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One-step hydrothermal synthesis of Se-doped NiTe electrocatalysts for efficient hydrogen production from saline water assisted by the anodic iodide oxidation

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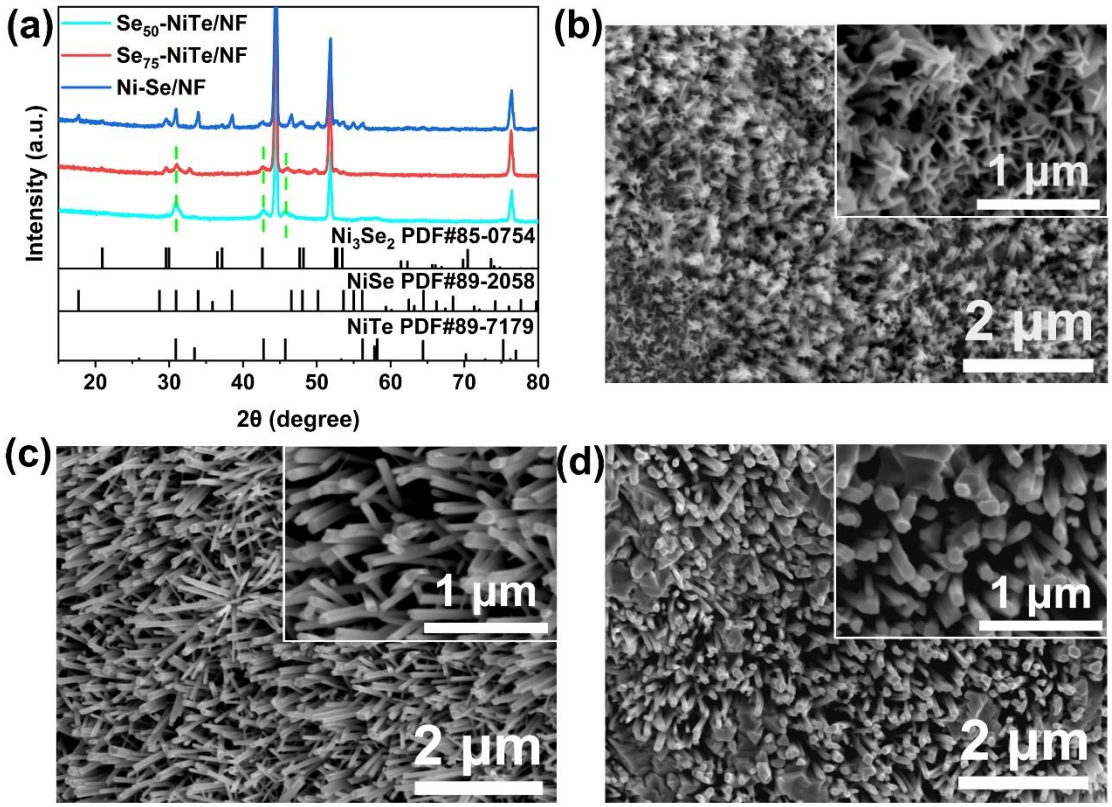

Fig. S1 (a) XRD patterns and (b) SEM images of Se_{50}-NiTe/NF, Se_{75}-NiTe/NF and Ni-Se/NF electrodes.

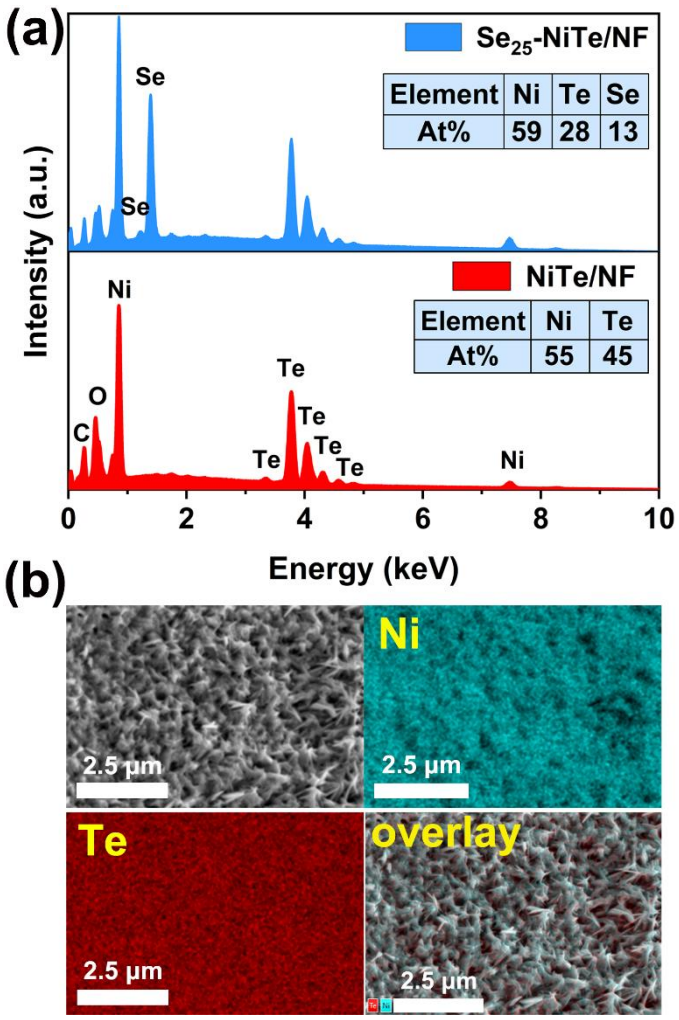

Fig. S2 (a) EDS spectra of the NiTe/NF and Se_{25}-NiTe/NF electrodes. (b) SEM image and the corresponding elemental maps of the NiTe/NF electrode.

