Supporting Information

High-Entropy CoNiFeCuP Nanoparticles as Efficient and Durable Catalysts for Alkaline Oxygen Evolution Reactions

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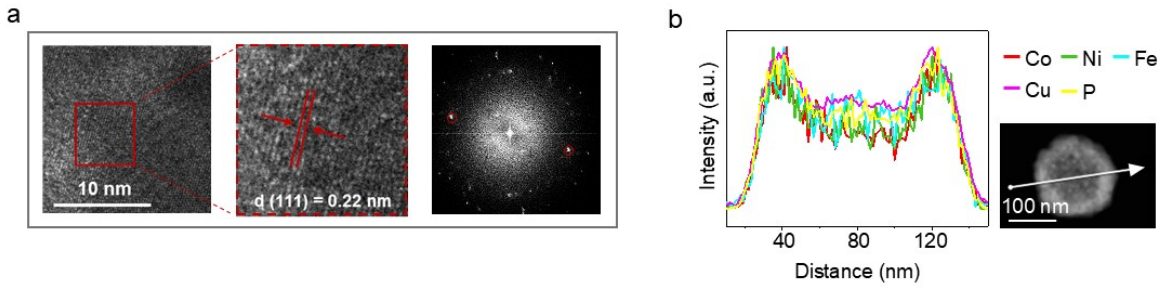

Figure S1. (a) HRTEM image and corresponding FFT patterns of CoNiFeCuP, showing the (111) plane of CoNiP. (b) EDS line-scan profile of CoNiFeCuP NPs, acquired along the arrow marked in the TEM image.

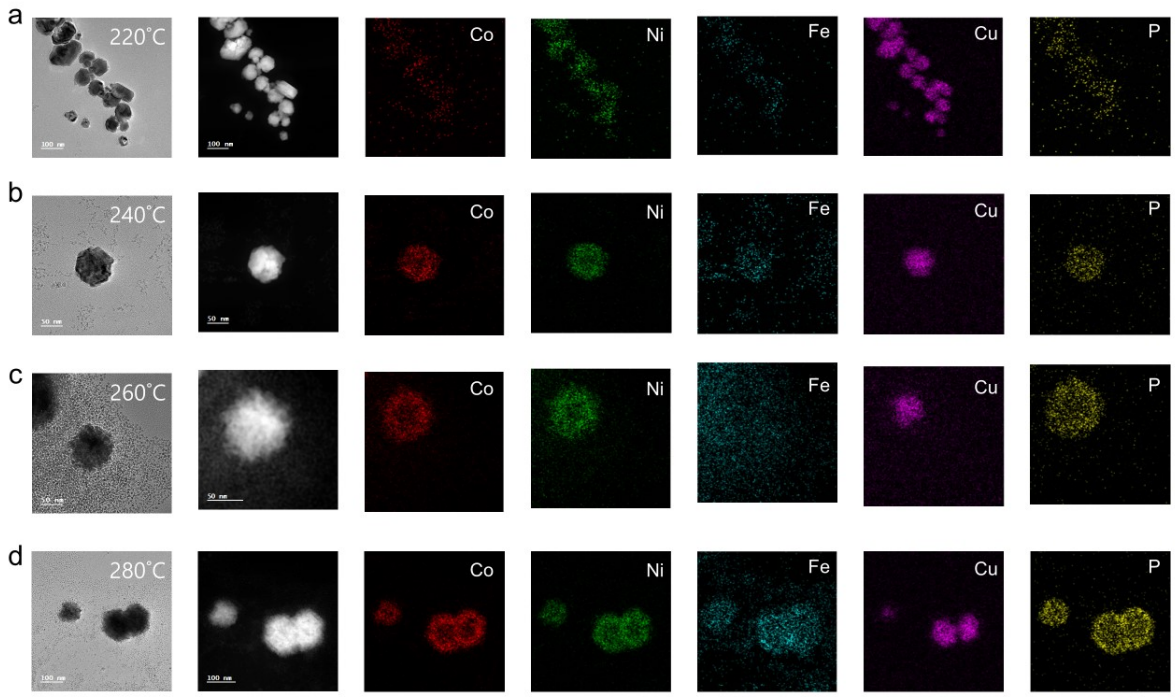

Figure S2. TEM and TEM-EDS mapping images of CoNiFeCuP at different reaction temperatures: (a) 220, (b) 240, (c) 260, and (d) 280 °C.

