Electronic Supplementary Information (ESI)

Amorphous cobalt-nickel borides boost electrocatalytic ethanol oxidation coupled with energy-saving hydrogen production

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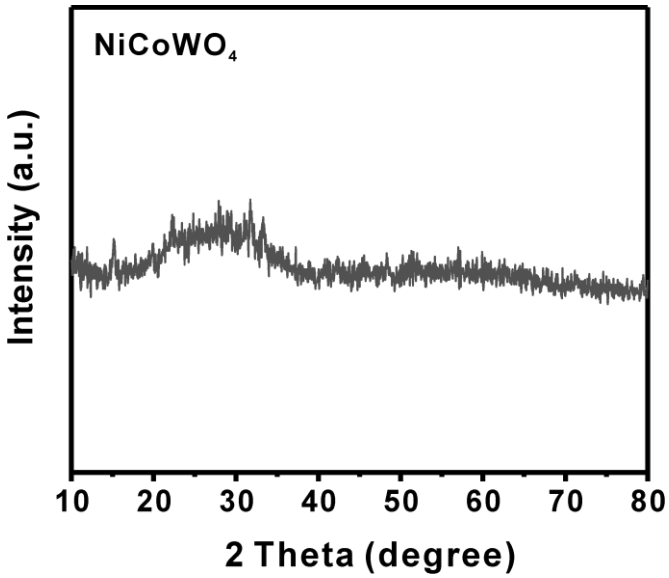

Figure S1. XRD pattern of $NiCoWO_4$.

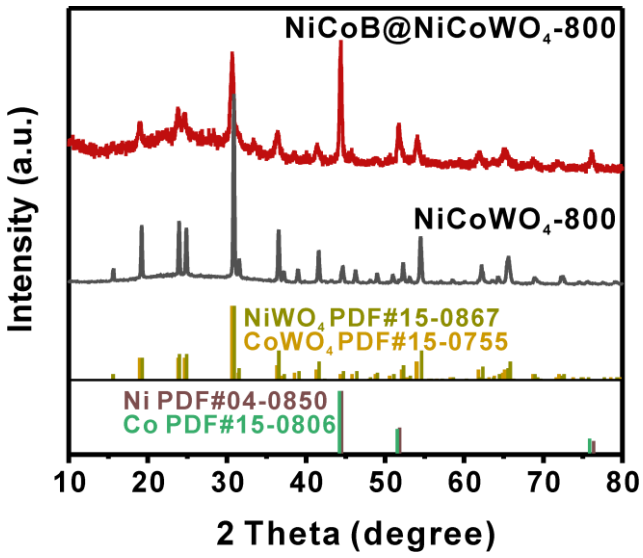

Figure S2. XRD pattern of (a) NiCoB@$NiCoWO_4$-800, (b) $NiCoWO_4$-800.

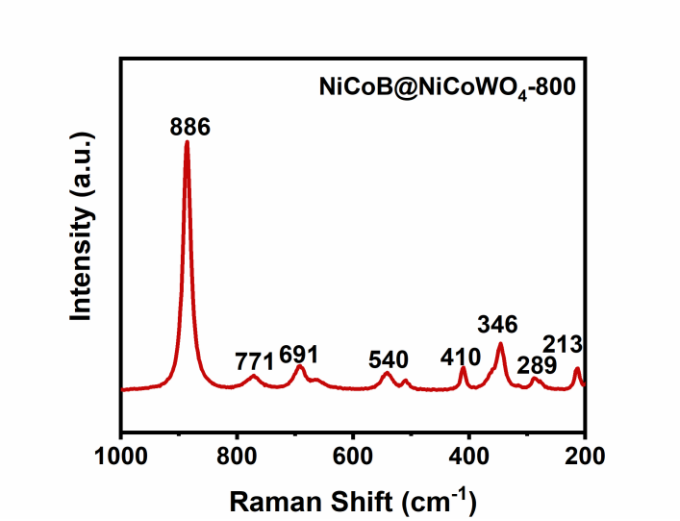

Figure S3. Raman pattern of NiCoB@$NiCoWO_4$-800.

