Supporting Information

Morphology control of metal-modified zirconium phosphate support structures for the oxygen evolution reaction

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Surface-area-to-volume ratio (SA:V) calculations:

All SA:V calculations are based off the average dimensions of the ZrP structures obtained through TEM/STEM.

α-ZrP:

Average diameter = 120 nm; side length = 60 nm; average height = 14 nm

Surface Area (assuming a regular hexagon structure) = $3\frac{\sqrt{3}s^2}{2} = 9353\ nm^2$

Volume = $3\frac{\sqrt{3}s^2}{2}$ *h = $1.31*10^5$ nm^3

SA:V = 0.071

ZrP_{rods}:

Average length = 760 nm

Average diameter = 25 nm

Surface area (assuming a cylinder structure) = $2\pi rh+2\pi r^2$ = 6062 nm^2

Volume = πr^2h = $3.73*10^5$ nm^3

SA:V = 0.16

ZrP_{cubes}:

Average side length = 175 nm

Surface area (assuming a perfect cube) = $6s^2$ = $1.84*10^5$ nm^2

Volume = $5.36*10^6$ nm^3

SA:V = 0.034

$ZrP_{spheres}$:

Average radius = 765 nm

Surface area (assuming a perfect sphere) = $7.35*10^6$ nm^2

Volume = $1.88*10^9$ nm^3

SA:V = 0.0039

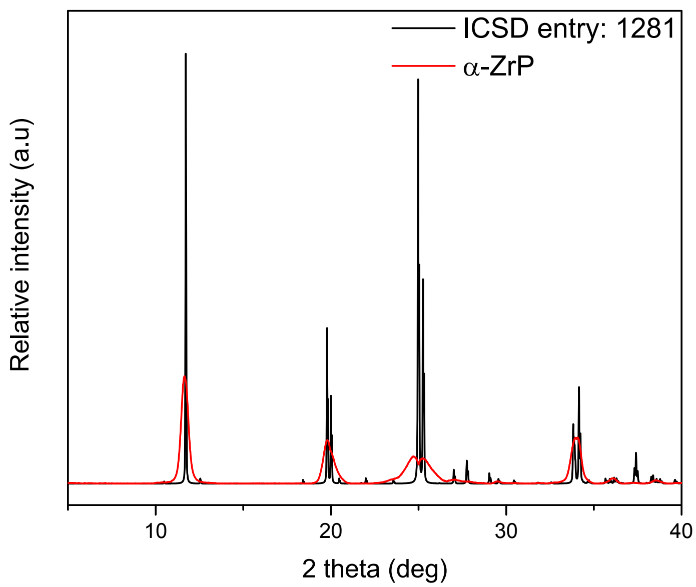

Figure S1. Experimentally determined XRPD pattern of α-ZrP and ICSD entry 1281.

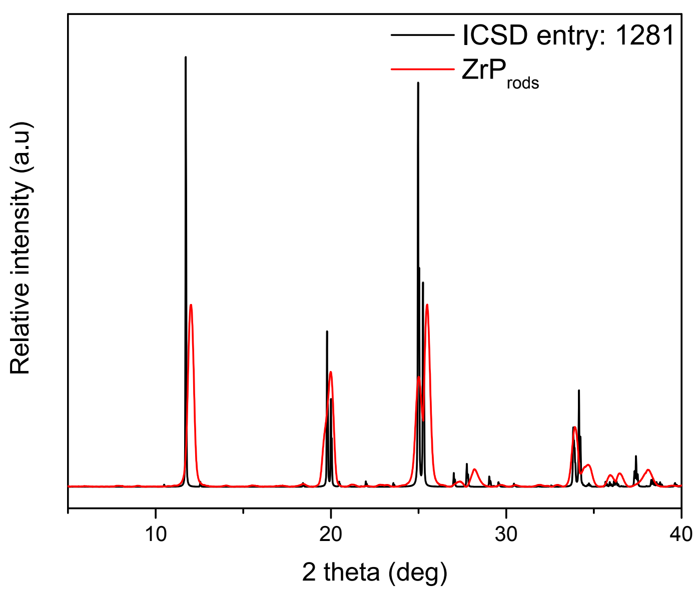

Figure S2. Experimentally determined XRPD pattern of ZrP_{rods} and ICSD entry 1281.