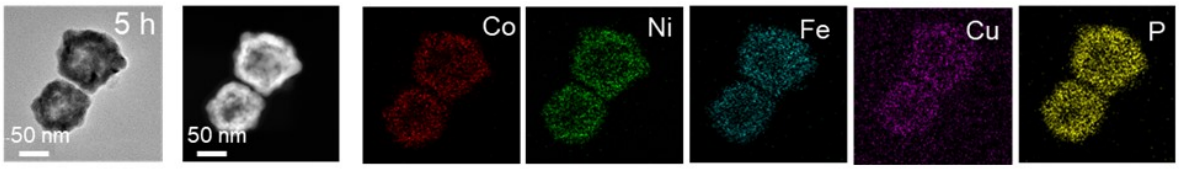

Figure S3. TEM, STEM, and TEM-EDS mapping images of CoNiFeCuP NPs after 5 h of reaction.

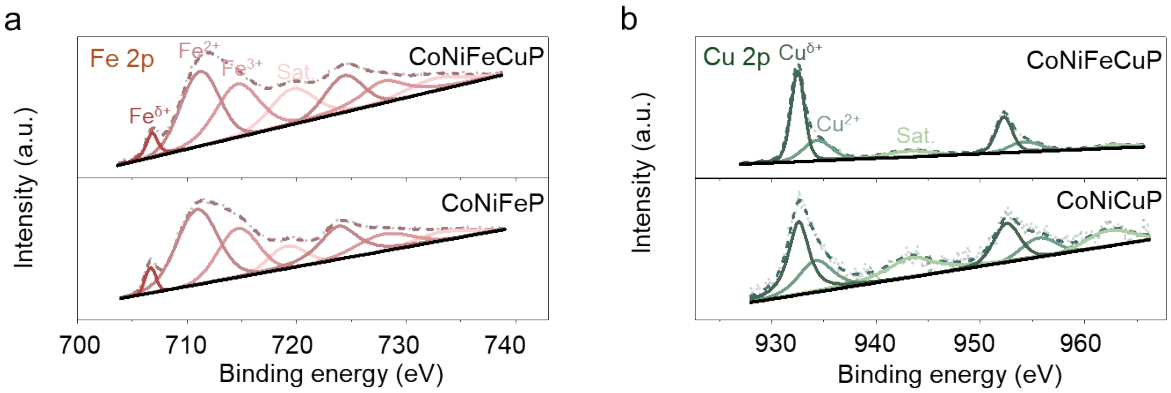

Figure S4. High-resolution (a) Fe 2p XPS spectra of CoNiFeCuP and CoNiFeP and (b) Cu 2p XPS spectra of CoNiFeCuP and CoNiCuP.

