Boosting alkaline hydrogen evolution performance of Co_4N porous nanowires by interface engineering of CeO_2 tuning

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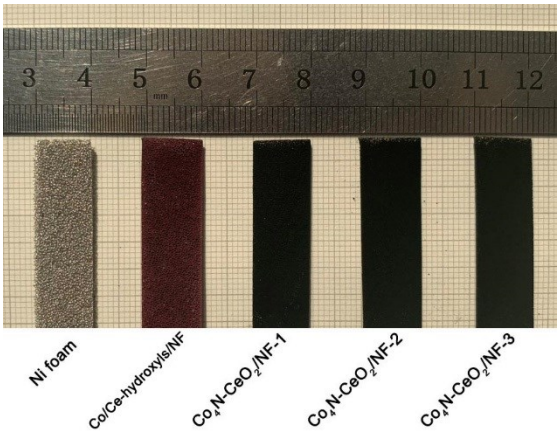

Figure S1. Optical pictures of as-prepared samples.

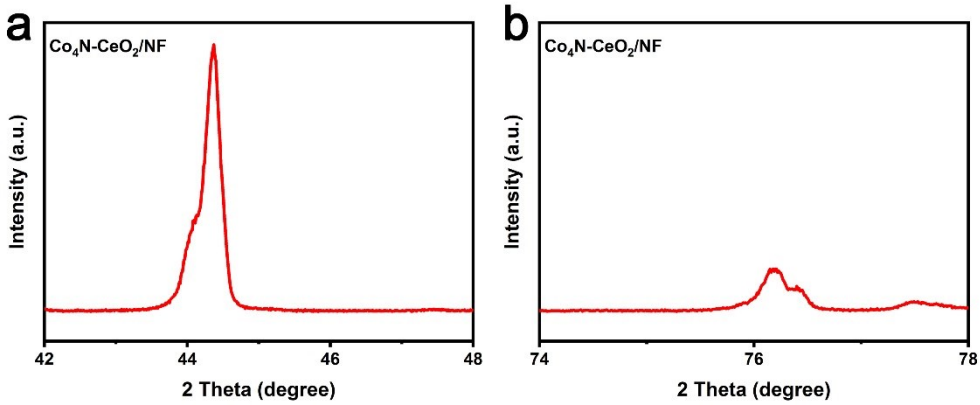

Figure S2. The enlarged XRD patterns of the CO_4N-CeO_2/NF.

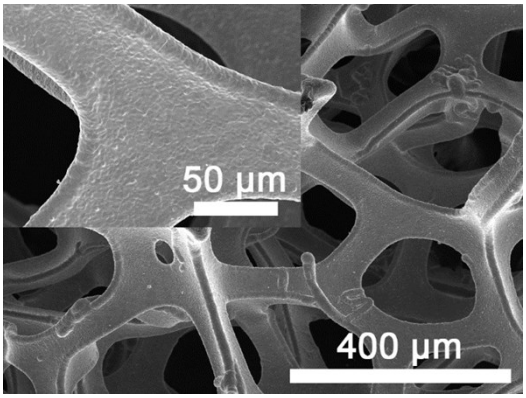

Figure S3. Typical SEM images of the starting Ni foam.

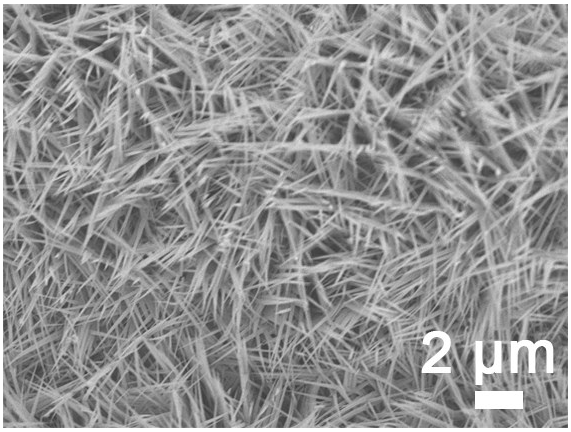

Figure S4. SEM image of Co_3O_4-CeO_2/NF nanowires on Ni foam.