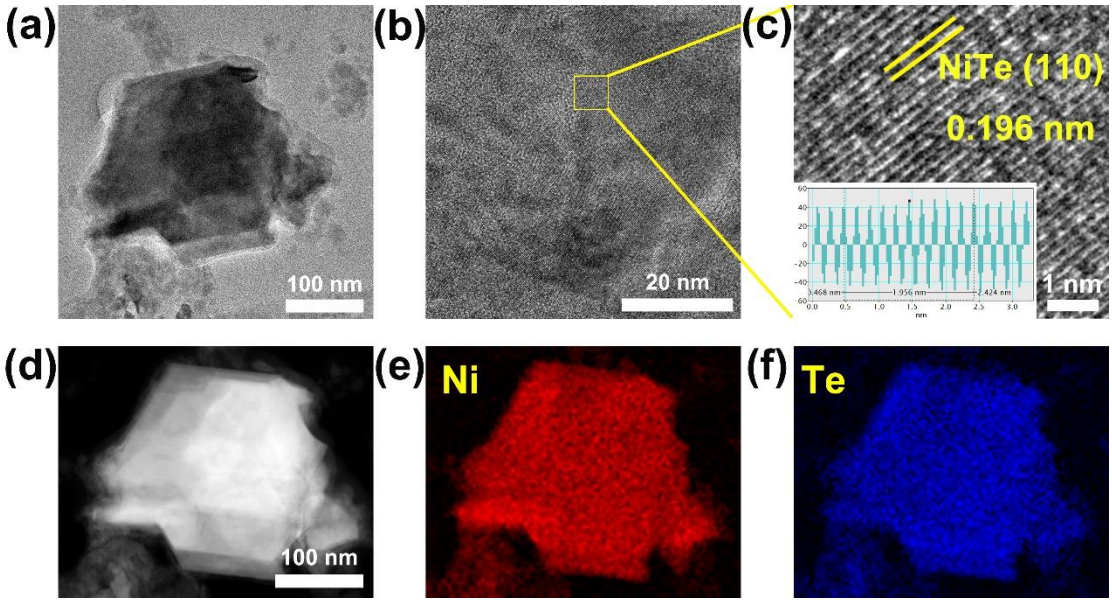

Fig. S3 (a) TEM image, (b-c) HRTEM images, (d) HAADF-STEM image and (e-f) the corresponding elemental maps of the NiTe/NF catalyst.

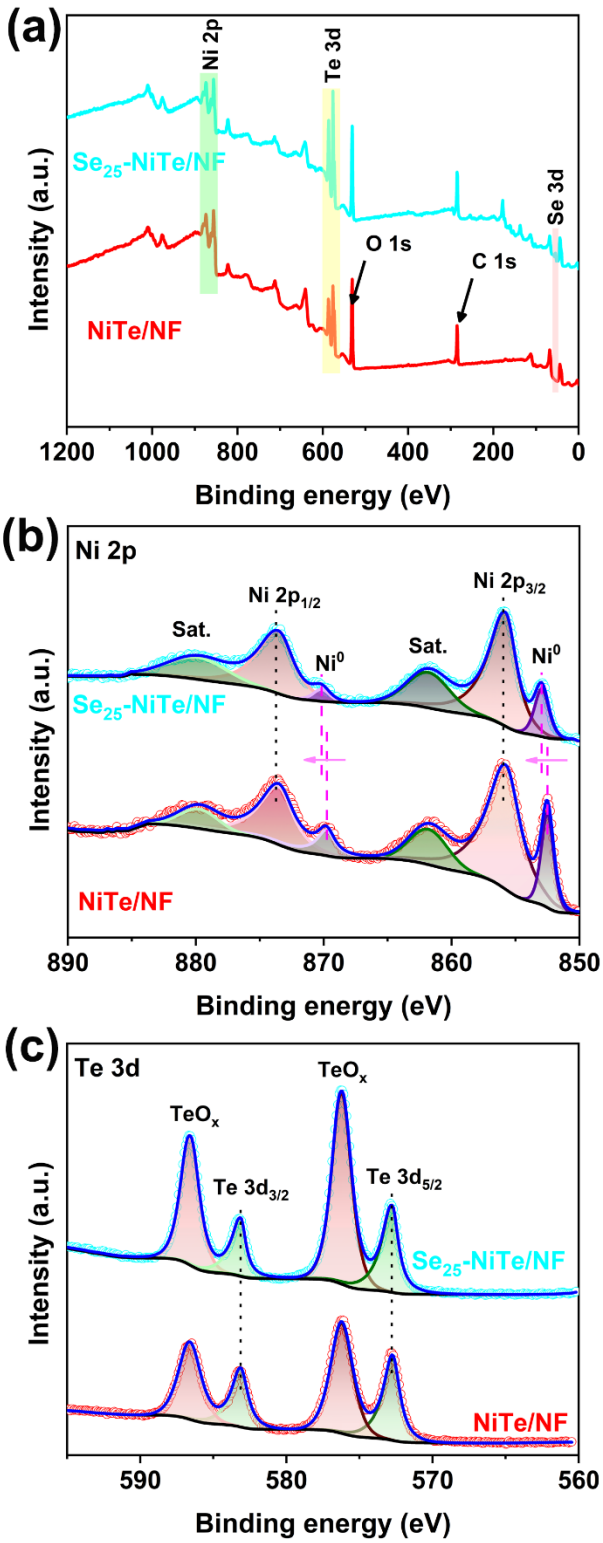

Fig. S4 (a) XPS survey spectrum. High-resolution (b) Ni 2p and (c) Te 3d XPS spectra of the NiTe/NF and Se_{25}-NiTe/NF electrodes.

