Supporting Information

Multivalent cation-modified Ni_xS_y for highly efficient and stable oxygen evolution electrocatalysis

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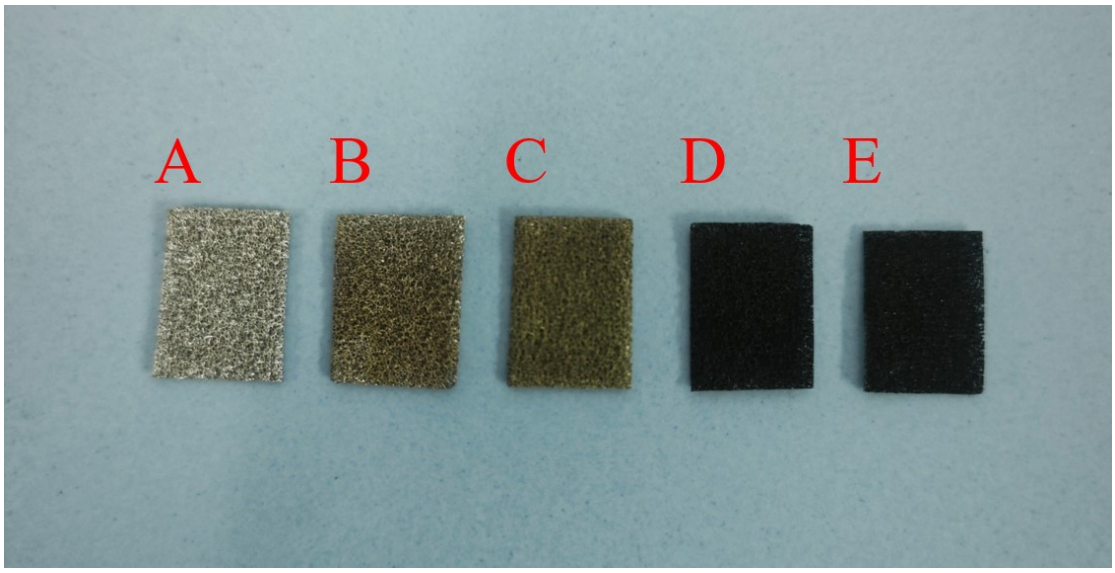

Fig. S1 Photograph of (A) bare Ni foam (B) NiFe-LDHs (C) NiFeV-LDHs (D) (Ni, Fe)$_3$S$_4$-NiS and (E) (Ni, Fe, V)$_3$S$_4$-NiS.

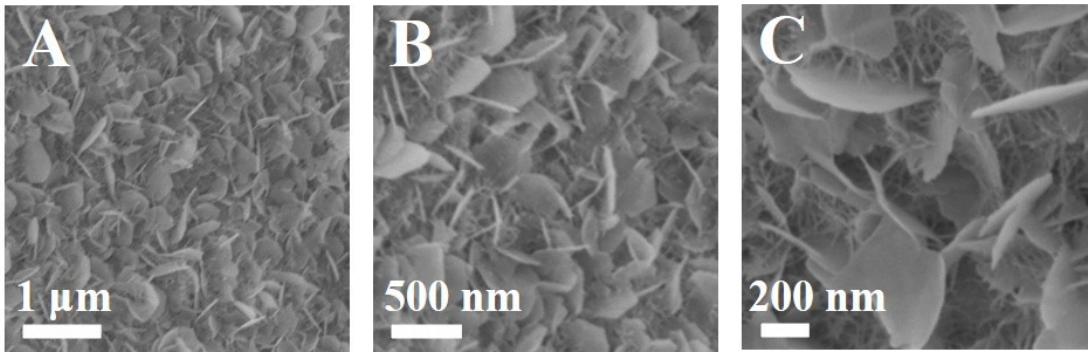

Fig. S2 SEM images of NiFe-LDHs.