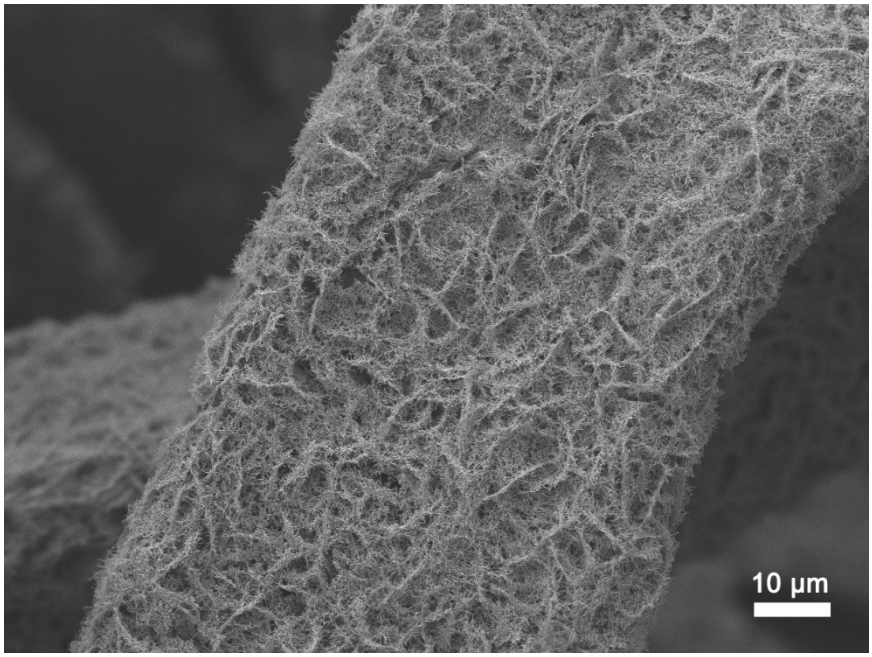

Figure S5. The low-resolution SEM image of Co_4N-CeO_2/NF-2 nanoarrays on Ni foam

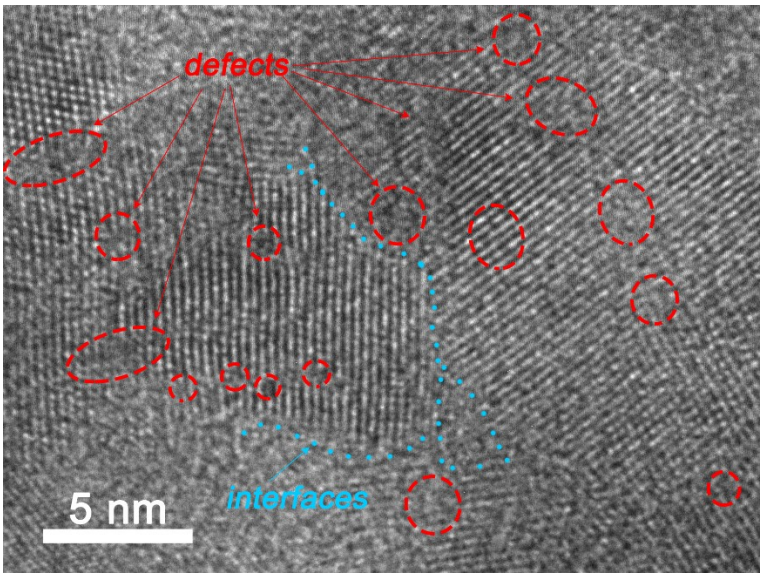

Figure S6. HRTEM images of Co_4N-CeO_2/NF.

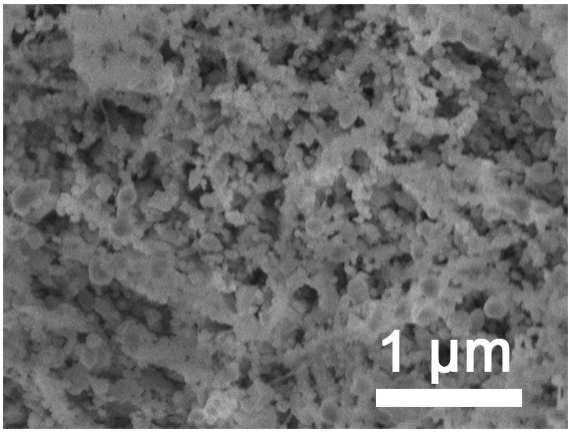

Figure S7. SEM image of pure Co_4N on Ni foam.