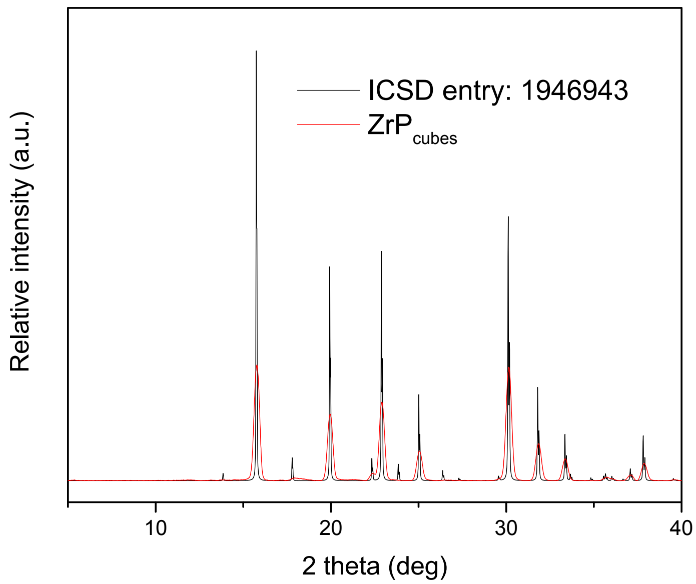

Figure S3. Experimentally determined XRPD pattern of ZrP$_{cubes}$ and ICSD entry 1946943.

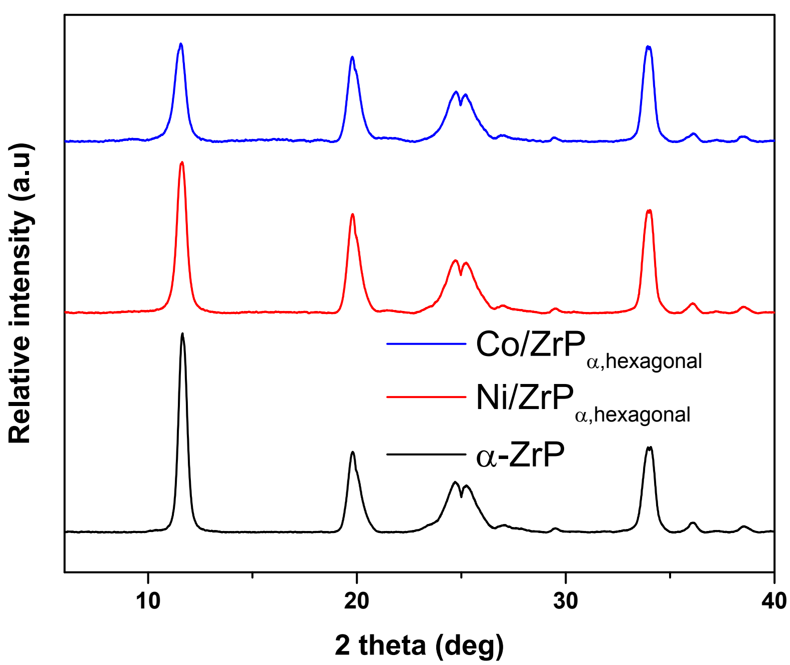

Figure S4. XRPD patterns of α-ZrP, Ni/ZrP$_{\alpha,hexagonal}$, and Co/ ZrP$_{\alpha,hexagonal}$.

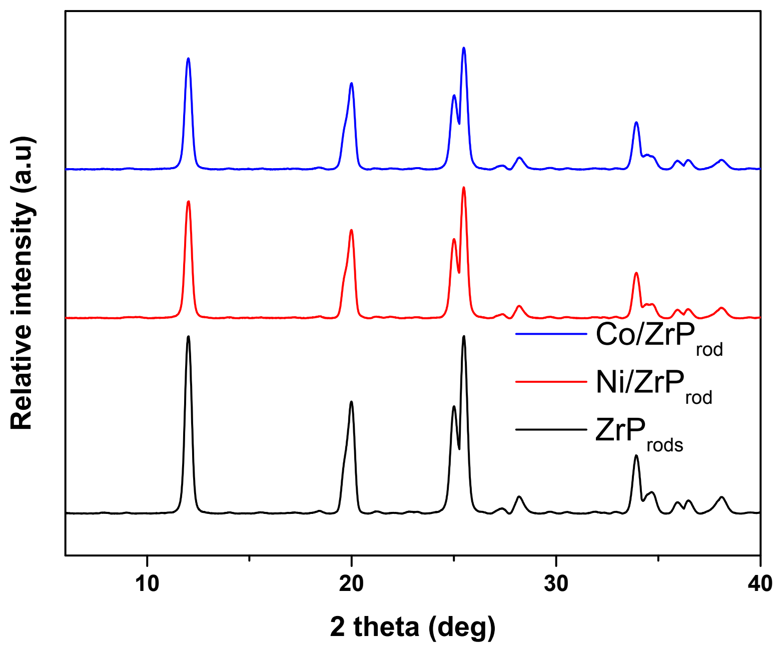

Figure S5. XRPD patterns of ZrP$_{rods}$, Ni/ZrP$_{rod}$, and Co/ZrP$_{rod}$.