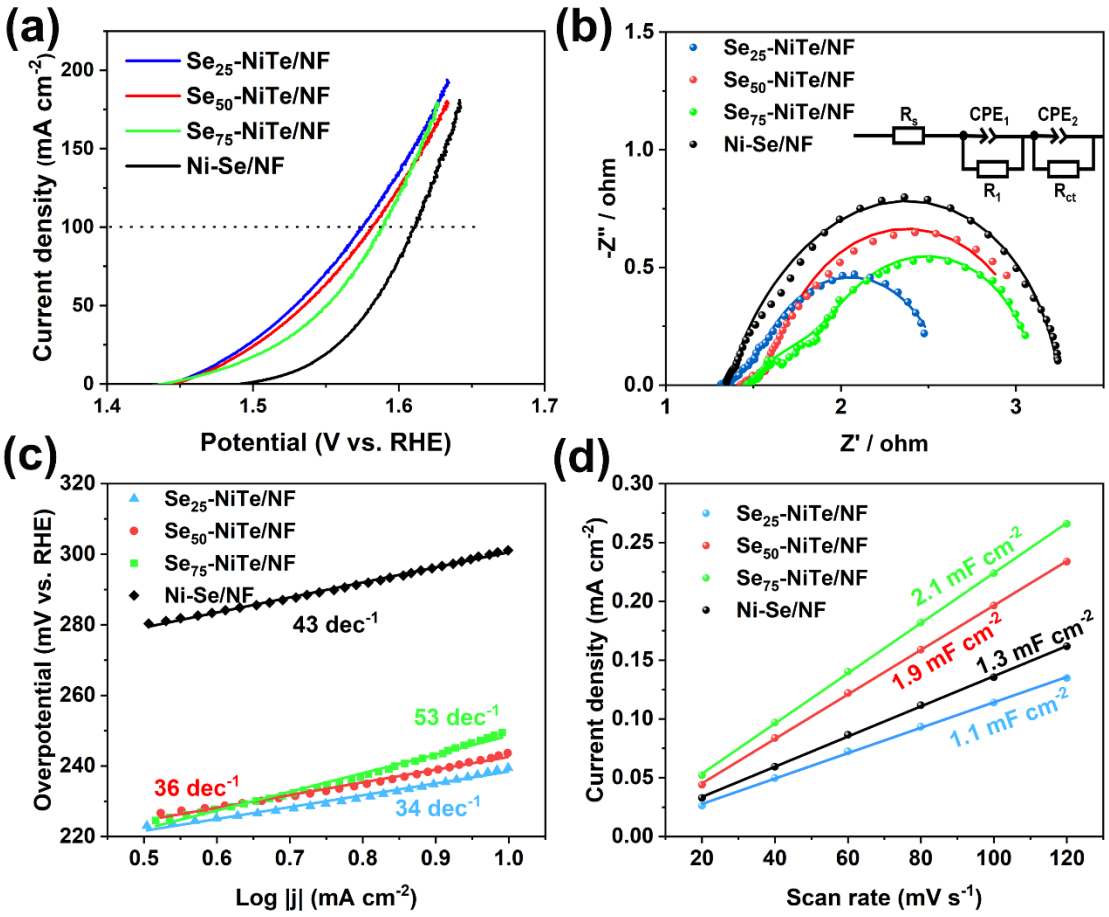

Fig. S5 Electrocatalytic performance of the Se-NiTe/NF electrodes with different selenium doping amounts tested in 1.0 M KOH + 0.5 M NaCl electrolyte. (a) Polarization curves. (b) Nyquist plots. Inset: equivalent circuit model used for fitting. (c) Tafel plots, and (d) C_{dl} values.