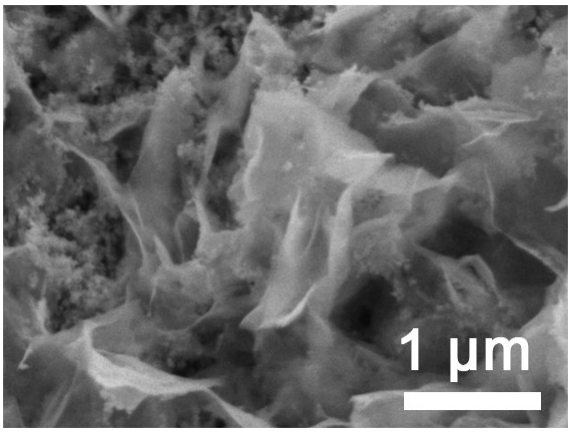

Figure S8. SEM images of pure CeO_2 on Ni foam.

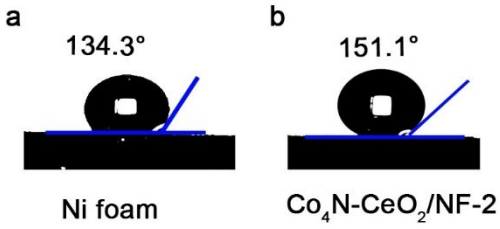

Figure S9. Digtial images of air bubbles on (a) blank Ni foam and (b) Co_4N-CeO_2/NF-2.

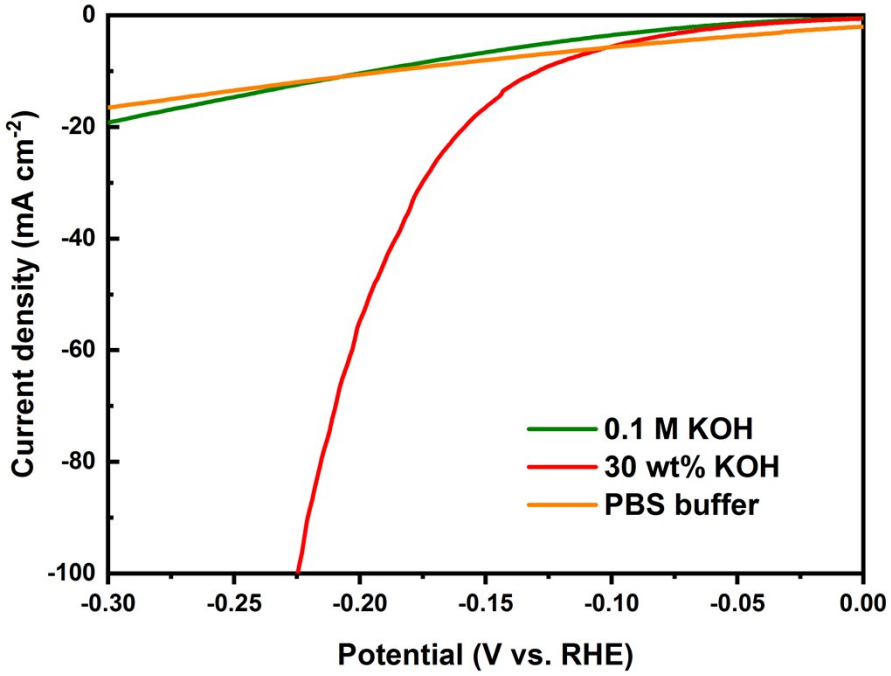

Figure S10. HER polarization curves of Co_4N-CeO_2/NF-2 electrodes in different electrolyte of 0.1 M KOH, 30 wt% KOH and PBS buffer solution.