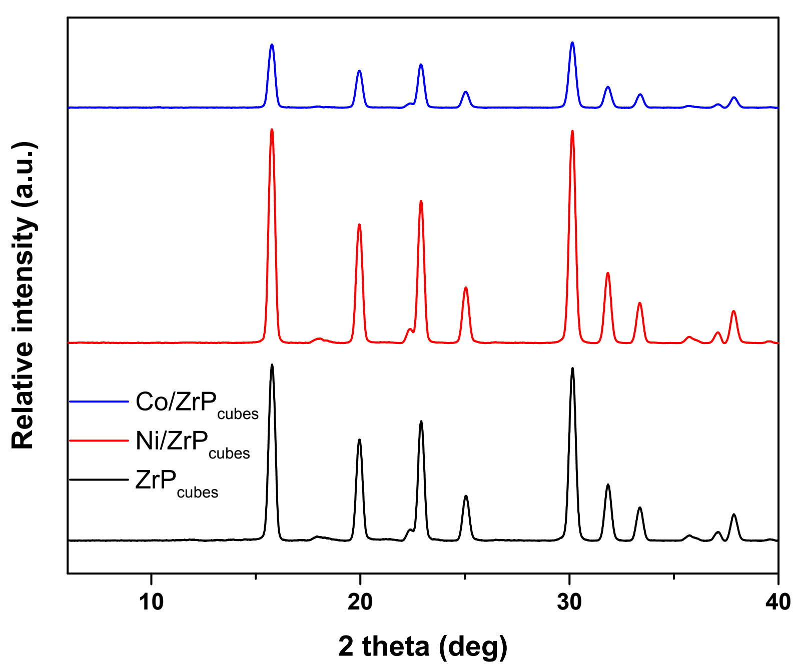

Figure S6. XRPD patterns of ZrP_{cubes} (τ'-ZrP), Ni/ZrP_{cube}, and Co/ZrP_{cube}.

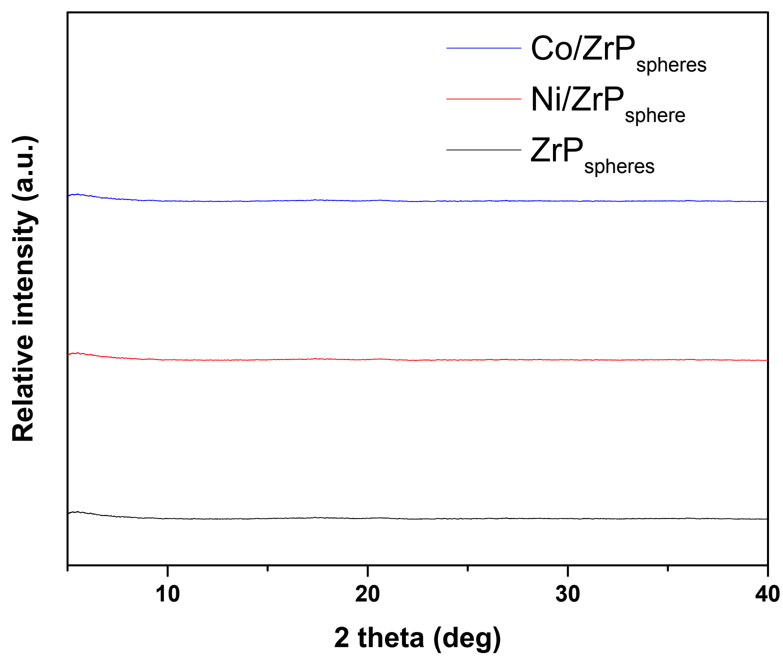

Figure S7. XRPD patterns of $ZrP_{spheres}$, Ni/$ZrP_{spheres}$, and Co/ZrP_{sphere}.

