Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.

Supporting Information

A composite containing of vanadium metaphosphate and cobalt metaphosphate as an efficient electrocatalyst for both hydrogen evolution and oxygen evolution in alkaline water splitting

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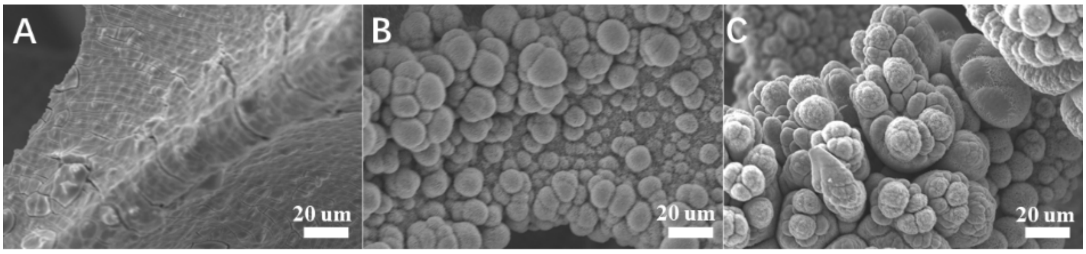

Figure S1 SEM images of the samples with the repetition number of (A) one, (B) three and (D) four.

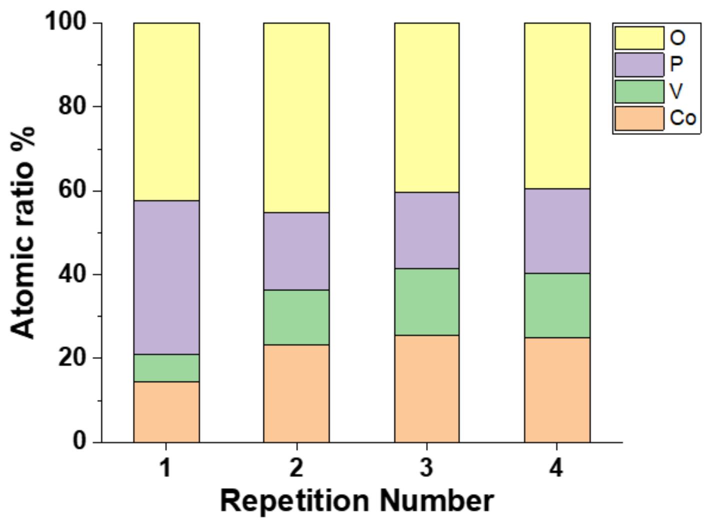

Figure S2 Atomic ratio of the samples with various repetition number based on SEM-EDS.

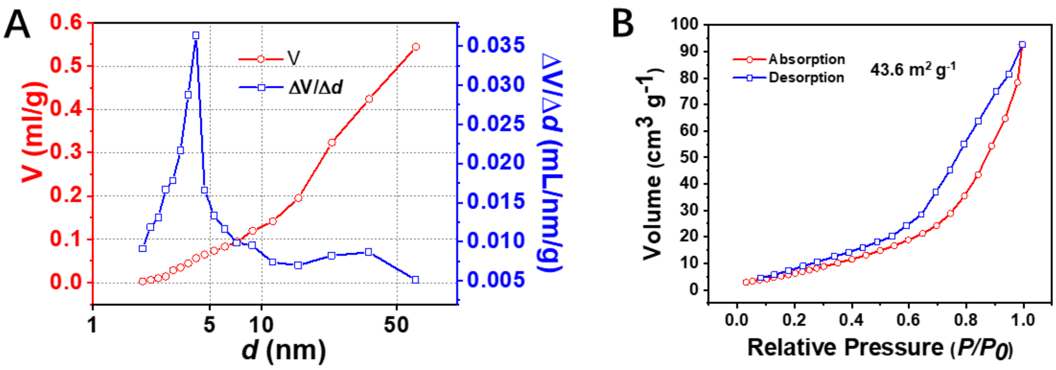

Figure S3. BET results of (A) pore properties and (B) area for $CoV(PO_3)_2$.