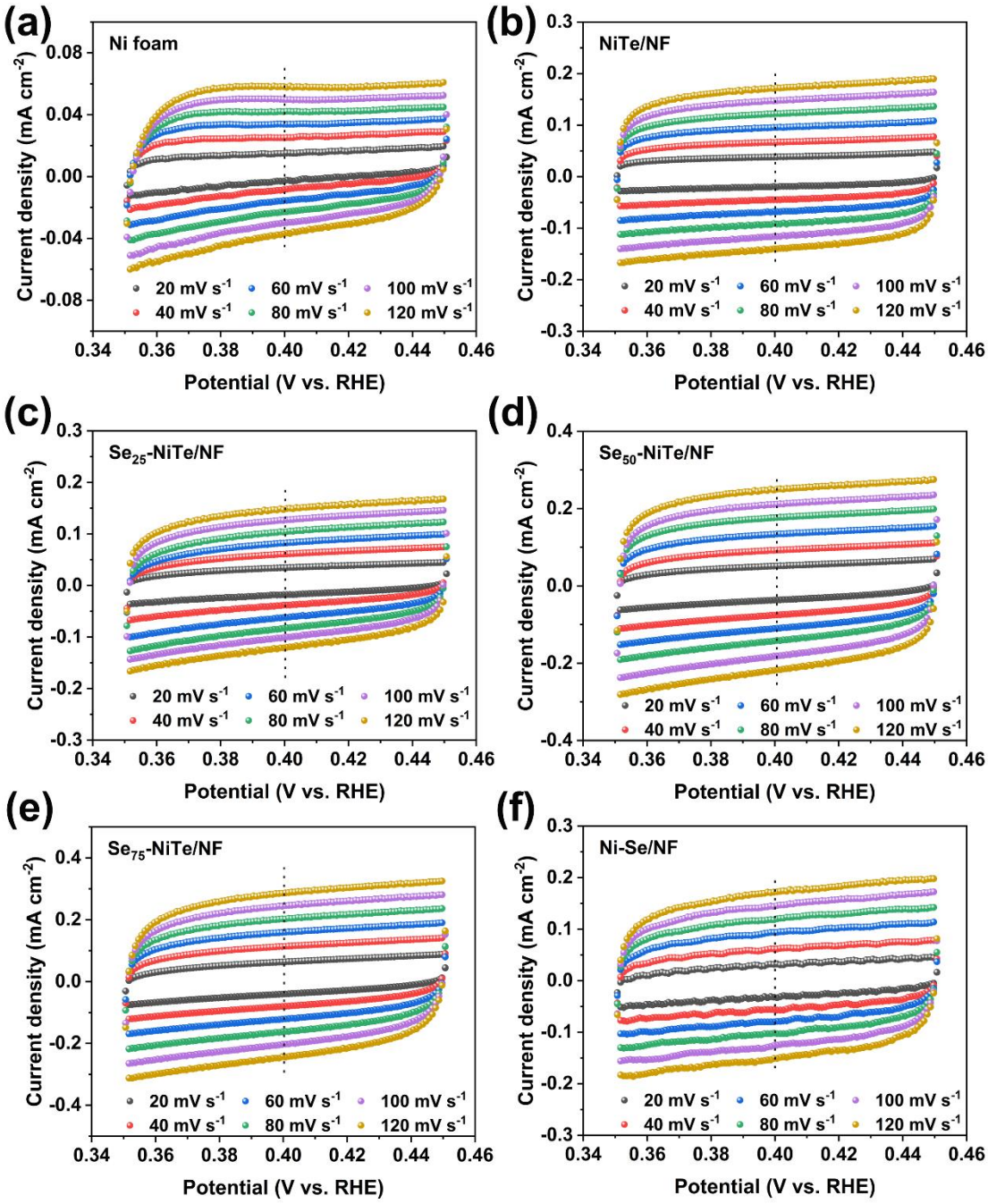

Fig. S6 The CV curves (Potential ranging from 0.35 – 0.45 V vs. RHE) of different electrocatalysts recorded at various scan rates from 20 to 120 mV s^{-1}. (a) Bare Ni foam, (b) NiTe/NF, (c) Se_{25}-NiTe/NF, (d) Se_{50}-NiTe/NF, (e) Se_{75}-NiTe/NF, and (f) Ni-Se/NF.

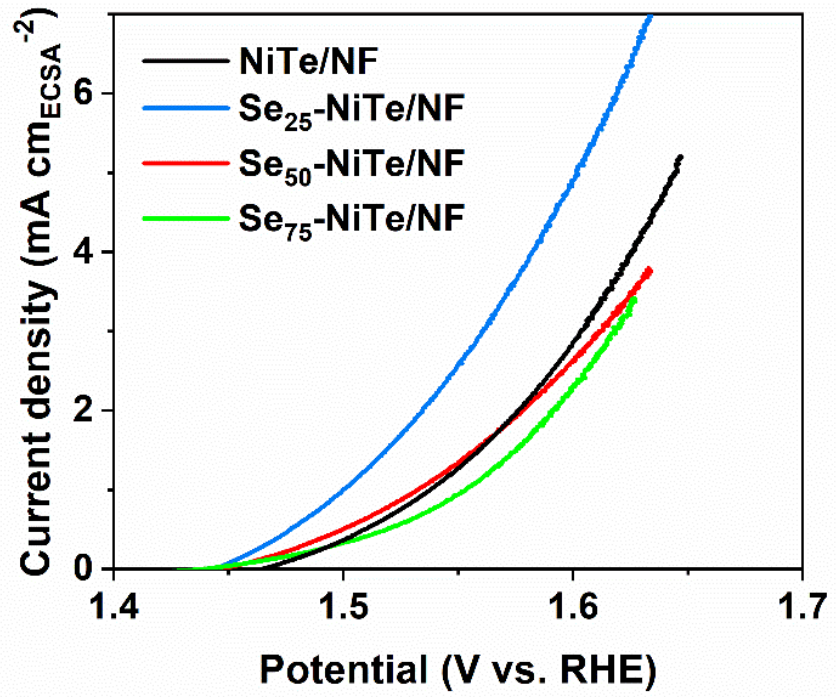

Fig. S7 ECSA normalized specific activities of NiTe/NF, Se_{25}-NiTe/NF, Se_{50}-NiTe/NF, and Se_{75}-NiTe/NF.