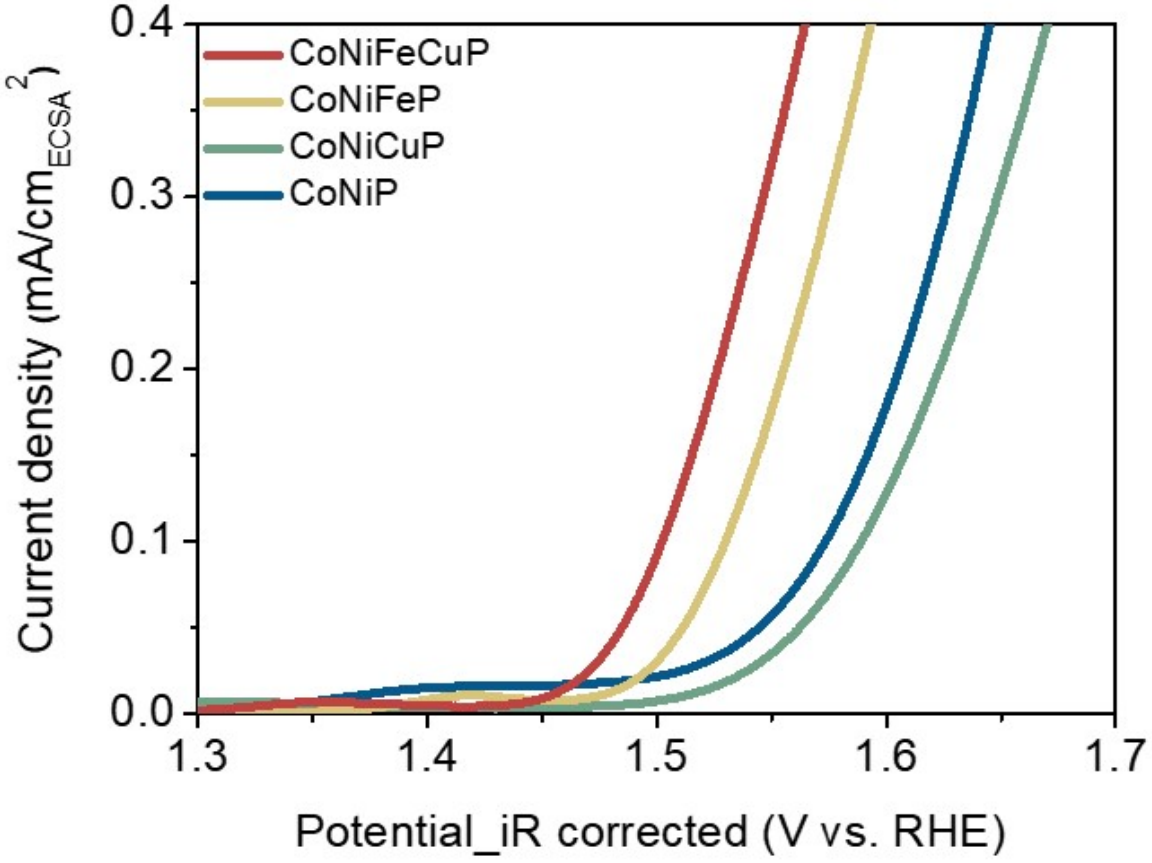

Figure S5. ECSA-normalized LSV curves of CoNiFeCuP.

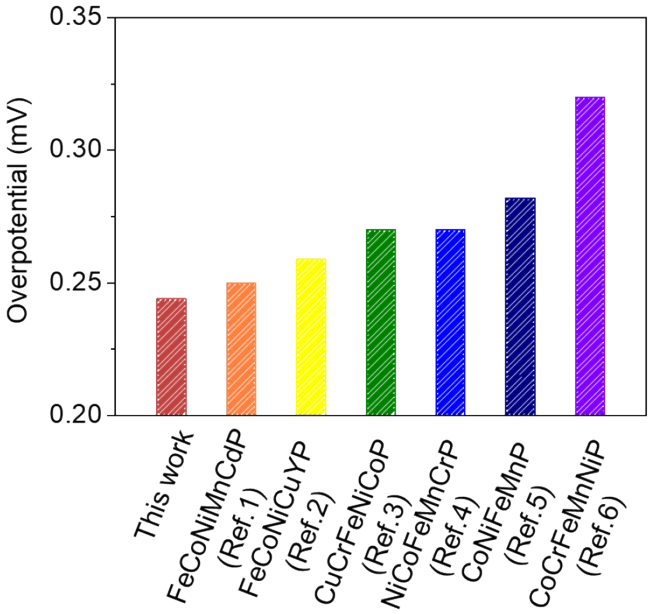

Figure S6. Comparison of the OER activities at 10 mA/cm² in an alkaline environment of high-entropy phosphides with those of the samples reported in the literature.