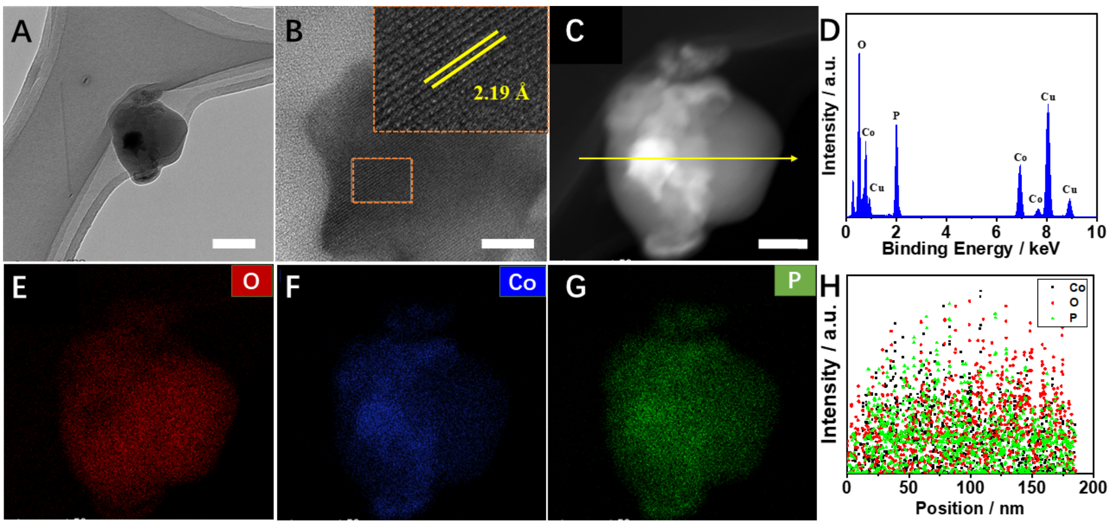

Figure S4. (A) TEM, (B) HRTEM and (D) HADDFT-STEM images of $Co(PO_3)_2$, and (D) the corresponding EDS, the elemental distribution of (E) O, (F) Co and (G) P, (H) the cross-sectional EDX line scanning according to the arrow in (C). The scale bars in (A), (B) and (C) are 100 nm, 10 nm and 50 nm, respectively.

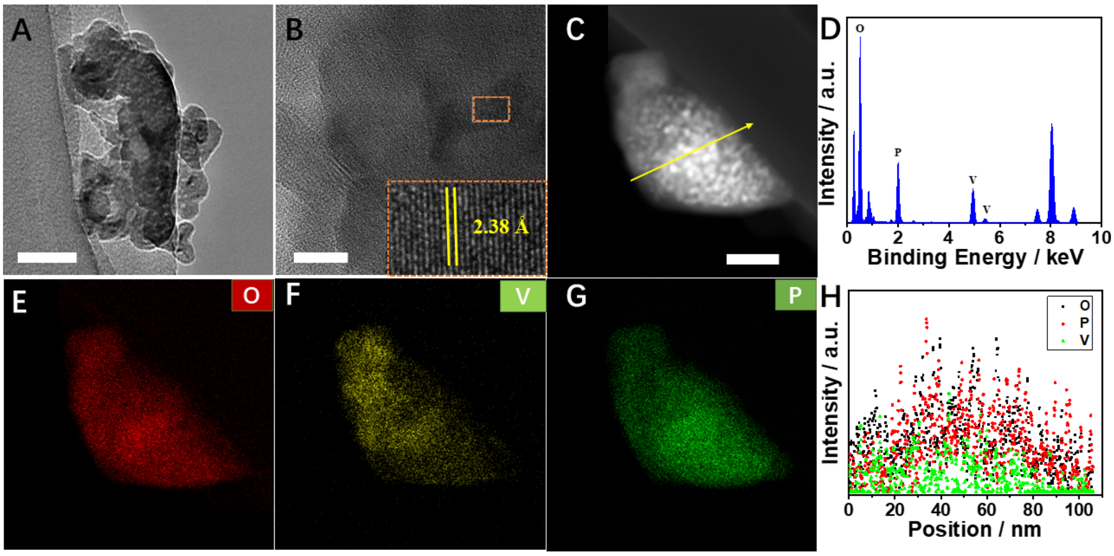

Figure S5. (A) TEM, (B) HRTEM and (D) HADDFT-STEM images of $V_X(PO_3)_2$, and (D) the corresponding EDS, the elemental distribution of (E) O, (F) V and (G) P, (H) the cross-sectional EDX line scanning according to the arrow in (C). The scale bars in (A), (B) and (C) are 50 nm, 10 nm and 50 nm, respectively.