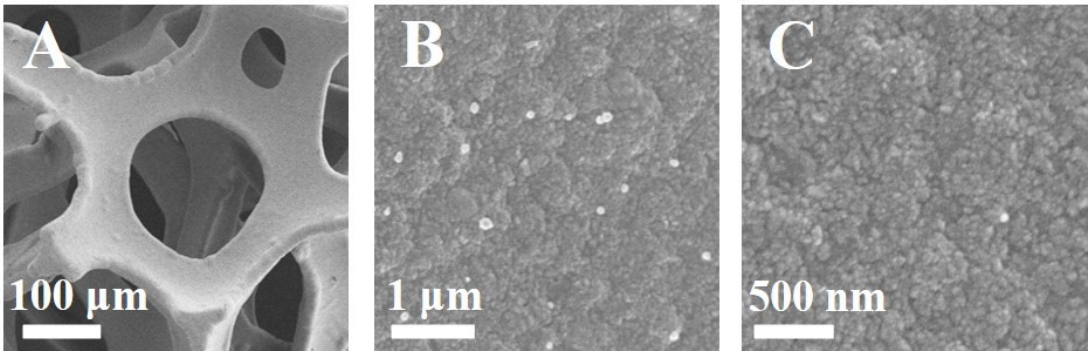

Fig. S3 SEM images of (Ni, Fe)$_3$S$_4$-NiS.

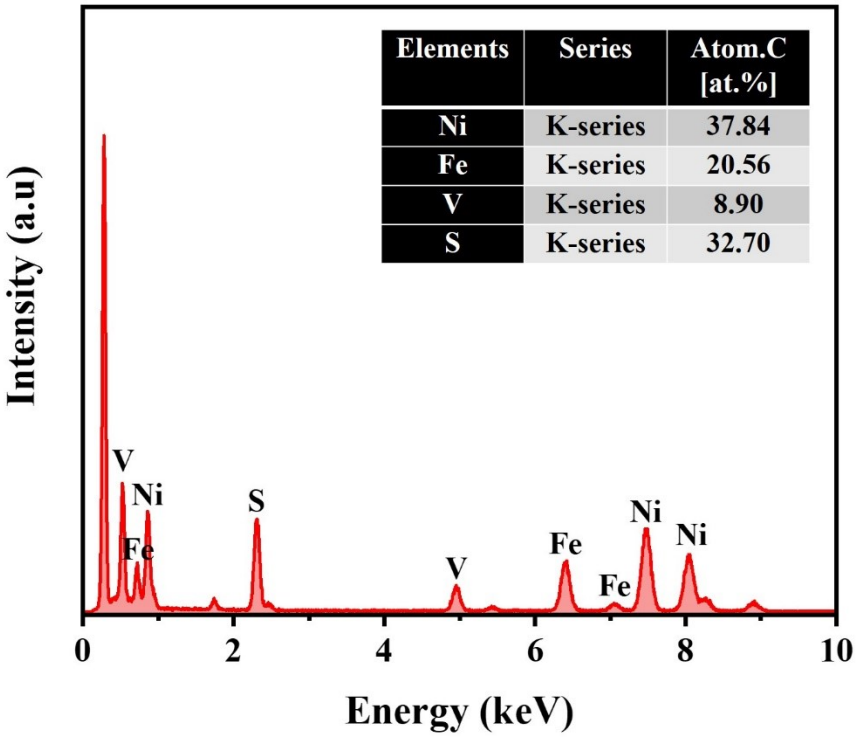

Fig. S4 EDS pattern of $(Ni, Fe, V)_3S_4$-NiS.