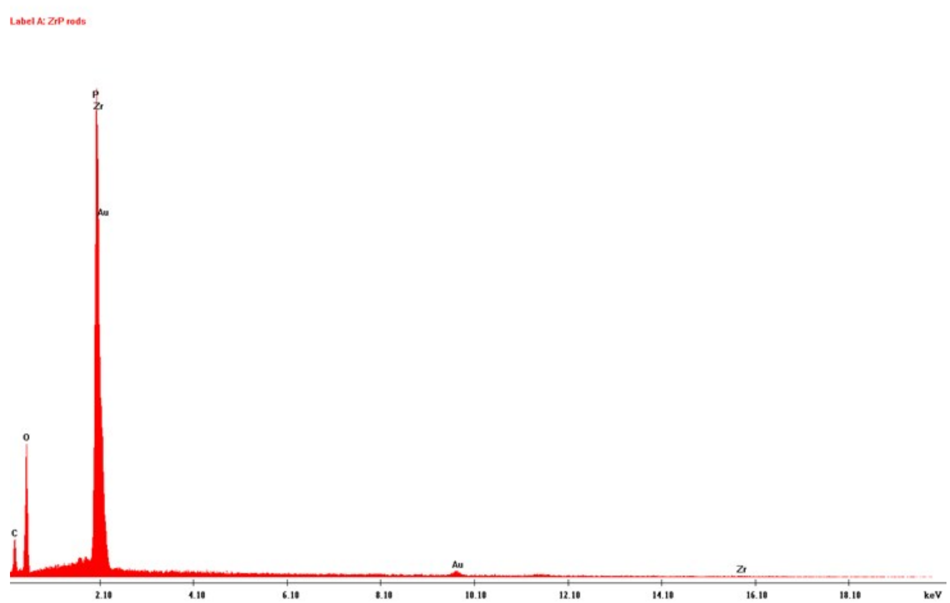

Figure S8. EDS spectrum of ZrP_{rods}.

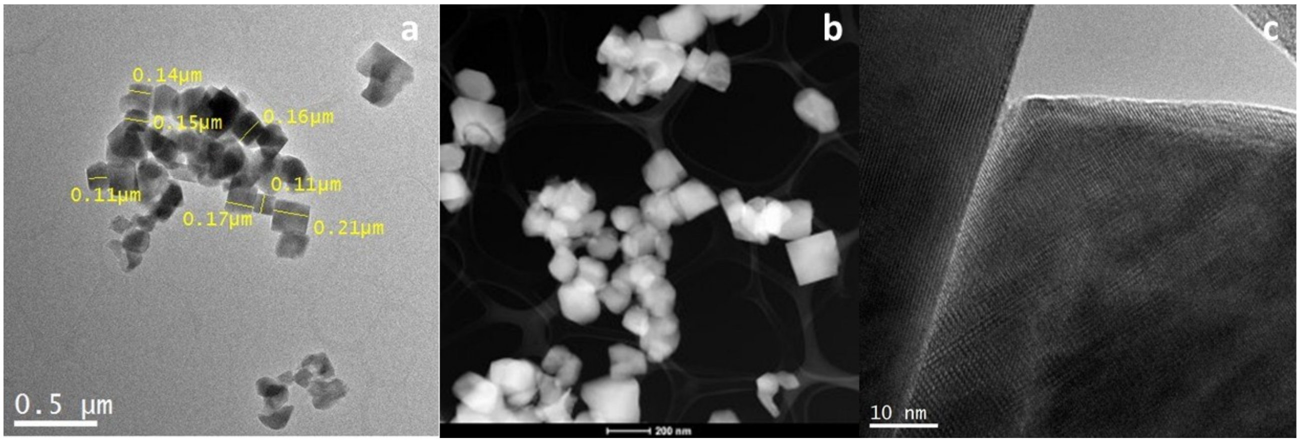

Figure S9. TEM/STEM micrographs of cobalt-modified ZrP_{cubes}. Scale bar: 0.5 µm, 200 nm, and 10 nm; respectively.

