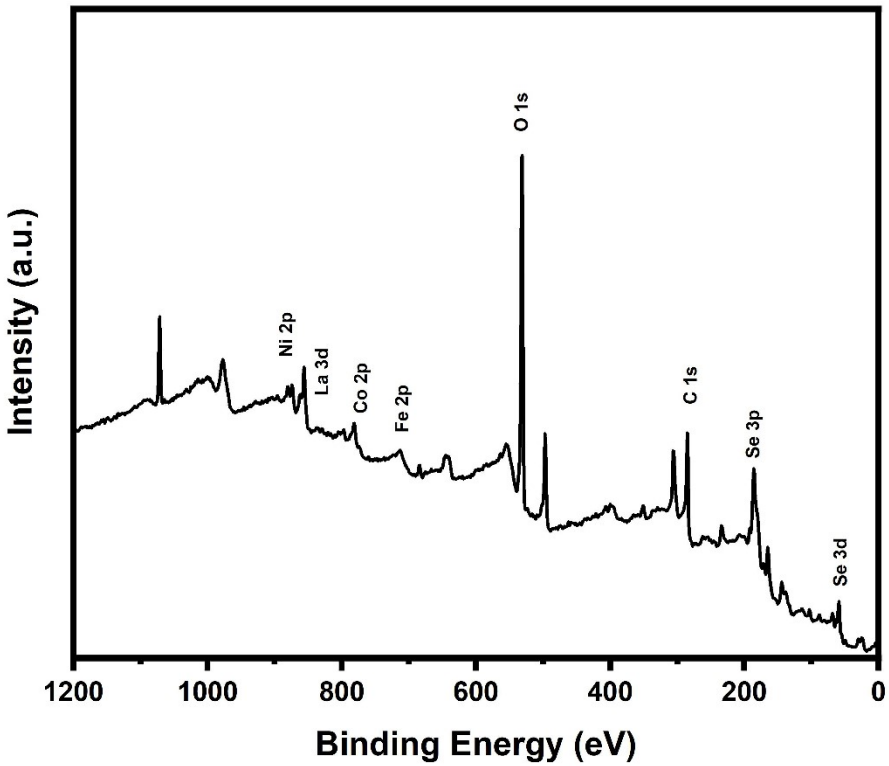

Fig. S3 XPS total spectra of La-CoNiOOH@FeSe@NiSe/NF.