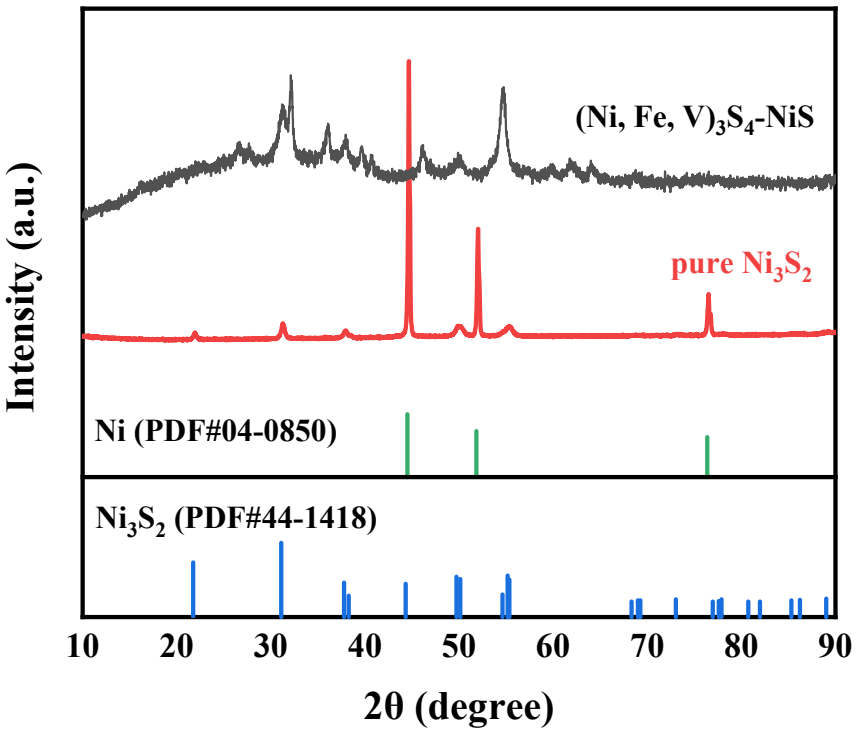

Fig. S5 XRD pattern of (Ni, Fe, V)$_3$S$_4$-NiS and pure Ni_3S_2.