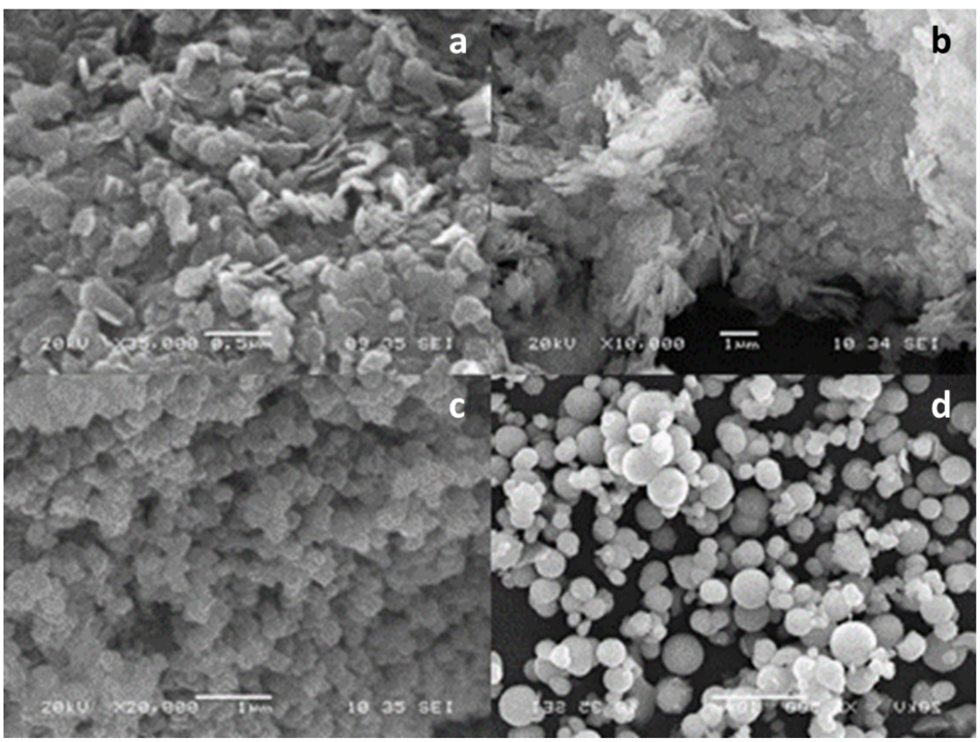

Figure S10. SEM micrographs of (a) α-ZrP, (b) ZrP_{rods}, (c) ZrP_{cubes}, and (d) $ZrP_{spheres}$. Scale bar: 0.5 µm, 1 µm, 1 µm, and 10 µm; respectively.

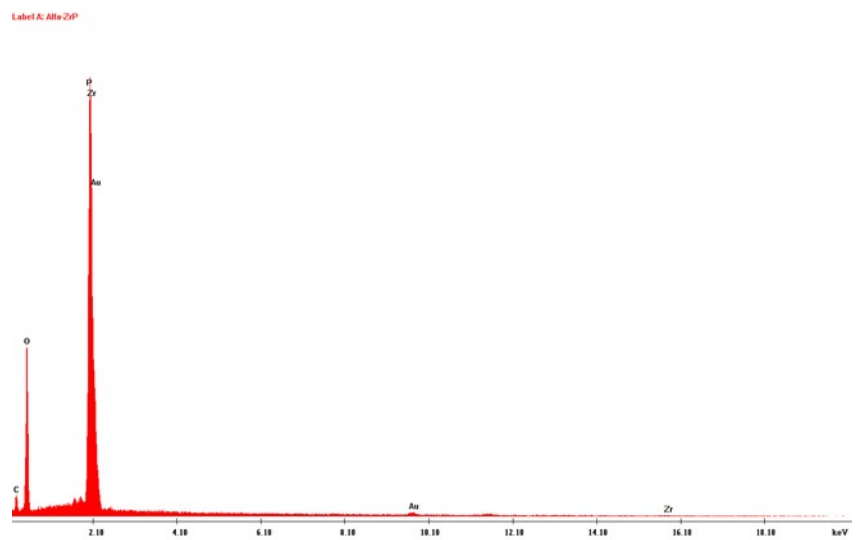

Figure S11. EDS spectrum of α-ZrP.

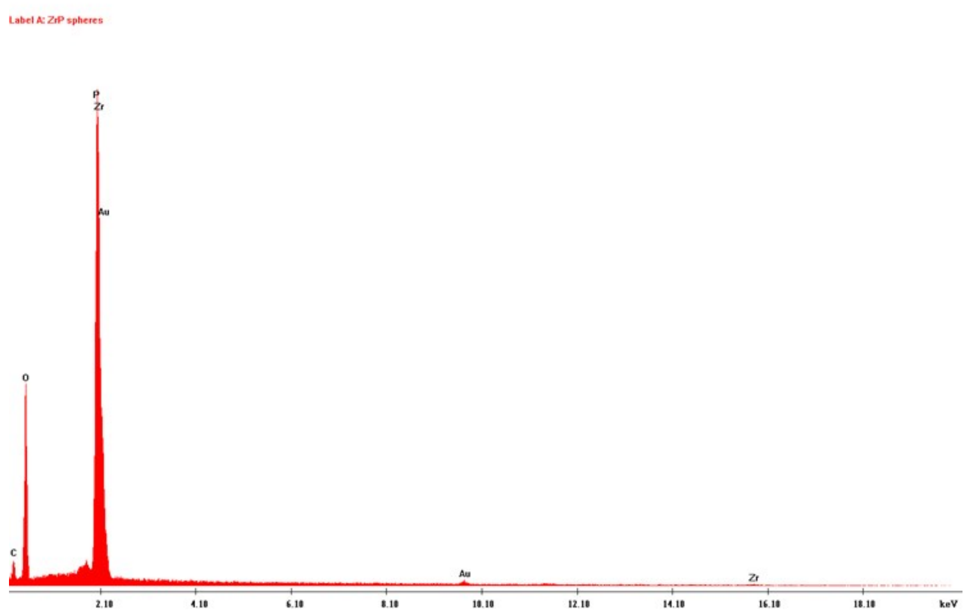

Figure S12. EDS spectrum of $ZrP_{spheres}$.