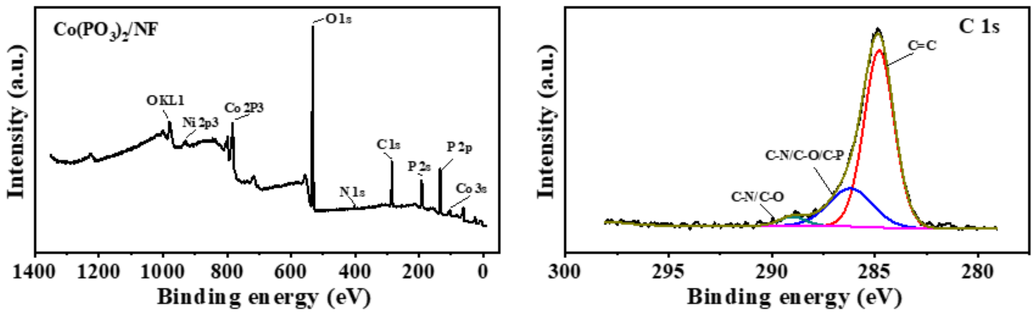

Figure S6. XPS of $Co(PO_3)_2$ and the calibrated carbon.

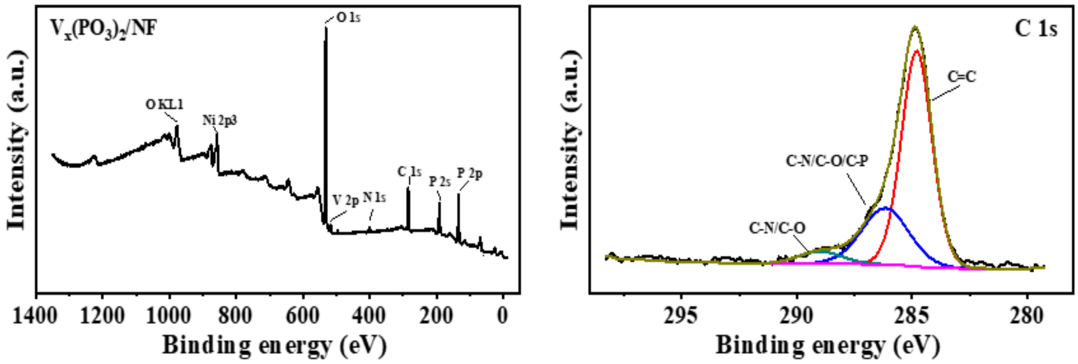

Figure S7. XPS of $V_X(PO_3)_2$ and the calibrated carbon.

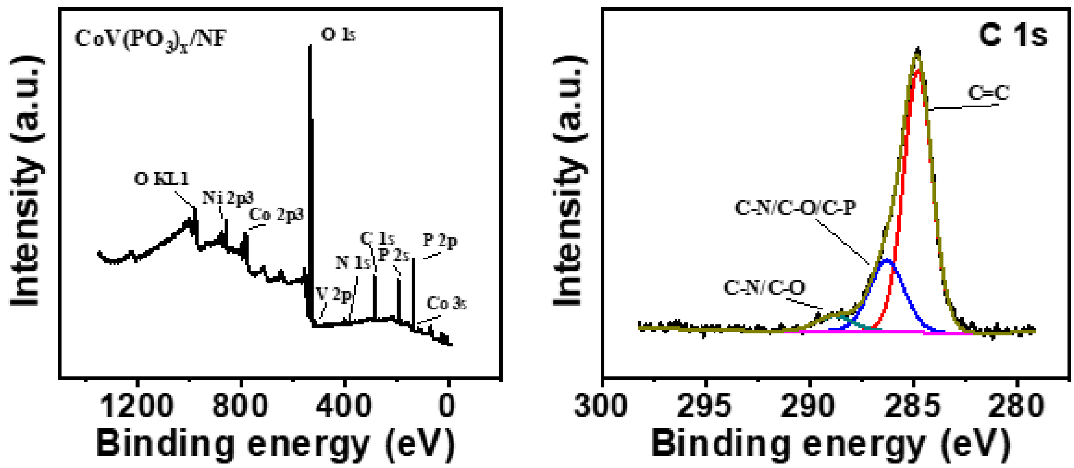

Figure S8. XPS of $CoV_X(PO_3)_2$ and the calibrated carbon.