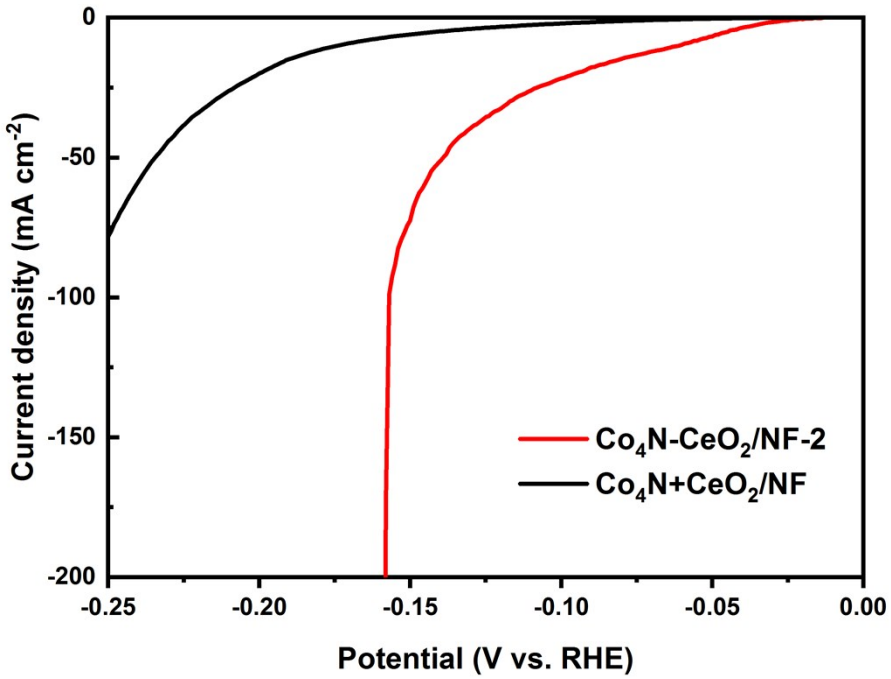

Figure S11. HER polarization curves of the Co_4N-CeO_2/NF-2 electrode compared to the physical mixture of Co_4N and CeO2 casted on the Ni foam.

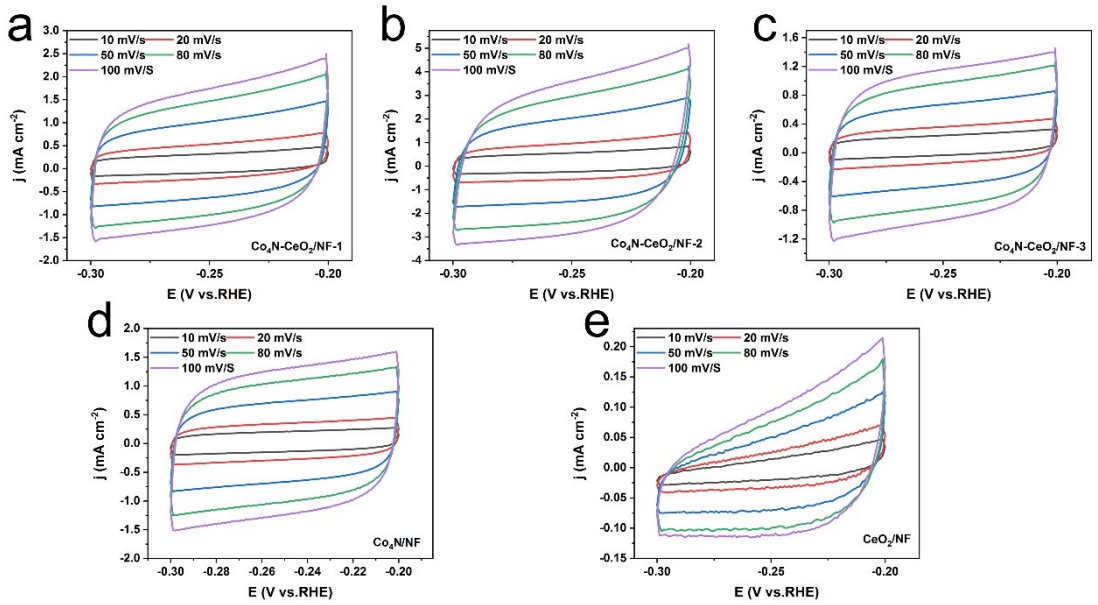

Figure S12. Typical cyclic voltammograms at different scan rates. (a) Co_4N-CeO_2/NF-1, (b) Co_4N-CeO_2/NF-2, (c) Co_4N-CeO_2/NF-3, (d) Co_4N/NF and (e) CeO_2/NF with scan rates ranging from 10 mV/s to 100 mV/s.