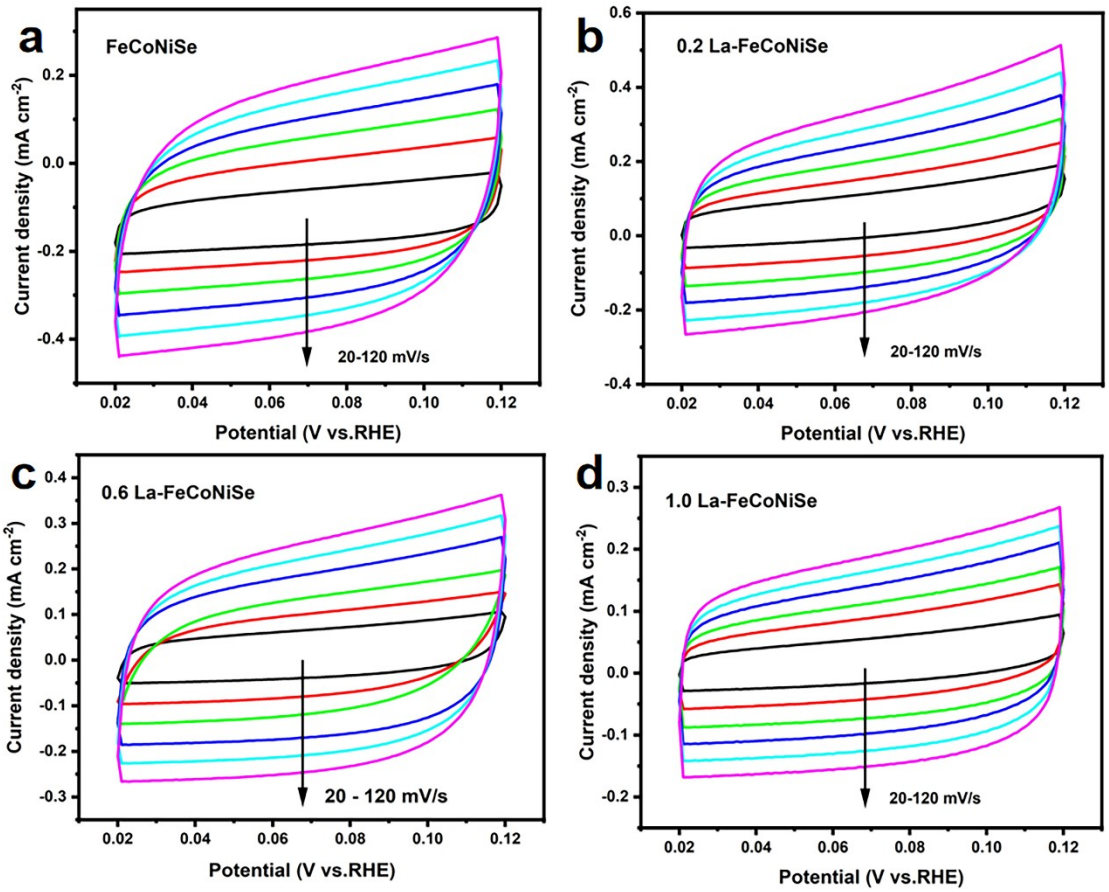

Fig. S4 CV curves in the non-faradaic capacitance current range at different scan rates for (a) 0 La-CoNiOOH@FeSe@NiSe/NF, (b) 0.2 La-CoNiOOH@FeSe@NiSe/ NF, (c) 0.6 La-CoNiOOH@FeSe@NiSe/NF, and (d) 1.0 La-CoNiOOH@FeSe@ NiSe/NF in 1 M KOH electrolyte.

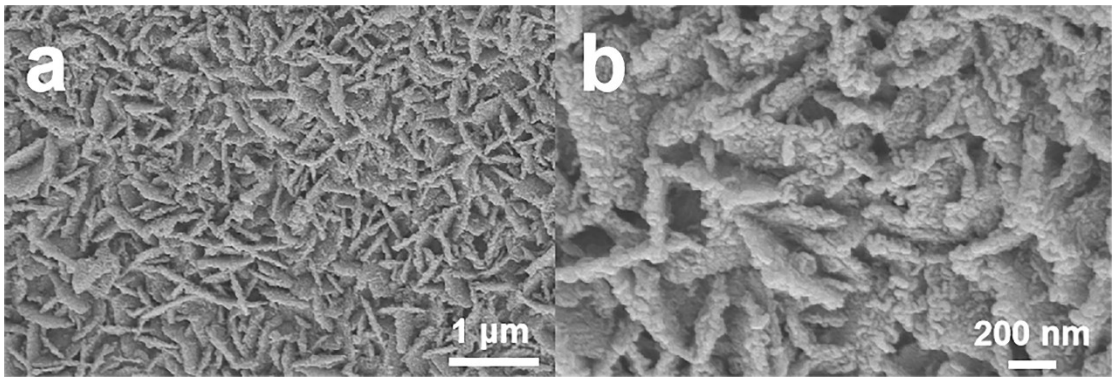

Fig. S5 (a, b) SEM images of La-CoNiOOH@FeSe@NiSe/NF after long OER test.