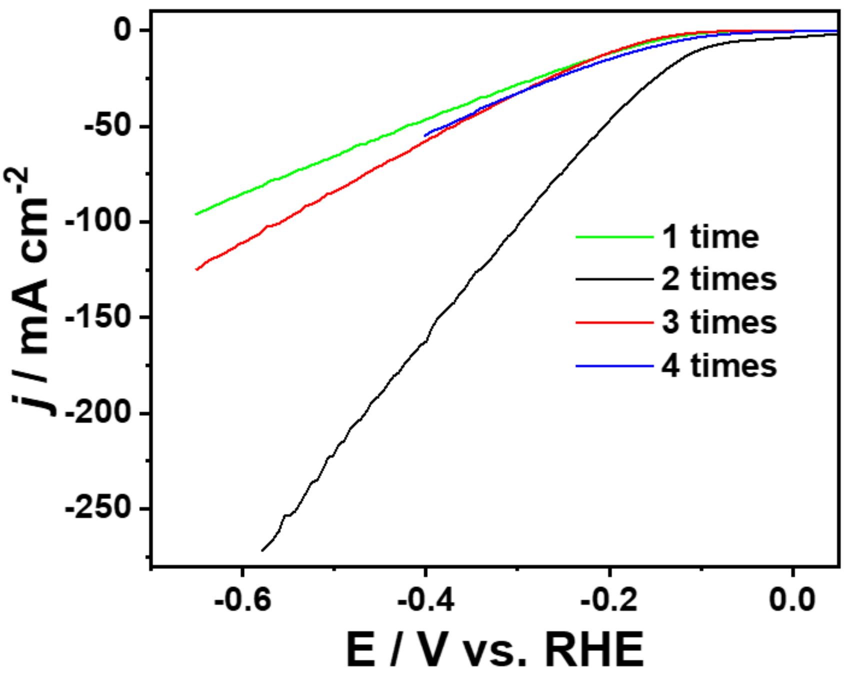

Figure S9. HER comparison of the samples with different repetition number.

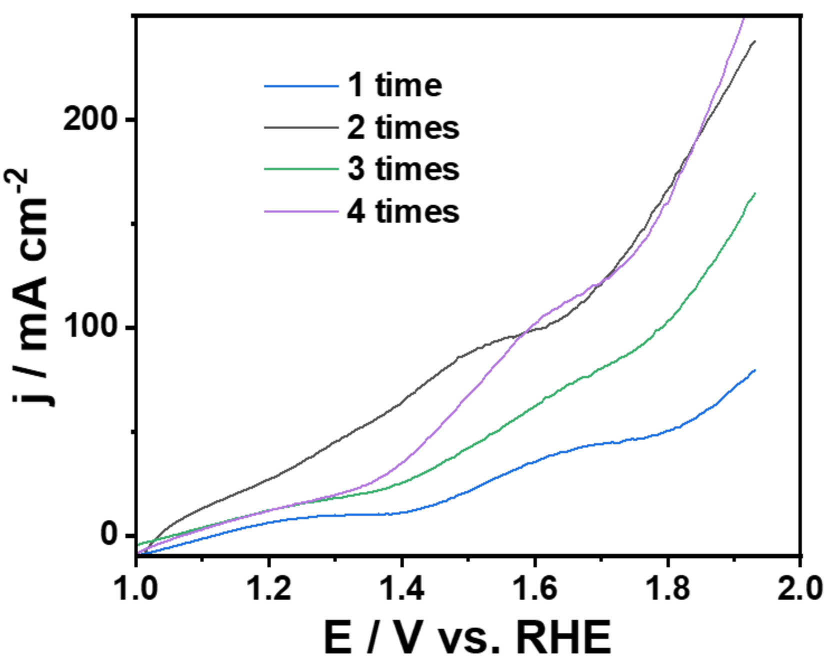

Figure S10. OER Comparison of the samples with different repetition number.