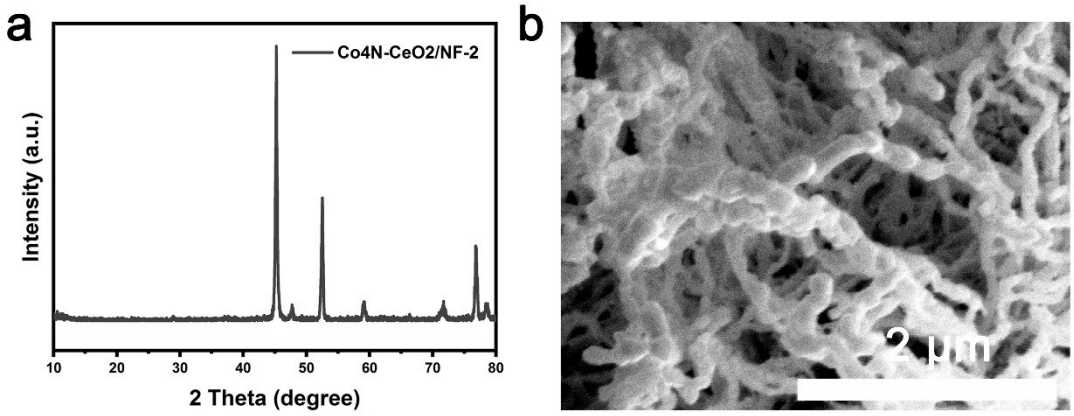

Figure S13. Characterizations after the HER stability test. (a) The XRD pattern and (b) SEM image of Co_4N-CeO_2/NF-2 after HER stability test.

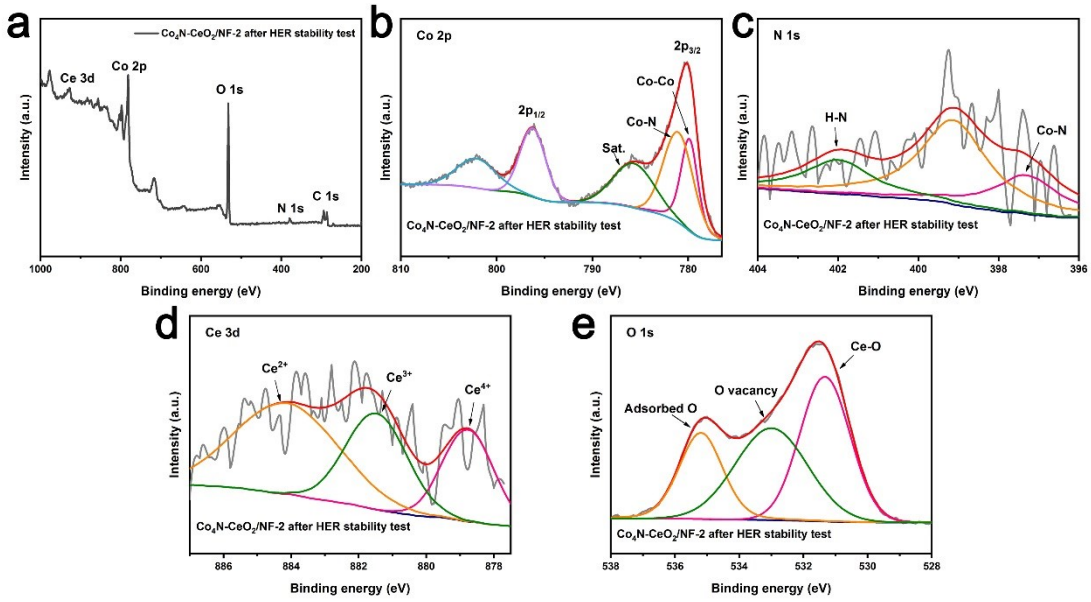

Figure S14. XPS spectra of (a) survey, (b) Co 2p, (C) N 1s, (d) Ce 3d, and (e) O 1s for the Co_4N-CeO_2/NF-2 electrode after HER stability test.

