

Supporting Information

Phytic acid-derivative transition metal phosphides encapsulated in N,P-codoped carbon: an efficient and durable hydrogen evolution electrocatalyst in a wide pH range

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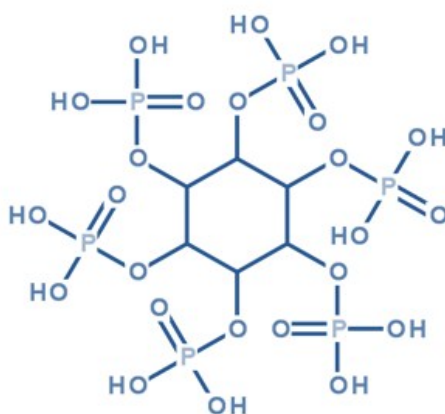


Fig. S1. Molecular structure of PA.

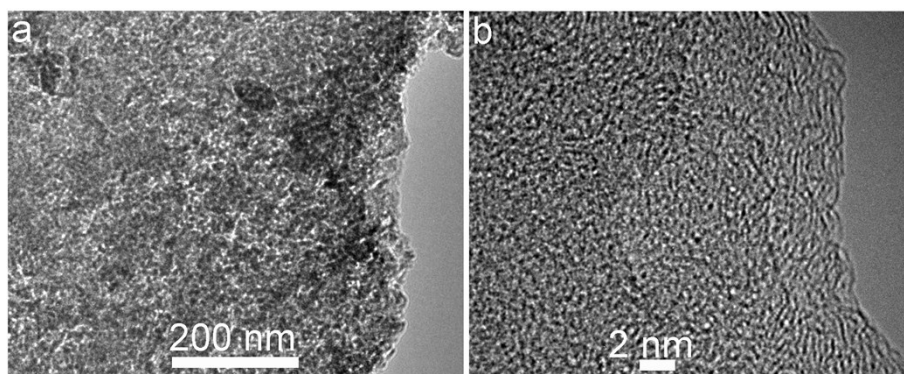


Fig. S2. TEM images of N,P-codoped carbon.

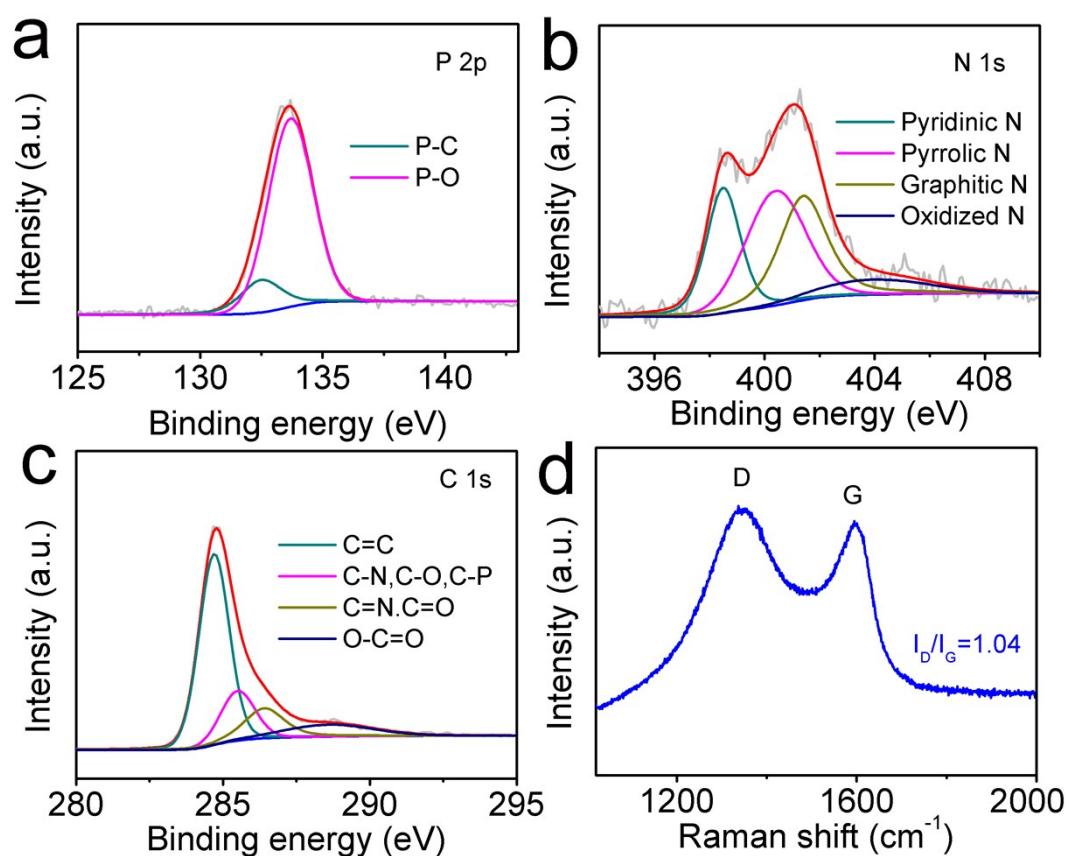


Fig. S3. (a-c) The high-resolution XPS spectra of the NPC. (d) Raman spectrum of NPC.