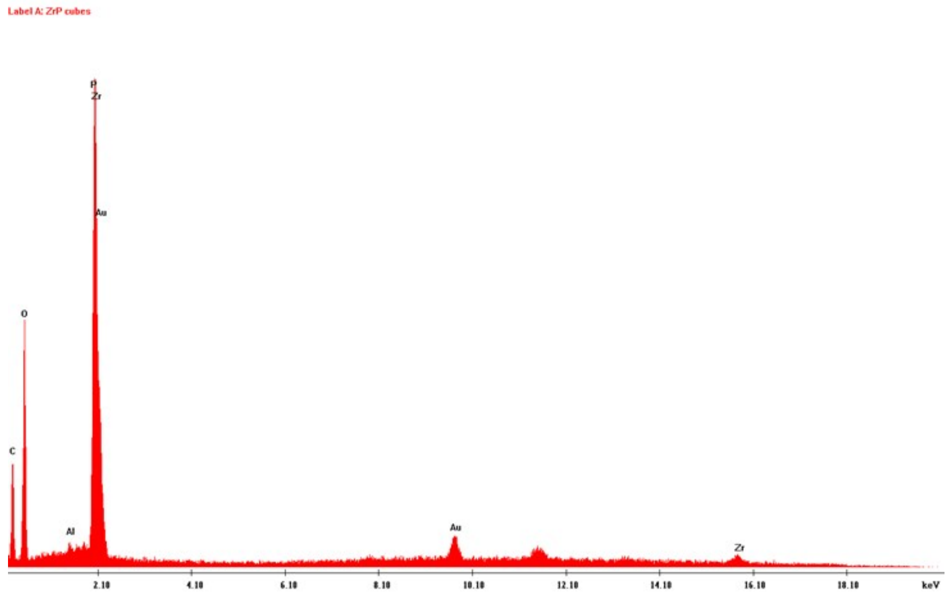

Figure S13. EDS spectrum of ZrP_{cubes}.

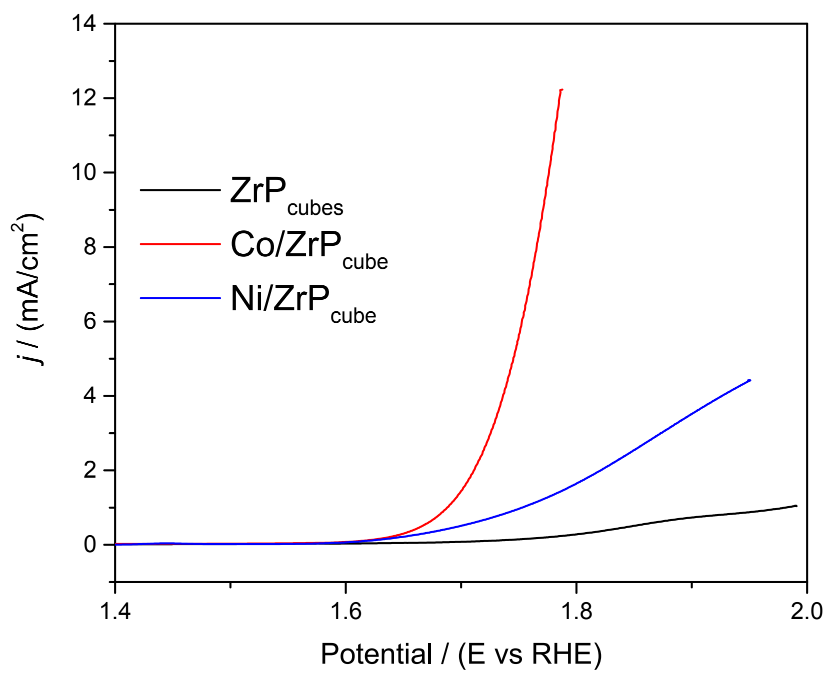

Figure S14. Linear sweep voltammograms of ZrP_{cubes}, and both metal-modified ZrP_{cube} catalysts.