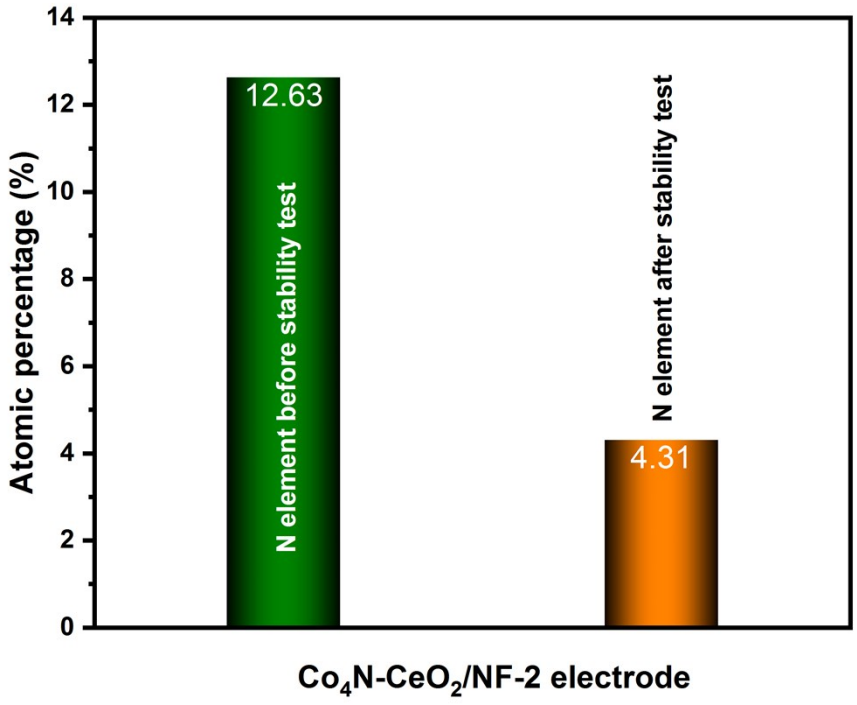

Figure S15. The atomic percentage of N element before and after HER stability test.

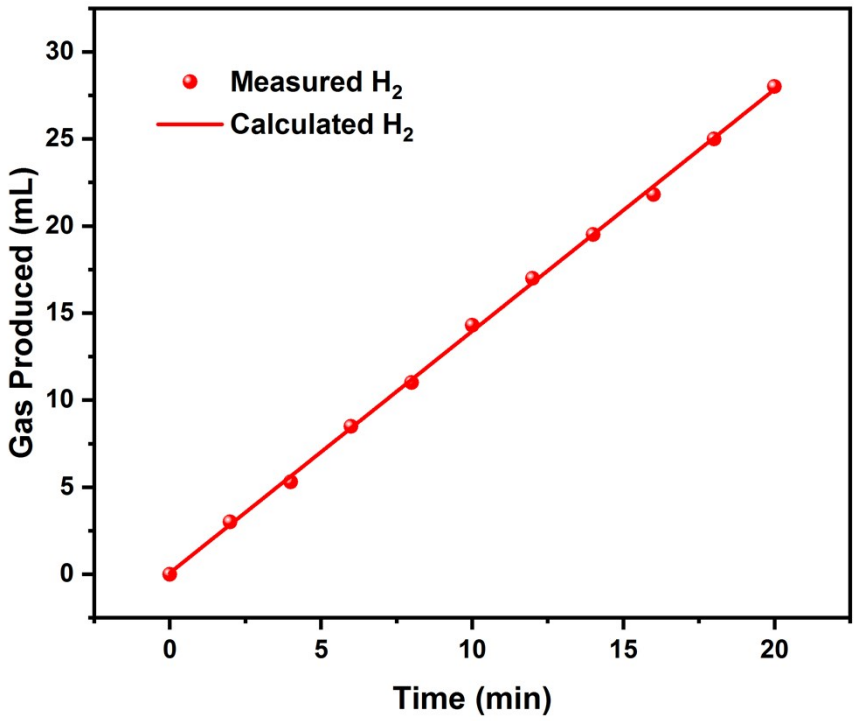

Figure S16. Experimental and theoretical calculated amount of the evolved H_2 over the Co_4N-CeO_2/NF-2 electrode at a constant current density of 200 mA cm^{-2} in 1.0 M KOH electrolyte.