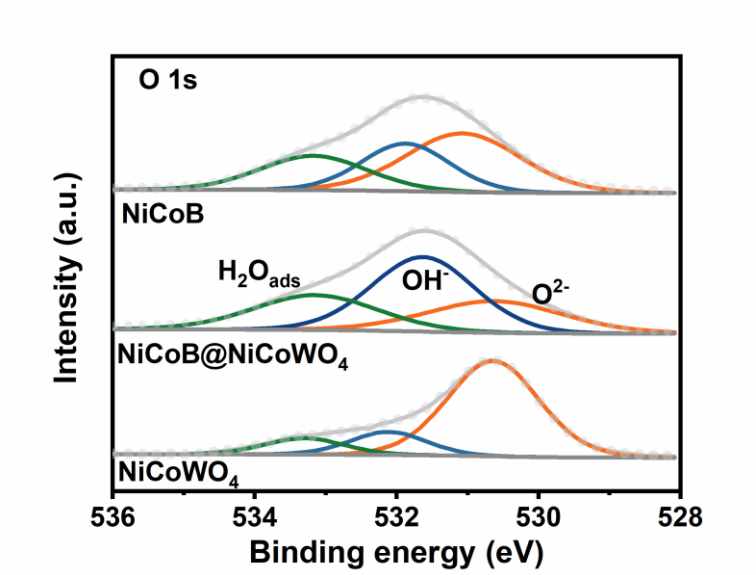

Figure S4. O 1s for the as-prepared catalysts

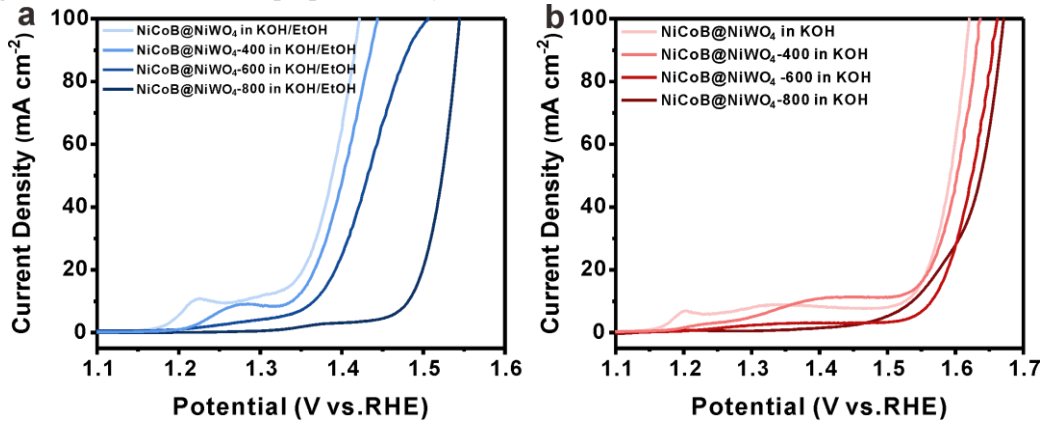

Figure S5. LSV curve of NiB@$NiCoWO_4$, NiB@$NiCoWO_4$-400, NiB@$NiCoWO_4$-600 and NiB@$NiCoWO_4$-800.

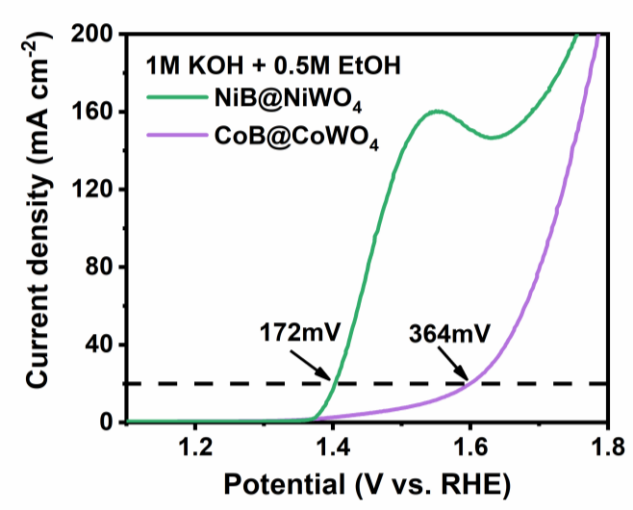

Figure S6. LSV curve of NiB@NiCoWO$_4$ and CoB@CoWO$_4$ in 1M KOH with 0.5M EtOH.