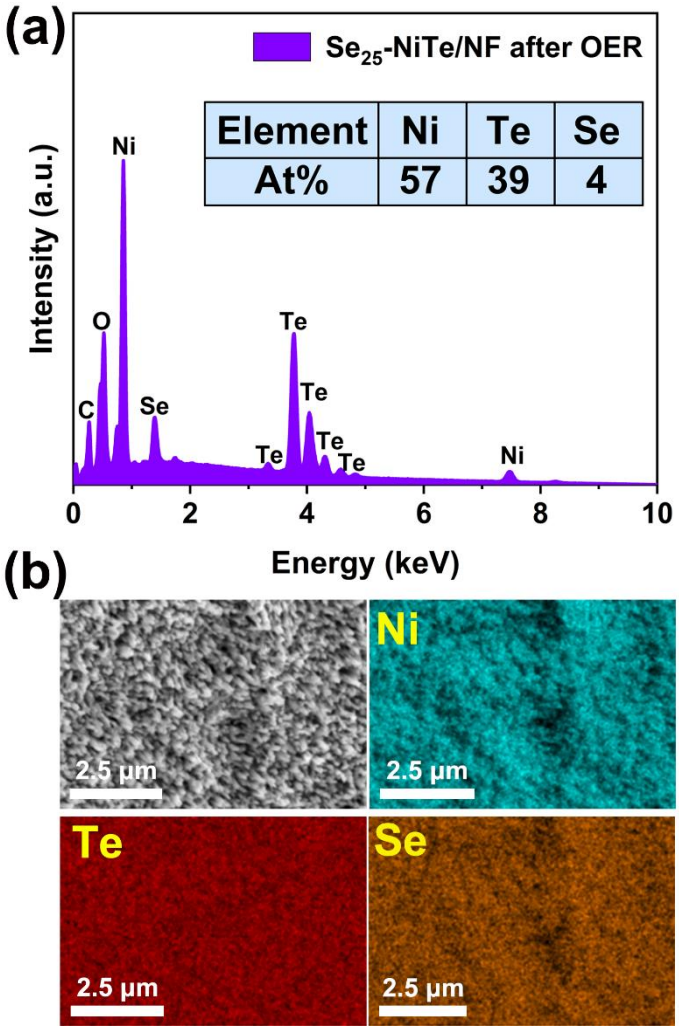

Fig. S8 (a) EDS spectra and (b) SEM image and the corresponding elemental maps of the Se_{25}-NiTe/NF electrode after the OER stability test (100 mA cm^{-2} for 200 hours in 1.0 M KOH + 0.5 M NaCl electrolyte).

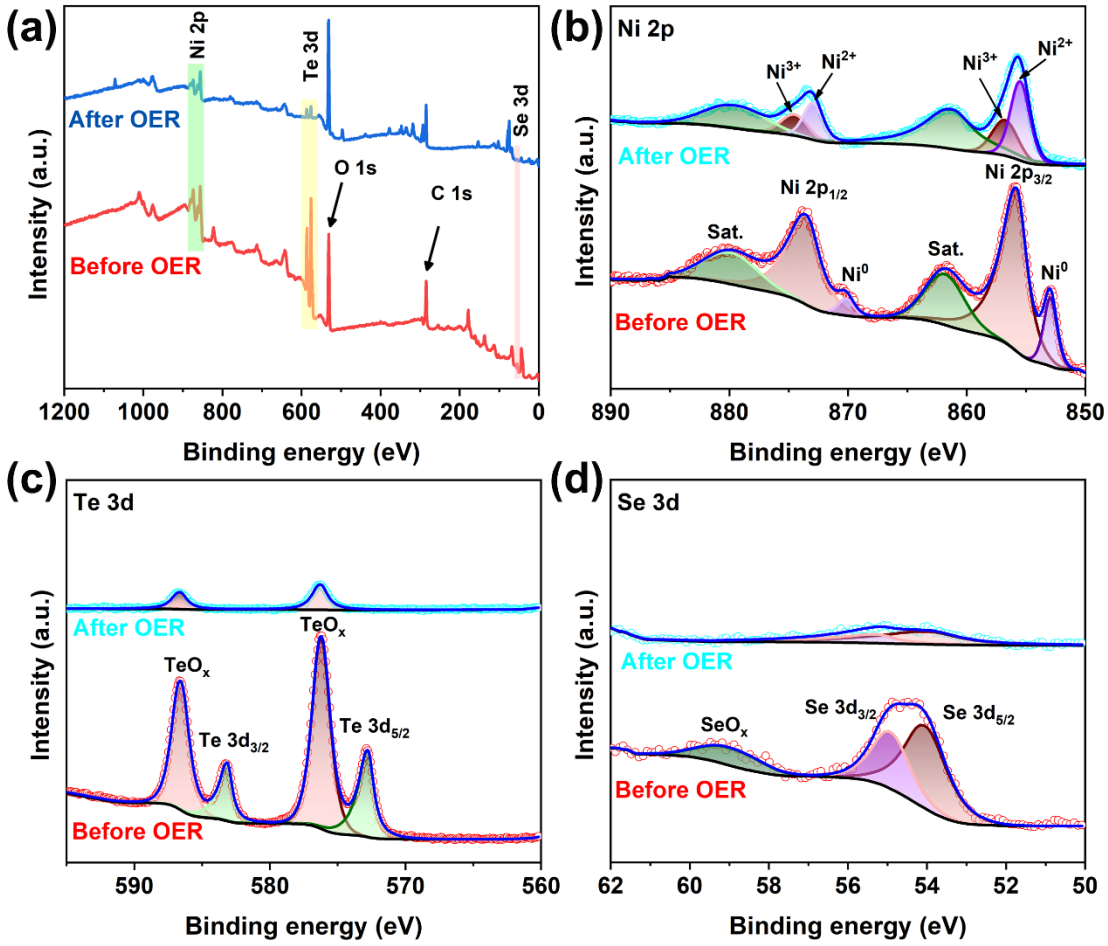

Fig. S9 (a) XPS survey spectrum. High-resolution XPS spectra in the (b) Ni 2p, (c) Te 3d and (d) Se 3d regions acquired from the Se_{25}-NiTe/NF electrode before and after the OER chronopotentiometry at a current density of 100 mA cm^{-2} in 1.0 M KOH + 0.5 M NaCl electrolyte.