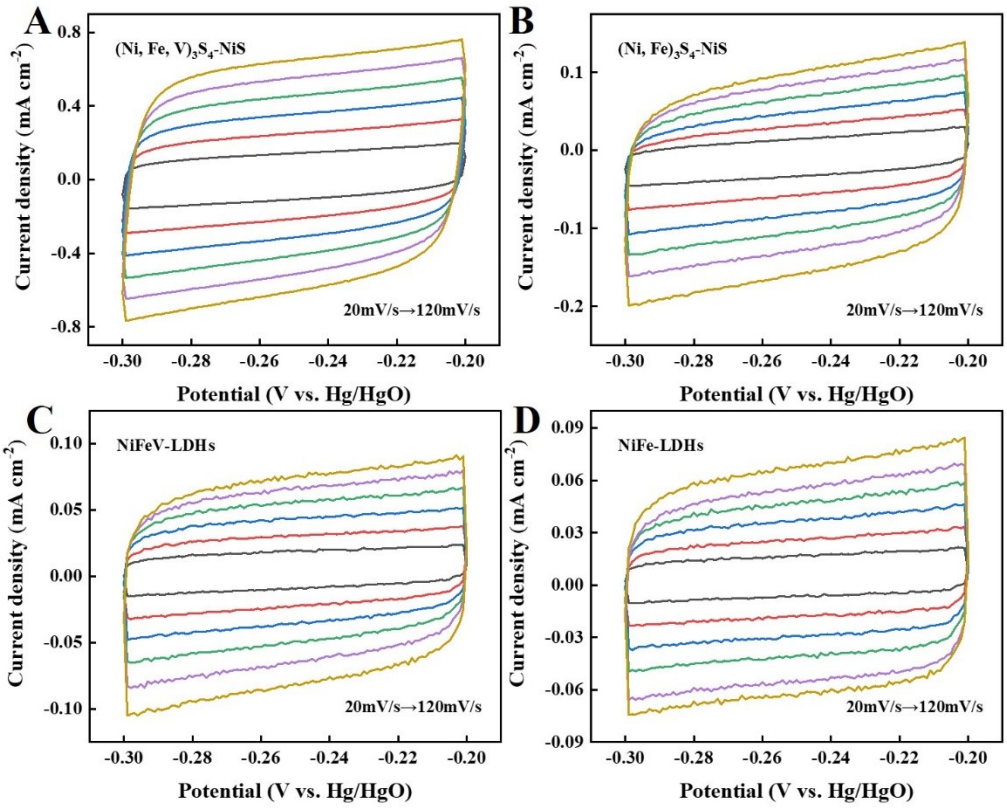

Fig. S6 Cyclic voltammetry curves of (Ni, Fe, V)$_3$S$_4$-NiS (A), (Ni, Fe)$_3$S$_4$-NiS (B), NiFeV-LDHs (C) and NiFe-LDHs (D) at various scan rates in the region of 0.2-0.3 V vs. Hg/HgO.

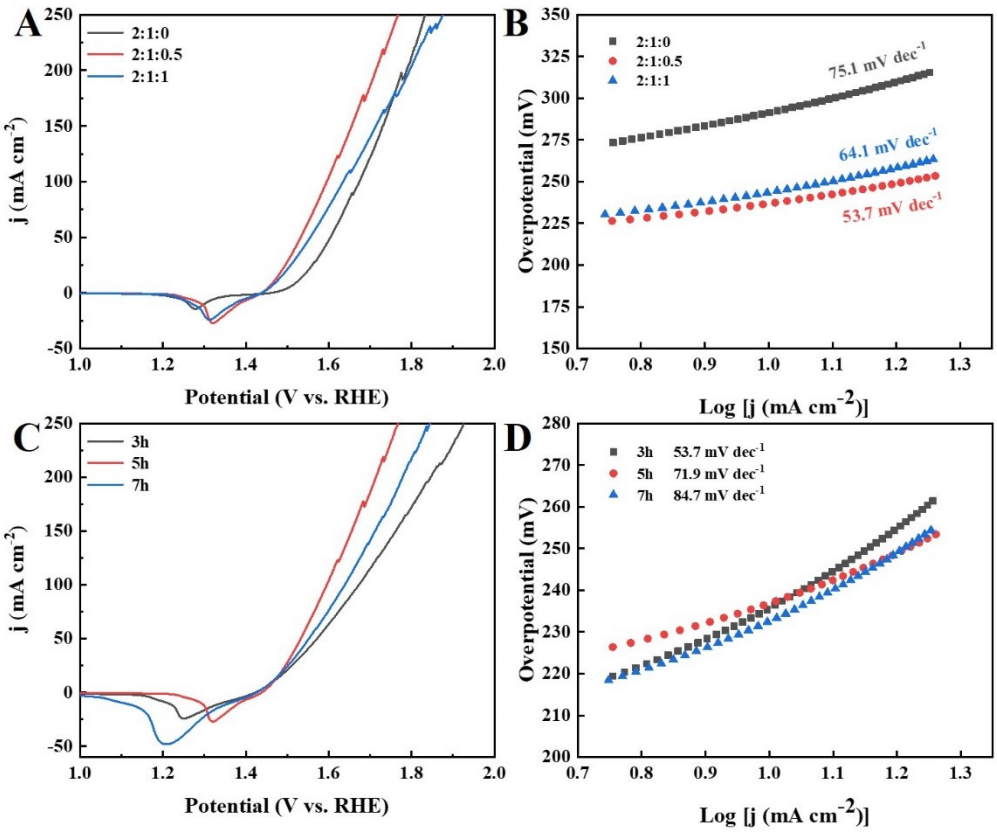

Fig. S7 (A) Polarization curves of samples with different vulcanization ratios of Ni: Fe: V, (B) The corresponding Tafel plots of the catalysts, (C) Polarization curves of samples with different vulcanization times and (D) The corresponding Tafel plots of the catalysts.