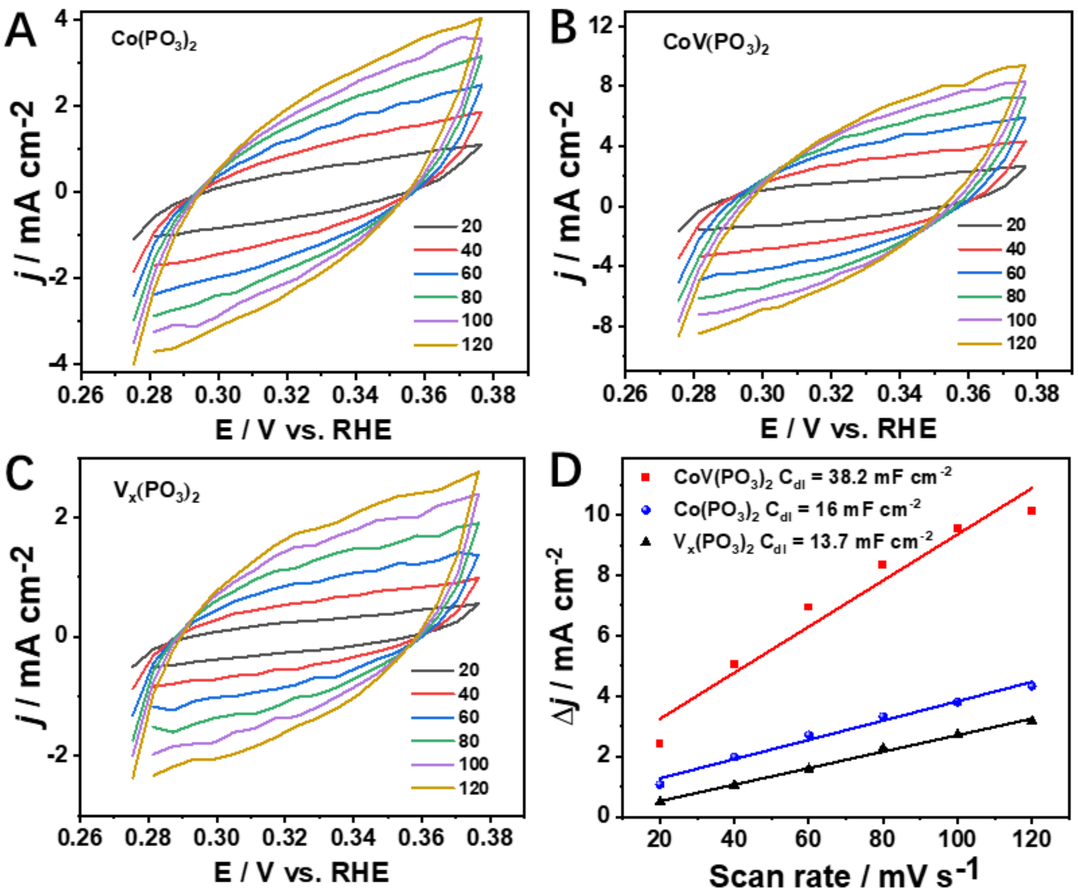

Figure S11. CV curves of $Co(PO_3)_2$, $CoV(PO_3)_2$ and $V_X(PO_3)_2$ at various scanning speed and (D) the calculated C_{dl}.

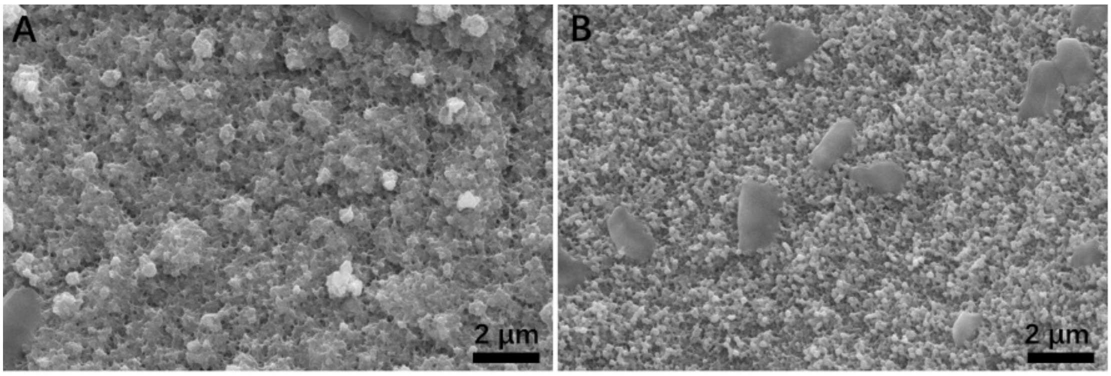

Figure S12 SEM of the sample $CoV(PO_3)_2$ after (A) HER and (B) OER durability test.