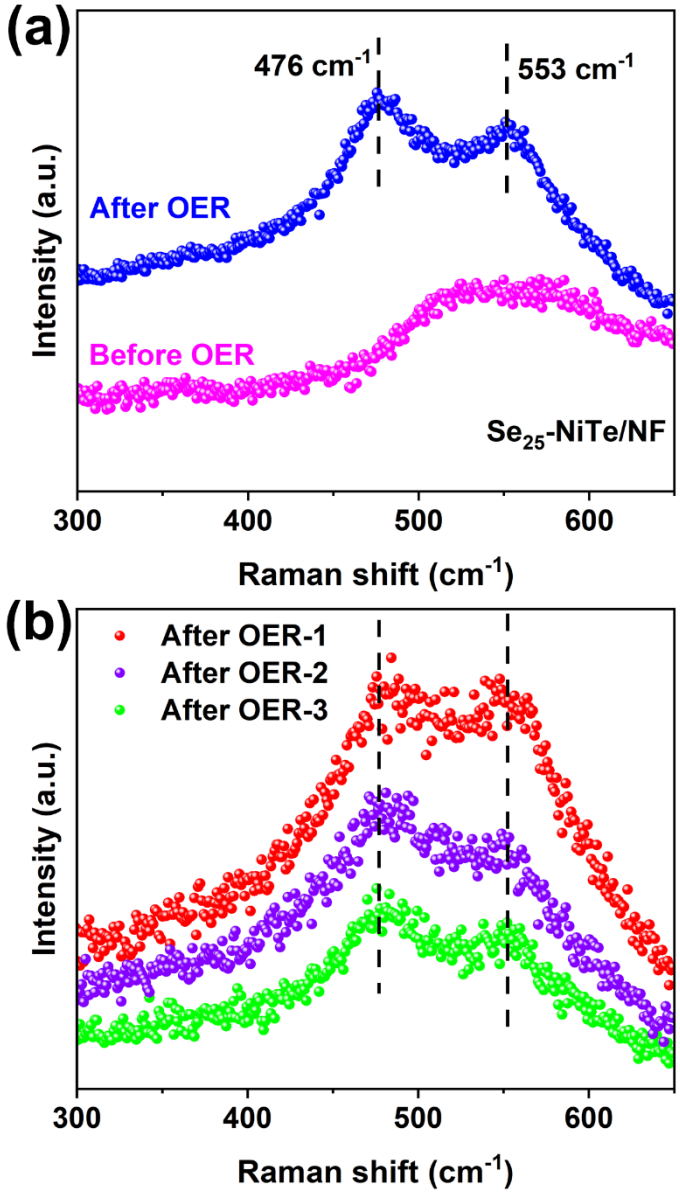

Fig. S10 (a) Raman spectra of the Se_{25}-NiTe/NF electrode before and after the OER stability test in alkaline-saline water solution (100 mA cm^{-2} for 200 hours). (b) Raman spectra acquired at different positions over the same piece of electrode after the OER.

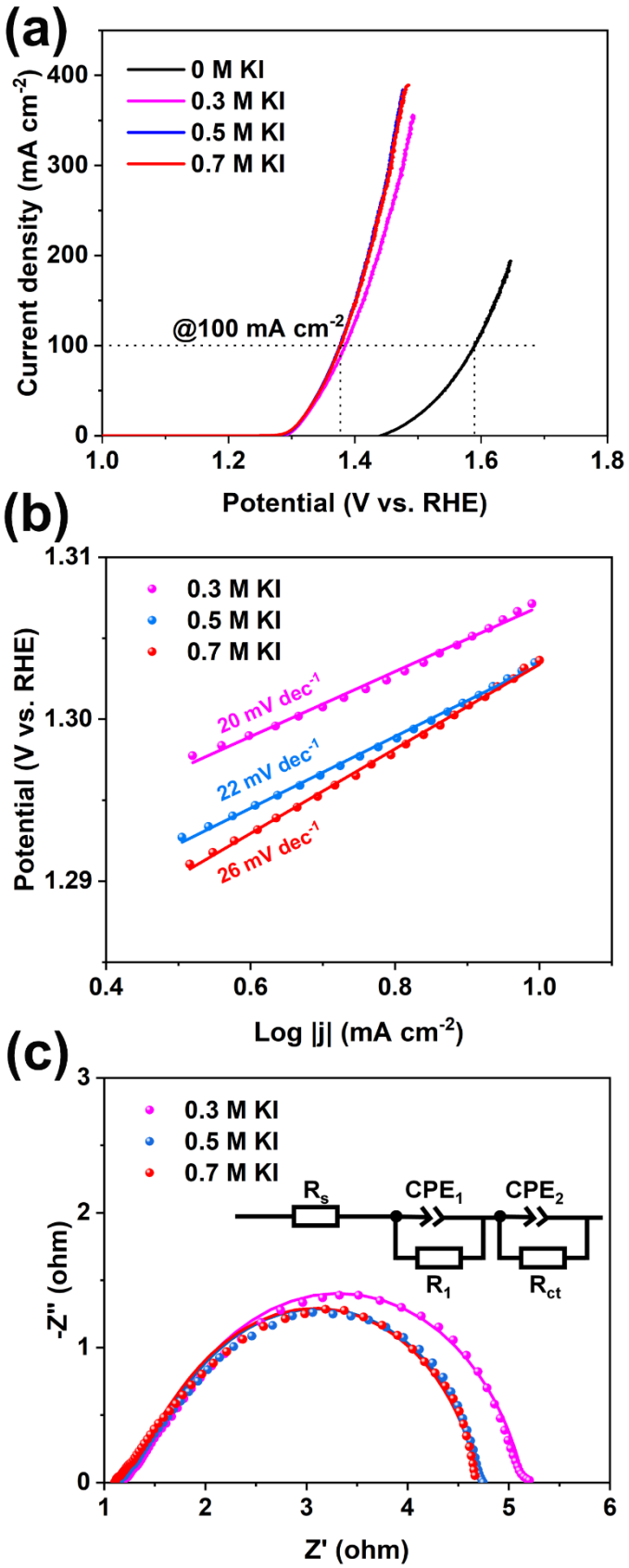

Fig. S11 (a) IOR polarization curves, (b) Tafel plots, and (c) Nyquist plots of the Se_{25}-NiTe/NF electrode recorded in simulated seawater electrolyte (1.0 M KOH + 0.5 M NaCl) in the presence of different molar concentrations of KI.