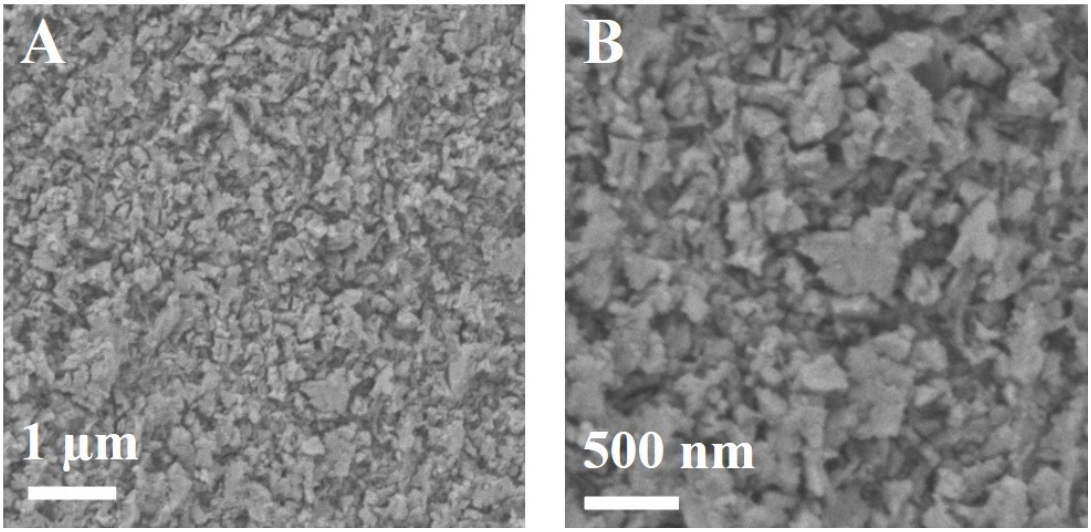

Fig. S8 SEM images of (Ni, Fe, V)$_3$S$_4$-NiS prepared by overvulcanization.