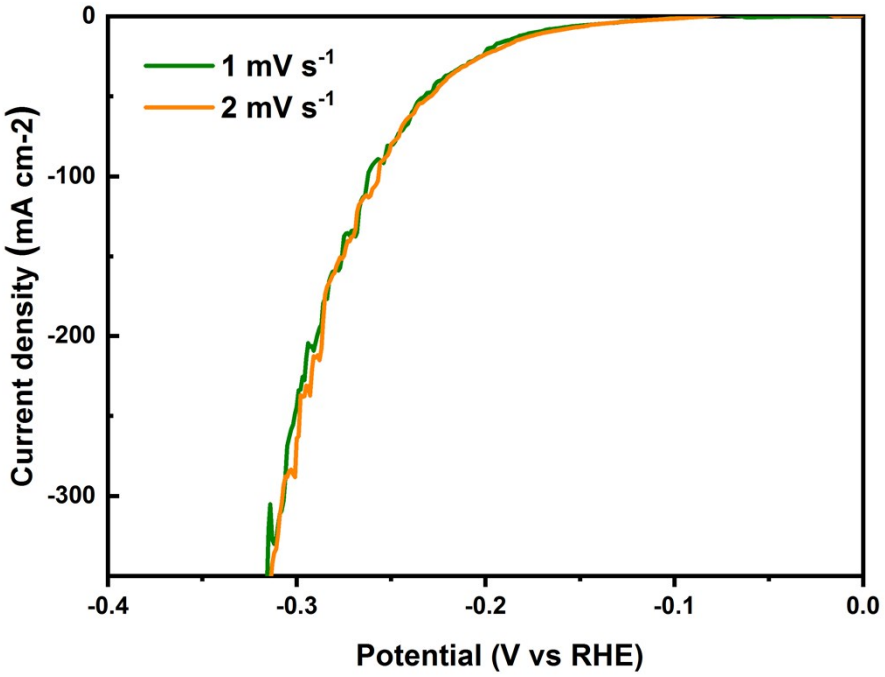

Figure S17. The HER polarization curves without *iR*-correction of the Co_4N-CeO_2/NF-2 different sweep speeds.

Table S1. Comparison of the electrocatalytic HER activity for Co_4N-CeO_2/NF and reported catalysts in 1.0 M KOH electrolyte.

Catalysts	Substrate	$n_{j=10}$ (mV)	b (mV dec^{-1})	Refs
Ni/CeO_2	CNT	91	----	S1
CoN/Ni_3N	Carbon cloth	68	69	S2
Cu_4N/Ni_3N	Carbon cloth	71.4	106.5	S3
Mo_2N/Mo_2C	GC	152	68	S4
CoP/NiCoP	Ti foil	133	88	S5
Co_3O_4-CeO_2	Carbon cloth	90	57.8	S6
NF@NiFe LDH/CeO_x	Ni foam	154	101	S7
Ni_3N-CeO_2	Ti mesh	80	122	S8
Co_4N-CeO_2	Ni foam	52	56.8	This work

Table S2. Comparison of the electrocatalytic HER activity for Co_4N-CeO_2/NF and reported catalysts at high current density of 50 or 100 mA cm^{-2} in 1.0 M KOH electrolyte.

Catalysts	**Substrate**	**$\eta_{j=50/100}$ (mV)**	**Refs**
Ni_3S_2/MnO_2	Ni foam	η_{100}=197	S9
NiFe LDH@Ni_3N	Ni foam	η_{100}=142	S10
$Ni_xCo_{3-x}S_4/Ni_3S_2$	Ni foam	η_{100}=258	S11
Co-doped CeO_2	Cu foam	η_{100}=132	S12
CeO_2-Cu_3P	Ni foam	η_{50}=228	S13
NiFe LDH/CeO_x	Ni foam	η_{100}=267	S14
Sn-Ni_3S_2	Ni foam	η_{100}=171	S15
CoNi/$CoFe_2O_4$	Ni foam	η_{100}=189	S16
Co_4N-CeO_2	Ni foam	η_{100}=149	This work

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