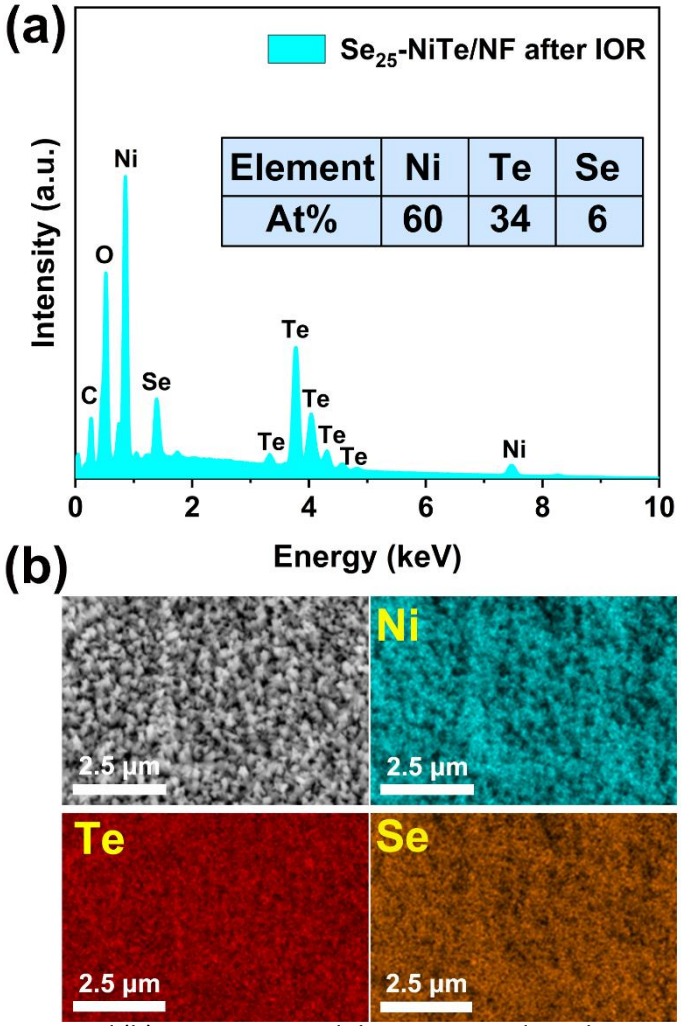

Fig. S12 (a) EDS spectra and (b) SEM image and the corresponding elemental maps of the Se_{25}-NiTe/NF electrode after the IOR stability test (100 mA cm^{-2} for 500 hours in 1.0 M KOH + 0.5 M NaCl + 0.5 M KI electrolyte).

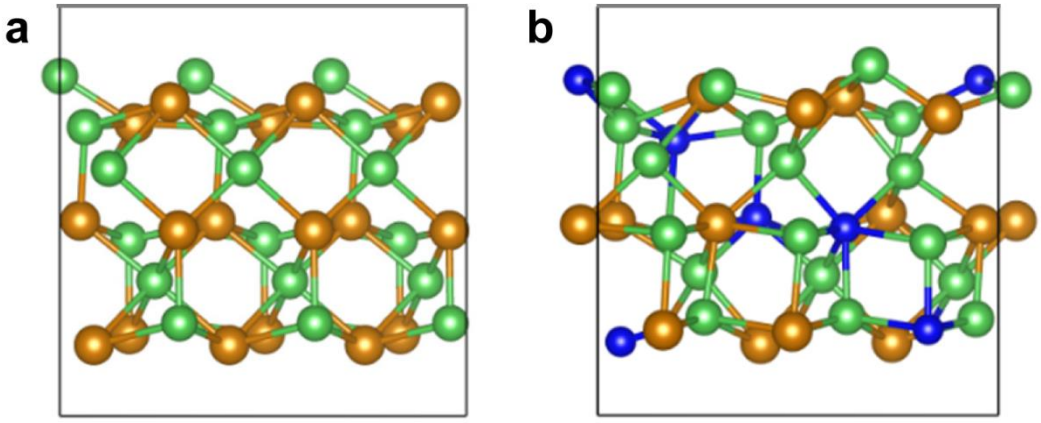

Fig. S13 Optimized configurations for (a) the NiTe and (b) the Se-NiTe catalyst. The green, brown and blue spheres represent Ni, Te and Se, respectively.

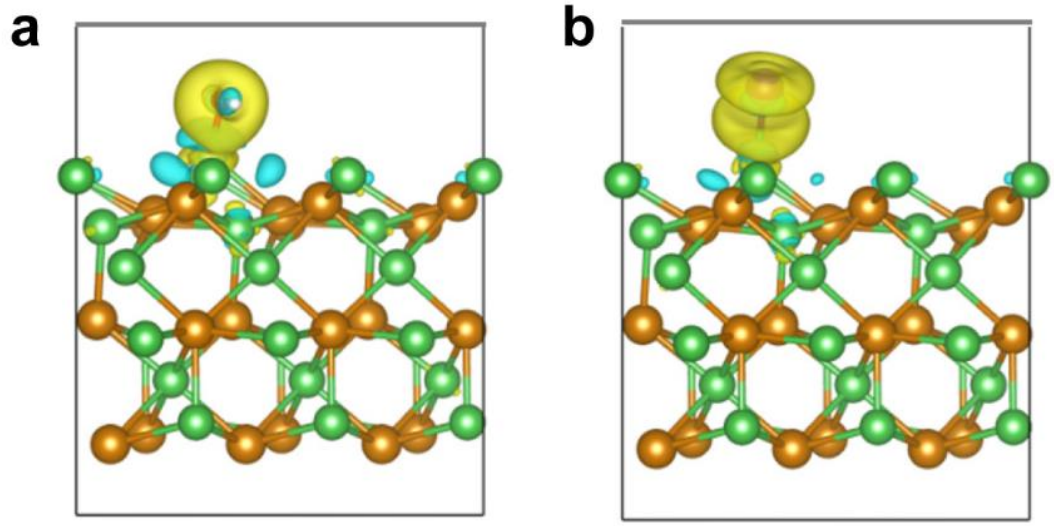

Fig. S14 The structural model and the corresponding charge density difference on pristine NiTe toward the (a) *OH and (b) I* adsorption. The green, brown, red, white and purple spheres represent Ni, Te, O, H and I, respectively. The yellow or cyan regions indicate the accumulation or depletion of the charges, respectively.