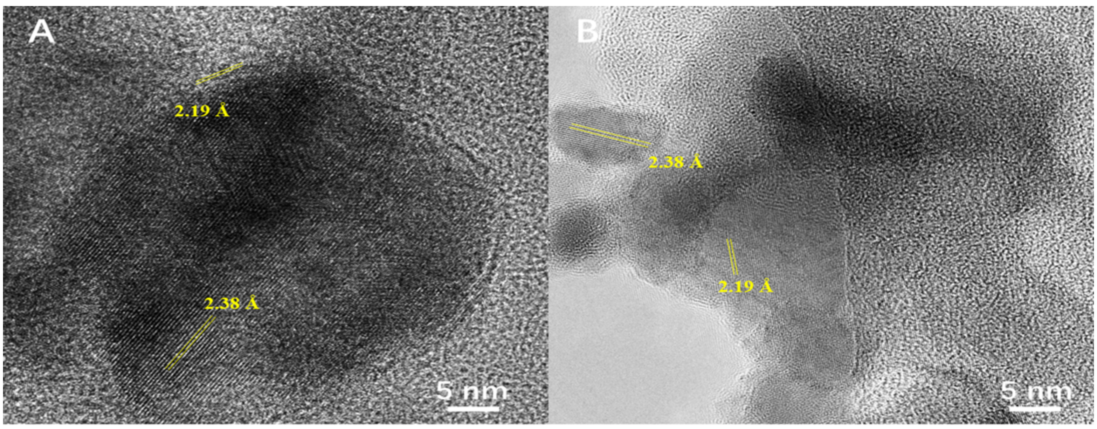

Figure S13 HRTEM of $CoV(PO_3)_2$ after (A) HER and (B) OER durability test.

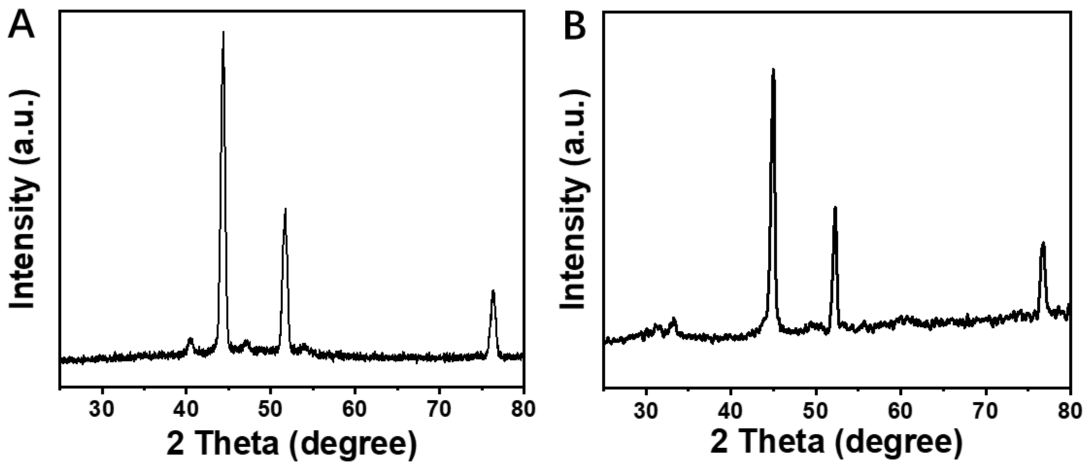

Figure S14 XRD of the sample after (A) HER and (B) OER durability test.