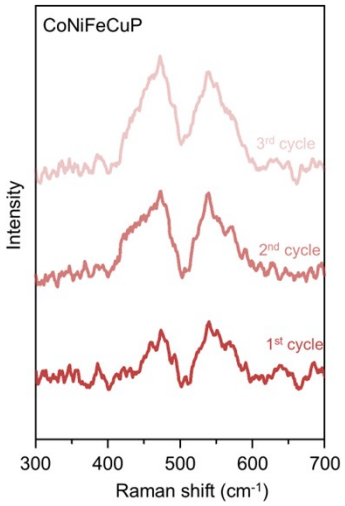

Figure S7. *In situ* Raman spectra of CoNiFeCuP NPs measured at 1.7 V (vs. RHE) during three OER cycles (from bottom to top).

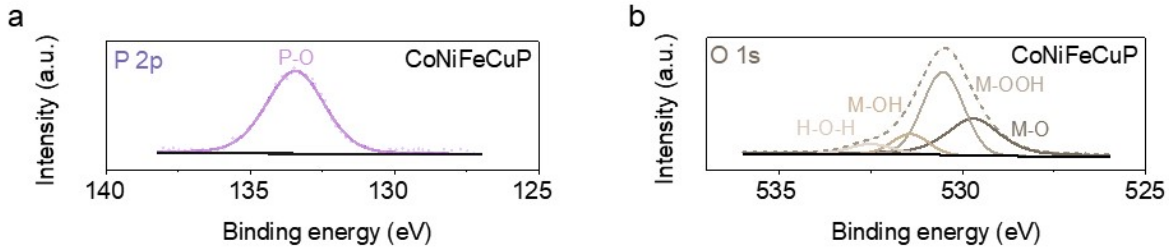

Figure S8. High-resolution (a) P 2p and (b) O 1s XPS spectra of CoNiFeCuP after LSV cycles.

Table S1. Atomic percentage analysis of the synthesized phosphides based on SEM-EDS results.

Sample	Co (at%)	Ni (at%)	Fe (at%)	Cu (at%)	P (at%)
CoNiP	30.1	31.8	-	-	38.1
CoNiCuP	19.31	23.4	-	22.5	34.7
CoNiFeP	22.4	22.2	20.3	-	35.1
CoNiFeCuP	19.1	19.6	15.1	14.6	31.6

Table S2. Atomic percentage analysis of CoNiFeCuP NPs at different reaction times based on SEM-EDS results.

Time (h)	Co (at%)	Ni (at%)	Fe (at%)	Cu (at%)	P (at%)
0	26.7	26.2	9.7	28.3	9.1
2	17.7	19.0	15.4	17.3	30.6
3	19.8	19.5	16.3	12.5	31.9
4	19.3	19.7	15.2	14.5	31.3
5	18.7	19.6	15.0	14.8	31.9

Table S3. SEM-EDS atomic ratio analysis of CoNiFeCuP at different reaction temperatures.

Temperature (°C)	Co (at%)	Ni (at%)	Fe (at%)	Cu (at%)	P (at%)
220	1.4	4.1	1.7	91.0	1.8
240	11.4	12.6	4.1	69.5	2.4
260	20.9	18.8	10.6	40.0	9.7
280	22.8	22.0	9.5	34.3	11.4

Table S4. Stability comparison of high-entropy phosphides with various reported catalysts in alkaline OER.

Sample	Current density or voltage	Operating time (h)	Ref.
This work	10 mA/cm^2	100	
FeCoNiMnCdP	1.55 V	24	[1]
FeCoNiCuYP/C	50 mA/cm^2	30	[2]
CuCrFeNiCoP	100 mA/cm^2	24	[3]
NiCoFeMnCrP	1.55 V	24	[4]
CoNiFeMnP	50 mA/cm^2	15	[5]
CoCrFeMnNiP	10 mA/cm^2	10	[6]

Table S5. Atomic percentage analysis of CoNiFeCuP after OER LSV using SEM-EDS.

Sample	Co (at%)	Ni (at%)	Fe (at%)	Cu (at%)	P (at%)
CoNiFeCuP	25.1	26.6	15.8	8.9	23.7

References

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