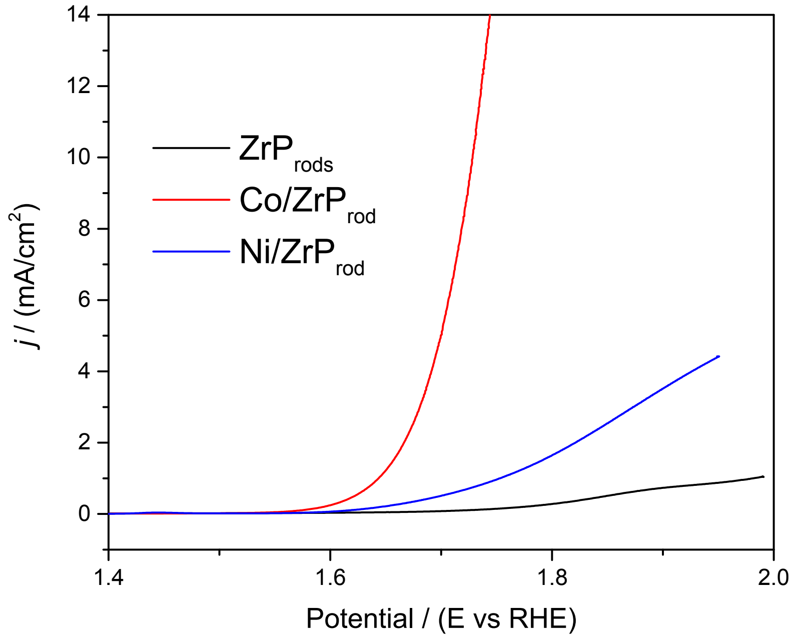

Figure S15. Linear sweeps voltammograms of ZrP_{rods}, and both metal-modified ZrP_{rod} catalysts.

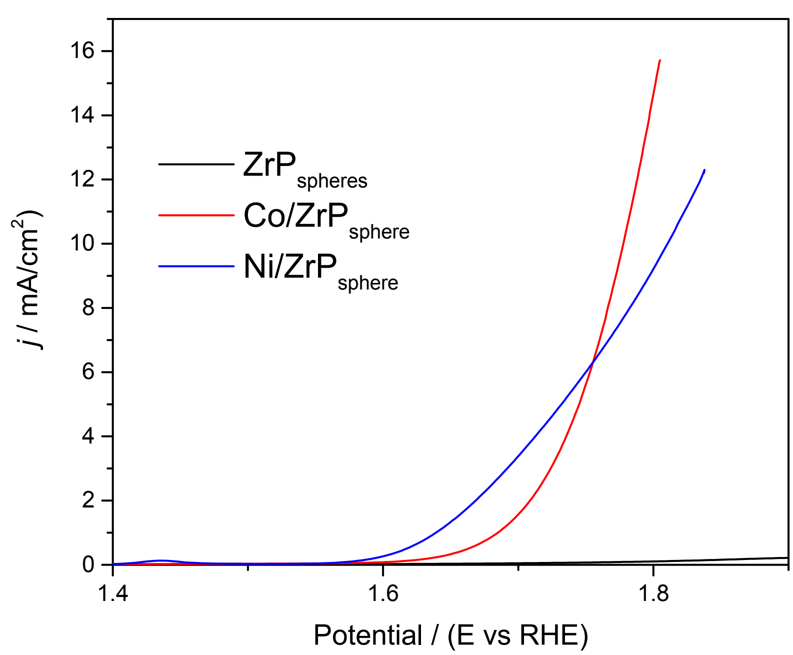

Figure S16. Linear sweeps voltammograms of $ZrP_{spheres}$, and both metal-modified ZrP_{sphere} catalysts.