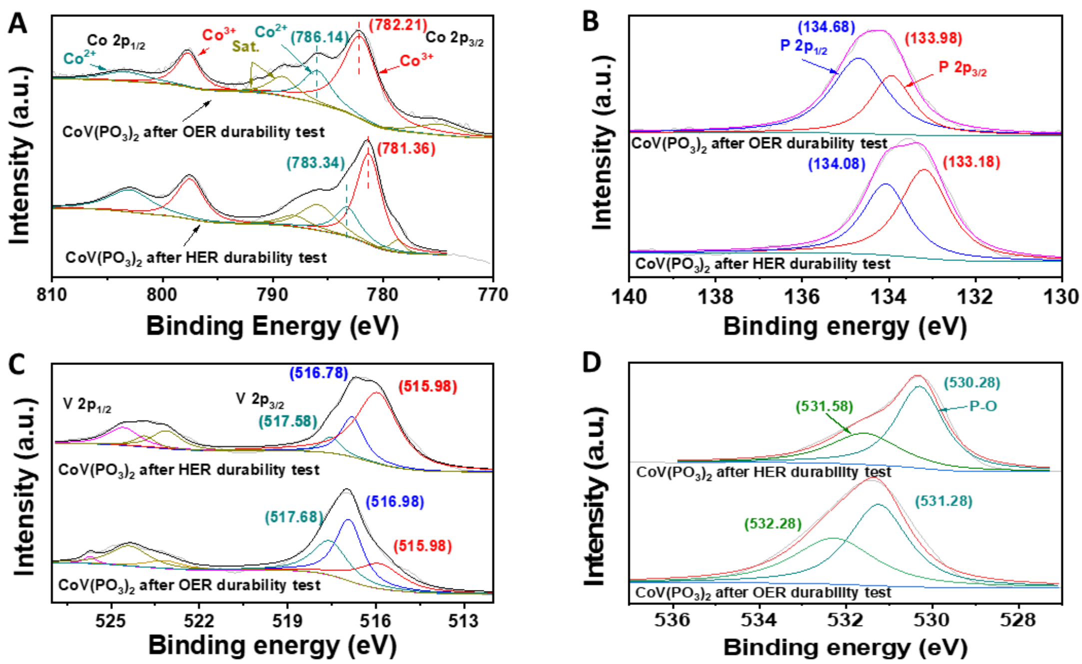

Figure S15 XPS of (A) Co, (B) P, (C) V and (D) O after durability test.

Table S1 Comparison of HER catalytic activity with reported HER catalysts for non-precious materials in 1 M KOH.

Catalyst	***η*@10 mA cm^{-2} mV**	**Electrolyte**	**Ref.**
$CoV(PO_3)_2$	96	1.0 M KOH	This work
Ni-Coalloy	107	1.0 M KOH	[1]
$Co_{0.2}$-VOOH	130	1.0 M KOH	[2]
V-doped WS_2	134	1.0 M KOH	[3]
NiCoP/rGO	209	1.0 M KOH	[4]
Ni-Co-P	150	1.0 M KOH	[5]
Janus Co/CoP	193	1.0 M KOH	[6]
CoOx@CN	232	1.0 M KOH	[7]
mac-CoO@Co/NGC	145	1.0 M KOH	[8]
$CuCo_2O_4$	115	1.0 M KOH	[9]

Table S2 Comparison of OER catalytic activity with reported OER catalysts for non-precious materials in 1 M KOH.

Catalyst	**Overpotential (mV)**	**Electrolyte**	**Ref.**
$CoV(PO_3)_2$	368(100 mA/cm^2)	1.0 M KOH	This work
NiFeV LDHs	195(20 mA/cm^2) 192(10 mA/cm^2)	1.0 M KOH	[10]
Exfoliated NiFe LDHs	300(10 mA/cm^2)	1.0 M KOH	[11]
Co9S8/CNS/CNT	267(10 mA/cm^2)	1.0 M KOH	[12]
Co3O4	290 (10 mA/cm^2)	1.0 M KOH	[13]
cobalt carbonate hydroxide superstructure	320 (10 mA/cm^2)	1.0 M KOH	[14]
Co3O4 nanosheets	330 (10 mA/cm^2)	1.0 M KOH	[15]
Co3O4 nanoparticles	485 (10 mA/cm^2)	1.0 M KOH	[16]
LDH FeCo	330 (10 mA/cm^2)	1.0 M KOH	[17]
NiVIr LDH	247(100 mA/cm^2)	1.0 M KOH	[18]
NiV LDHs	310 (10 mA/cm^2)	1.0 M KOH	[19]
Co2VO4	300(10 mA/cm^2) 386(100 mA/cm^2)	1.0 M KOH	[20]
V-Ni0.2Mo0.8N	245(20 mA/cm^2)	1.0 M KOH	[21]
Co0.2-VOOH	210 (10 mA/cm^2)	1.0 M KOH	[2]
Mo-doped CoP	305 (10 mA/cm^2)	1.0 M KOH	[22]
CoNi-MOFNA	215(10 mA/cm^2) 250(100 mA/cm^2)	1.0 M KOH	[23]

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