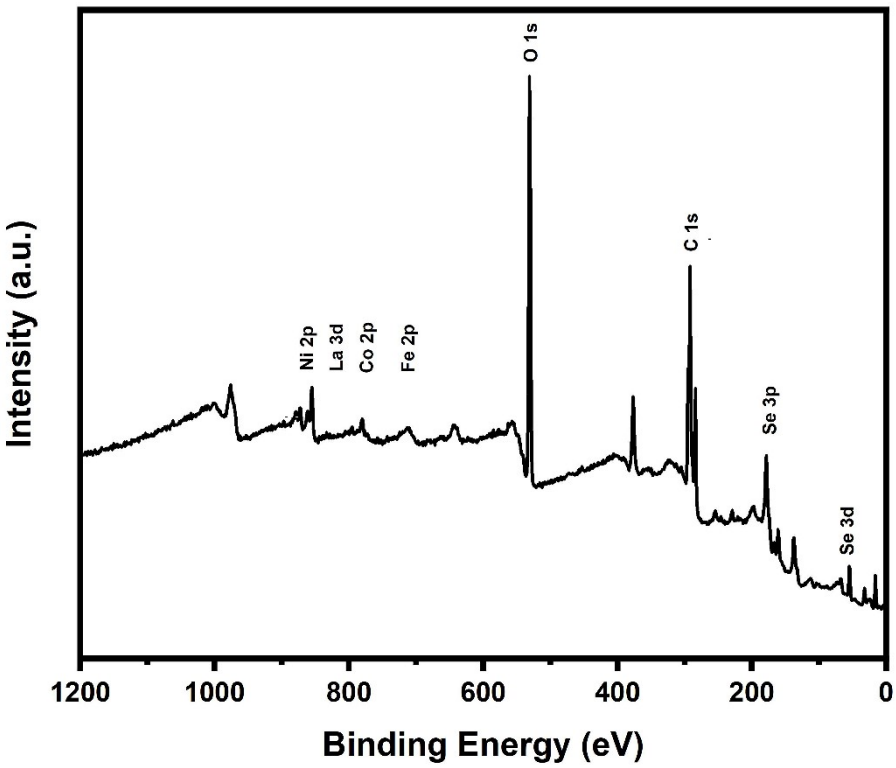

Fig. S6 XPS total spectra of La-CoNiOOH@FeSe@NiSe/NF after long OER test.

Table S1 OER parameters of various as-prepared catalysts in 1 M KOH.

Catalyst	**η_{10} (mV)**	**Tafel slope (mV dec^{-1})**	**C_{dl} (mF cm^{-2})**	**Rct (Ω)**
0.6 La-CoNiOOH @FeSe@NiSe/NF	270	35.35	2.15	0.1865
0 La-CoNiOOH @FeSe@NiSe/NF	320	91.75	0.19	0.5891
0.2 La-CoNiOOH @FeSe@NiSe/NF	319	66.57	2.04	0.2604
1.0 La-CoNiOOH @FeSe@NiSe/NF	302	64.48	1.33	0.379

Table S2 Comparison of OER performance of La-CoNiOOH@FeSe@NiSe/NF with other advanced electrocatalysts in alkaline media.

Catalysts	**η_{10} (mV)**	**Tafel slope ($mV\ dec^{-1}$)**	**References**
La-CoNiOOH@FeSe@NiSe/NF	270	35.35	This work
FeS_2/C	350	65.6	[S1]
Co-FeS_2/CoS_2	278	73	[S2]
$Co_{0.25}Fe_{0.75}S_2$	324	50	[S3]
FeS_2/MCoNiSe_2/NF	230	54.1	[S4]
Fe-CoNi LDHs	260	70	[S5]
CoCrFeNiMo HEAs	220	59	[S6]
$NiMoO_4$/Ni/CNTs	330	/	[S7]
FeS_2/$FeNi_3S_2$	188	/	[S8]
(Ni-Fe)S_x/NiFe$(OH)_y$	230	58	[S9]
NiO/Co_3O_4	262	58	[S10]
CoNiP/NC	300	66	[S11]
(Co,Ni)Se_2/C@FeOOH	241	44	[S12]
Co_3O_4/Fe_2O_3@NF	254	33	[S13]
Ni_3S_2@Ni_5P_4	399	75	[S14]

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