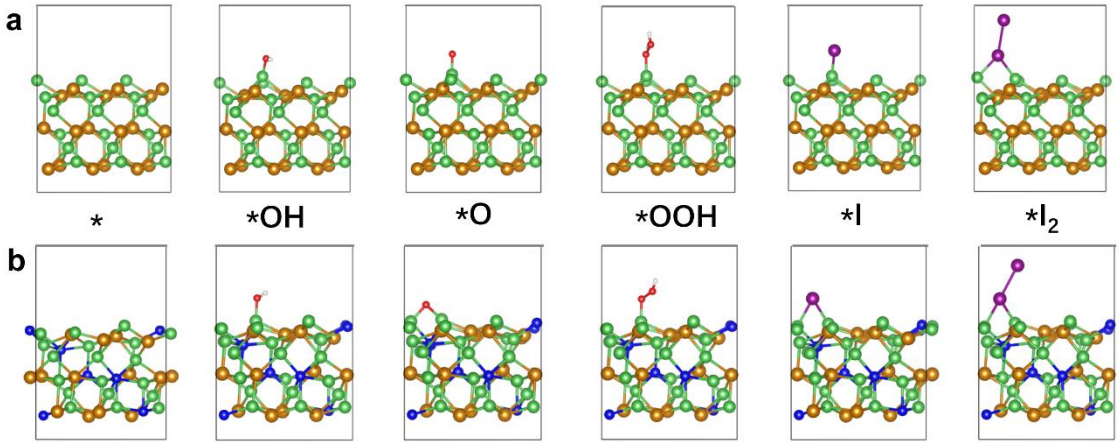

Fig. S15 The 3D configurations of (a) the NiTe and (b) the Se-NiTe catalyst during the OER and IOR. The green, brown, blue, red, white and purple spheres represent Ni, Te, Se, O, H and I, respectively.

Table S1. The fitting parameters of the EIS spectra of all samples under investigation.

Electrodes	R_s(Ω)	CPE_1	R_1 (Ω)	CPE_2	R_{ct} (Ω)	Electrolyte
Ni foam	1.43	0.00042	0.019	0.01	2.74	1.0 M KOH + 0.5 M NaCl
NiTe/NF	1.42	1.52	0.50	3.34	1.27	
Se_{25}-NiTe/NF	1.33	1.70	0.38	3.81	0.91	
Se_{50}-NiTe/NF	1.44	1.92	0.32	3.75	1.39	
Se_{75}-NiTe/NF	1.48	0.56	0.60	2.56	1.06	
Ni-Se/NF	1.34	0.96	0.44	0.53	1.48	
Ni foam	1.15	0.015	0.75	0.0037	4.21	1.0 M KOH + 0.5 M NaCl + 0.5 M KI
NiTe/NF	1.15	0.021	2.56	0.036	1.87	
Se_{25}-NiTe/NF	1.15	0.16	0.65	0.078	2.94	
Se_{25}-NiTe/NF	1.18	0.19	0.51	0.088	3.45	1.0 M KOH + 0.5 M NaCl + 0.3 M KI
Se_{25}-NiTe/NF	1.10	0.14	0.71	0.070	2.89	1.0 M KOH + 0.7 M NaCl + 0.7 M KI

Table S2. Comparison of the OER or SMOR performance of the Se_{25}-NiTe/NF electrode with that of other catalysts reported recently in the literature.

Catalysts/catalytic electrodes	Electrolyte	Potential @ 10 or 100 mA cm^{-2} (V vs. RHE)	Stability	References
Se_{25}-NiTe/NF	**1.0 M KOH + 0.5 M NaCl**	**1.47 @10 mA cm^{-2}**	**100 mA cm^{-2} for 200 hours**	**This work**
	1.0 M KOH + 0.5 M NaCl +0.5 M KI	**1.38 @100 cm^{-2}**	**100 mA cm^{-2} for 500 hours**	
NiMn-LDH	1.0 M KOH + 3 M CH_3OH	1.41 @100 cm^{-2}	\	S1
N-Co_9S_8/Ni_3S_2/NF	1.0 M KOH + 0.5 M $CO(NH_2)_2$	1.37 @100 cm^{-2}	20 mA cm^{-2} for 20 hours	S2
Ni_3N/Mo_2N	1.0 M KOH+ 0.33 M $CO(NH_2)_2$	1.36 @100 cm^{-2}	1.38 V for 40 hours	S3
$Ni(OH)_2$/NF	1.0 M KOH + 0.5 M CH_3OH	1.36 @100 cm^{-2}	\	S4
V_8C_7/CoP-0.18	1.0 M KOH+ 0.33 M $CO(NH_2)_2$	1.67 @100 cm^{-2}	10 mA cm^{-2} for 20 hours	S5
Ni-Mo-N/CFC	1.0 M KOH + 0.1 M $C_3H_5(OH)_3$	1.51 @100 cm^{-2}	\	S6
Fe-NiO/NiS_2	1.0 M KOH	1.50 @10 mA cm^{-2}	10 mA cm^{-2} for 100 hours	S7
CoO@S-CoTe	1.0 M KOH	1.476 @10 mA cm^{-2}	50 mA cm^{-2} for 36 hours	S8
Ni_2P-CoCH/CFP	1.0 M KOH	1.50 @10 mA cm^{-2}	20 mA cm^{-2} for 50 hours	S9

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