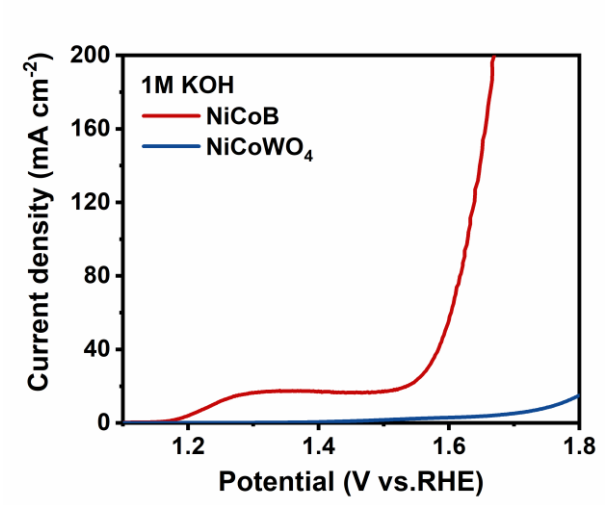

Figure S7. LSV curve of NiCoB and NiCoWO$_4$ in 1M KOH.

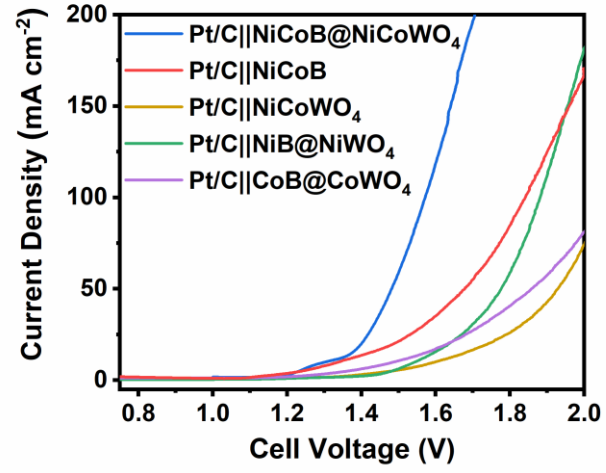

Figure S8. LSV curves of the ethanol–water electrolysis employed different electrodes.

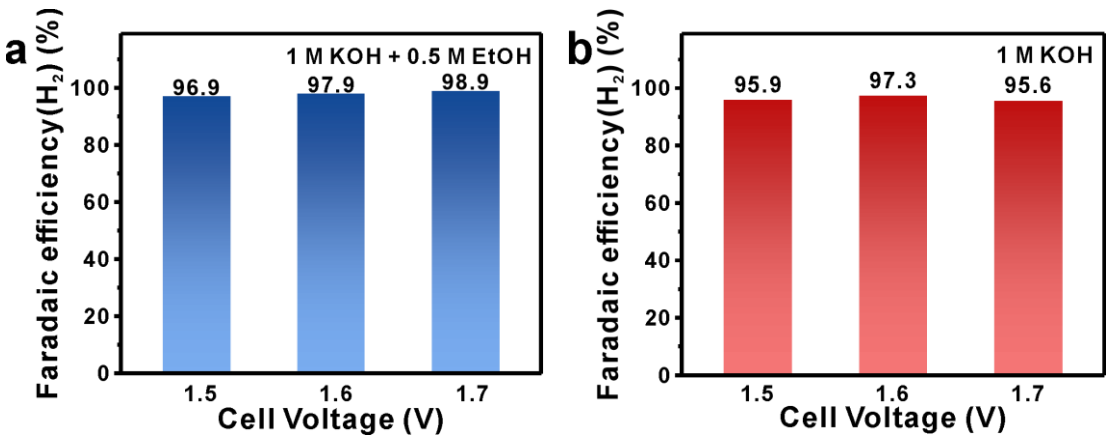

Figure S9. Faradaic efficiencies of H_2 generation at different potentials in KOH.

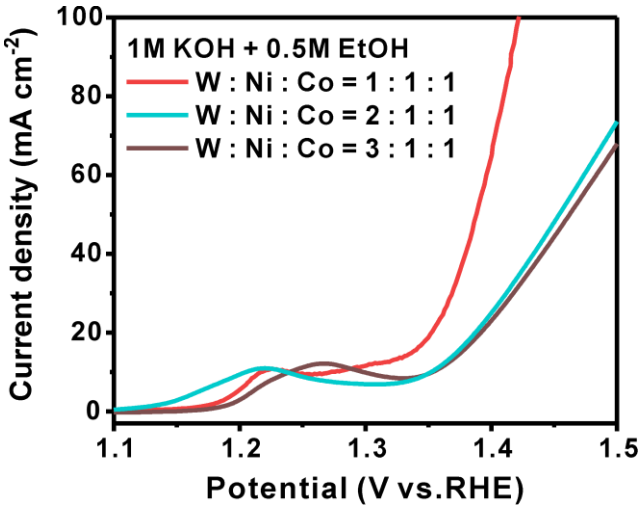

Figure S10. LSV curves of the NiCoB@$NiCoWO_4$ with different metal ratio.