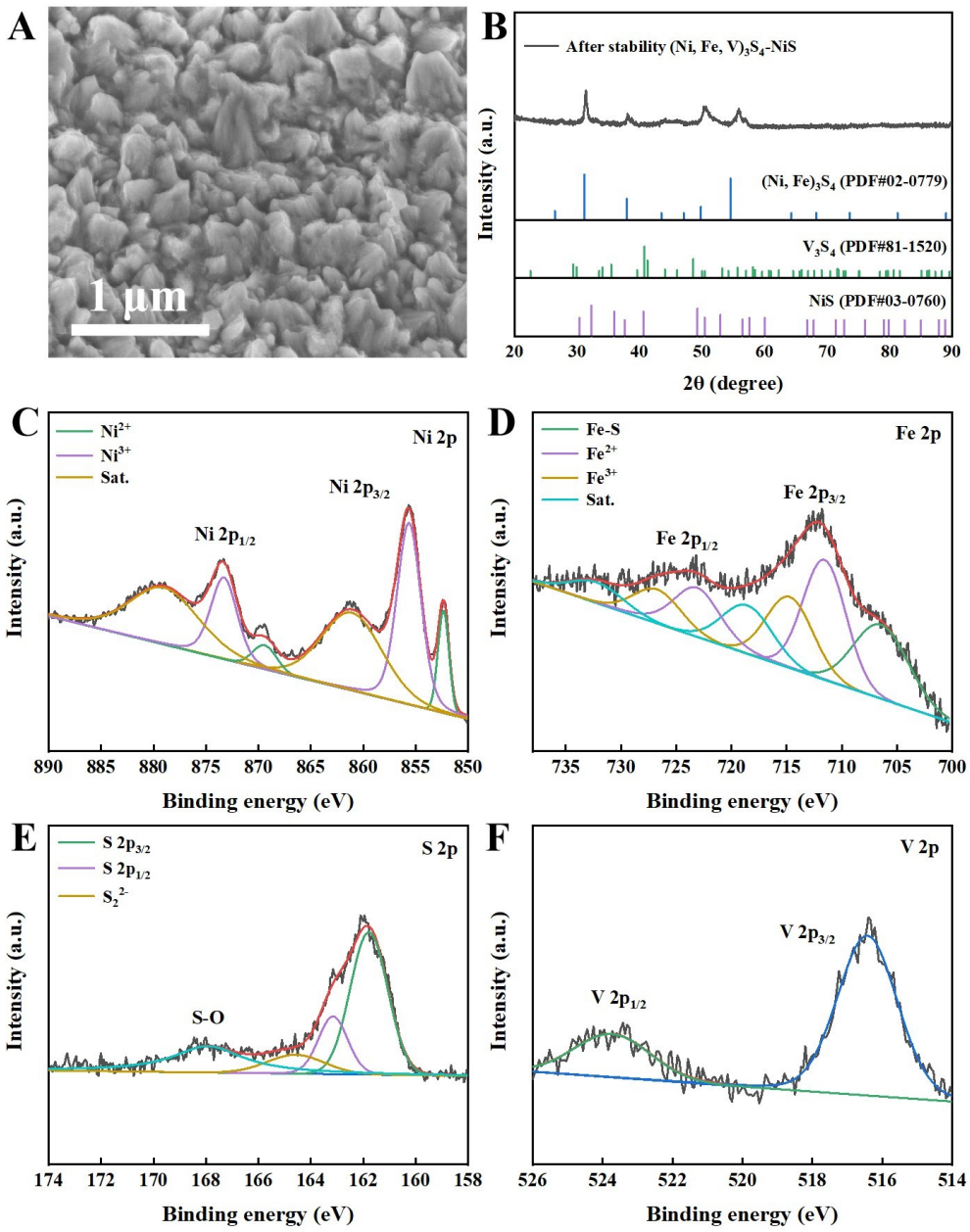

Fig. S9 Characterization of (Ni, Fe, V)$_3$S$_4$-NiS catalysts after stabilization: (A) SEM, (B) XRD and (C-F) XPS.

Table. S1 Comparison of the electrocatalytic OER performance of the (Ni, Fe, V)$_3$S$_4$-NiS with other non-noble-metal catalysts recently reported in alkaline solutions.

Catalyst	Electrolyte	η10 (mV)	Ref.
(Ni, Fe, V)$_3$S$_4$-NiS	1M KOH	236	This work
NiCo$_2$S$_4$@NiFe LDH	1M KOH	287	[1]
FeCoNi-LDH	1M KOH	299	[2]
CoS-Co(OH)$_2$@aMoS$_{2+x}$	1M KOH	380	[3]
Mo$_{(1-x)}$W$_x$S$_2$	1M KOH	285	[4]
CdS/Ni$_3$S$_2$	1M KOH	280	[5]
Ni$_3$S$_4$/NF	1M KOH	266	[6]
NiSe$_2$-CoSe$_2$/CFC	1M KOH	286	[7]
FeNi$_2$S$_4$ NPs/rGO	1M KOH	250	[8]
pc-Ni$_3$S$_2$@CNF	1M KOH	270	[9]
NiS$_2$@NS	1M KOH	290	[10]
NM50-Ni$_3$S$_4$	1M KOH	257	[11]
NiCu-LDH	1M KOH	290	[12]
Co$_3$O$_4$/Co-Fe	1M KOH	297	[13]
Ni$_{65}$Fe$_{35}$(OOH)	1M KOH	316	[14]
Co$_2$Fe-P	1M KOH	303	[15]
CoMnV-LDH	1M KOH	270	[16]

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