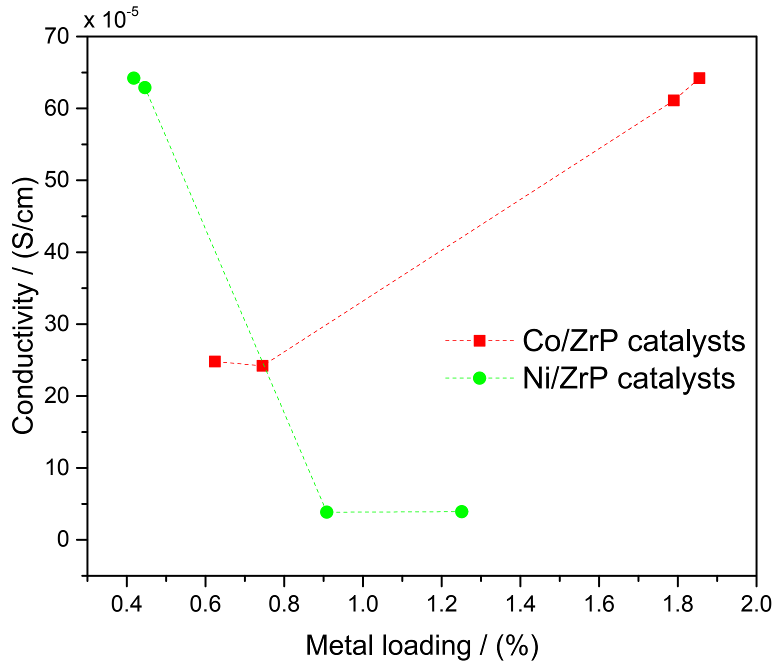

Figure S17. Conductivity vs metal loading for Co and Ni/ZrP catalysts.

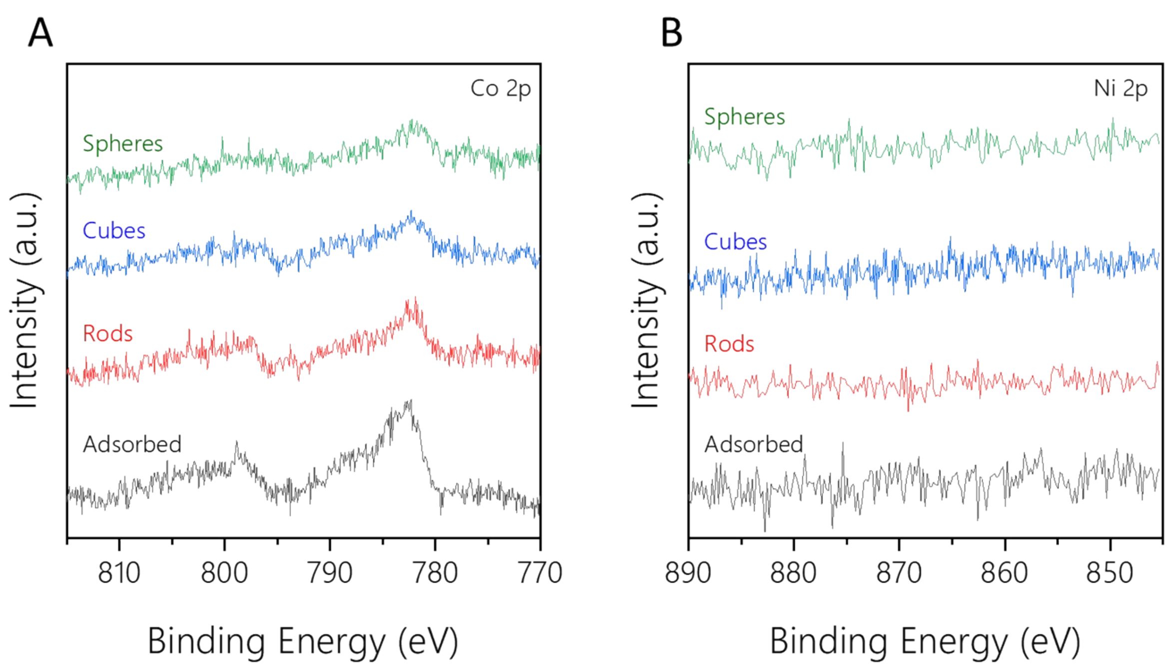

Figure S18. XPS spectra for A) Co-modified ZrP catalysts and B) Ni-modified ZrP catalysts.

Table S1. Mass activity (at η = 350 mV) and Tafel slope comparison for metal-modified ZrP catalysts and selected state-of-the-art OER catalysts in alkaline electrolyte.[1]

Catalyst	Mass activity @ η = 350 mV (A/g)	Tafel Slopes (mV/dec)
Co/ZrP $_{\alpha\text{,hexagonal}}$	115	79
Co/ZrP$_{rod}$	4	79
Co/ZrP$_{cube}$	72	82
Co/ZrP$_{sphere}$	56	86
Ni/ZrP $_{\alpha\text{,hexagonal}}$	50	132
Ni/ZrP$_{rod}$	85	127
Ni/ZrP$_{cube}$	91	134
Ni/ ZrP$_{sphere}$	272	67
IrO_x	257	47
Co_3O_4	30	49
$NiFeO_xH_y$	633	42

References:

1) D. Xu, M. Stevens, M. Cosby, S. Z. Oener, A. Smith, L. J. Enman, K. E. Ayers, C. B. Capuano, J. Renner, N. Danilovic, Y. Li, H. Wang, Q. Zhang and S. W. Boettcher, *ACS Catal.* 2019, **9,** 7-15.