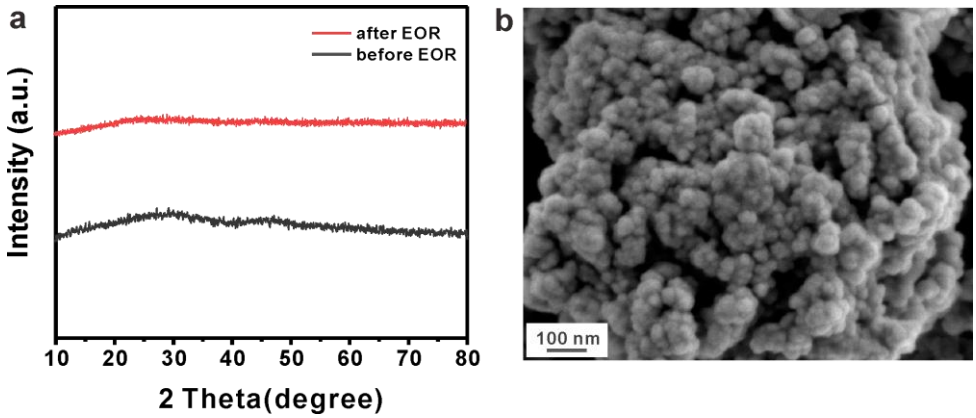

Figure S11. Characterization of the NiCoB@$NiCoWO_4$ after electrochemical reactions. (a) XRD pattern, (b) SEM image.

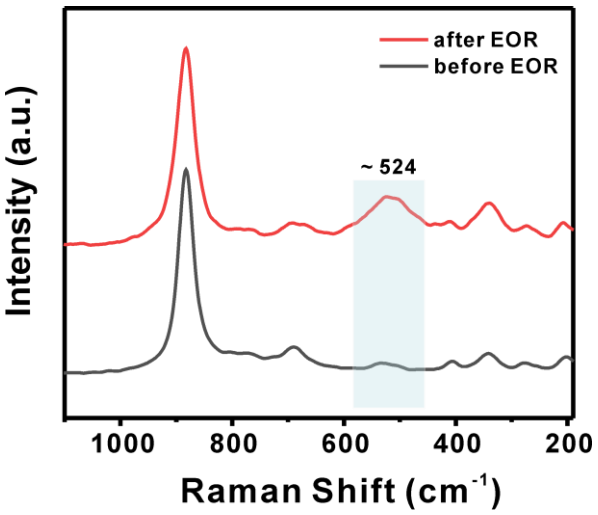

Figure S12. The Raman spectra of the NiCoB@$NiCoWO_4$ before and after electrochemical reactions.

Table S1. Comparison of electrocatalytic ethanol oxidation properties of the actual material with other selected catalysts reported in the previous literature.

Catalysts	Electrolyte	E (vs.RHE)	Ref.
NiCoB@NiCoWO4	1.0 M KOH + 0.5 M Ethanol	1.35V@20mA cm^{-2}	This work
Co-S-P/CC	M KOH + 1.0 M ethanol	1.38@10mA cm^{-2}	1
Perforated CoNi hydroxide nanosheets	1.0 M KOH + 1.0 M ethanol	1.39@10mA cm^{-2}	2
Co3O4 nanocubes	1.0 M NaOH + 1.0 M ethanol	1.55@10mA cm^{-2}	3
Ni3Fe/NiFe(OH)x	1.0 M KOH + 1.0 M ethanol	1.41@10mA cm^{-2}	4
aFe-NiB	1.0 M NaOH + 0.5 M urea	1.298@10mA cm^{-2}	5
Co(OH)2@HOS/CP	1.0M KOH + 3M methanol	1.385@10mA cm^{-2}	6
CoCu-bi-metal-organic framework	1.0M KOH + 3M methanol	1.365@10mA cm^{-2}	7

Table S2. Peak assignments for the IR spectra shown in Fig. 7b

Wave number (cm^{-1})	mode	Reference
1749	C=O stretching in CH_3CHO and CH_3COOH in solution	8-10
1620	C=O stretching of adsorbed acetaldehyde and acetyl	9
1520	O-C-O asymmetric stretching of acetate in solution	11
1457	O-C-O symmetric stretching in acetate	9, 11
1394	CH in-plane bending mode of adsorbed acetate/ acetate in solution	9, 11, 12
1277	C-O stretching in CH_3COOH	8, 9, 13

Notes and references

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