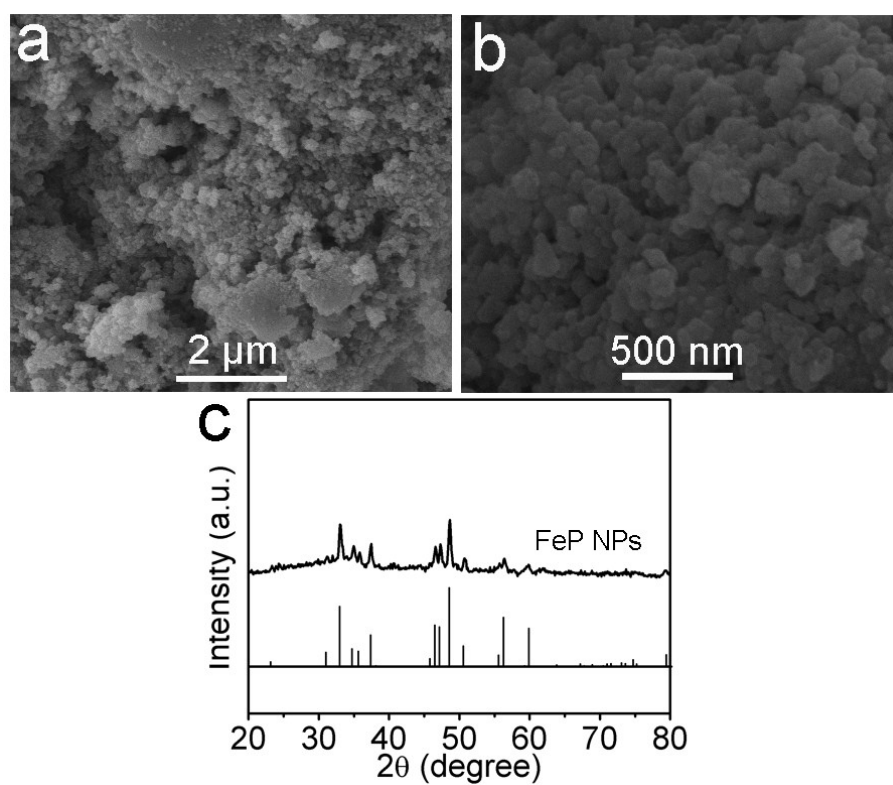


Fig. S4. (a) Low- and (b) high-magnification SEM images of FeP NPs. (c) XRD pattern of FeP NPs.

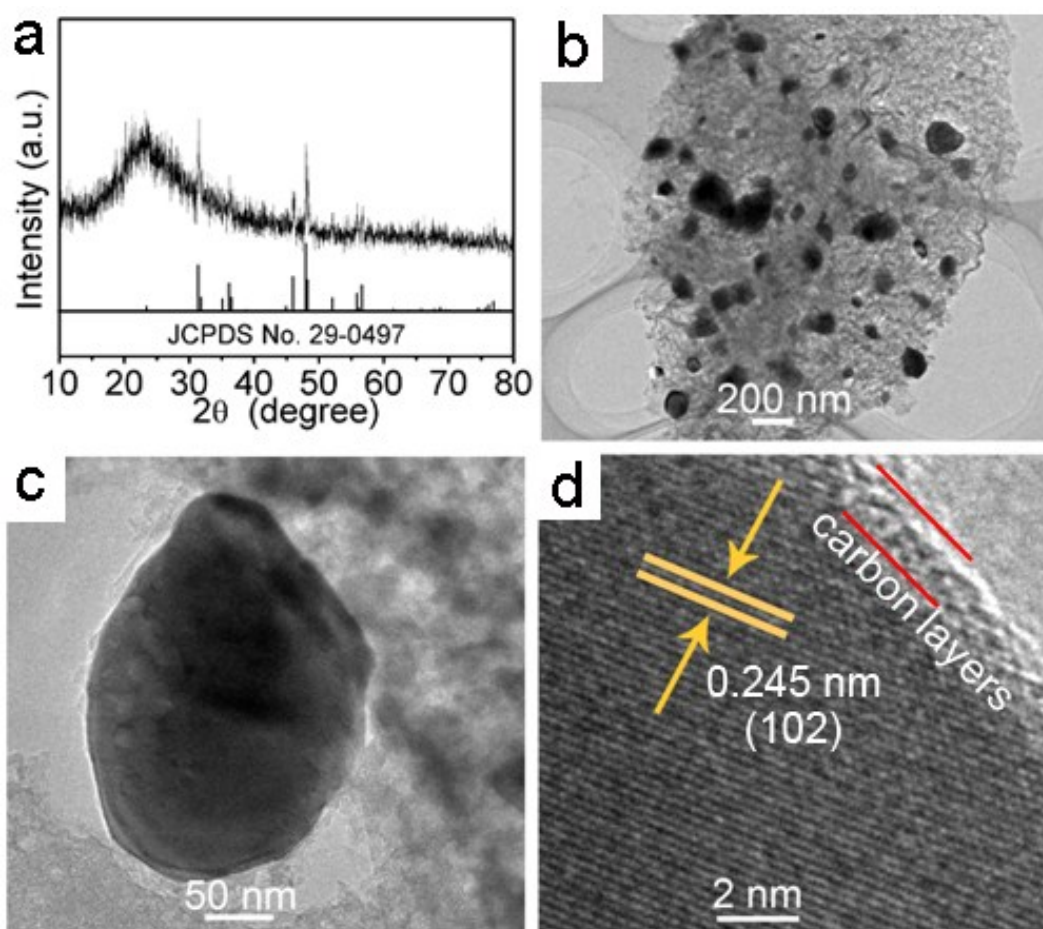


Fig. S5. (a) XRD pattern of CoP NPs@NPC. (b) Low- and (c) high-magnification TEM images of CoP NPs@NPC. (d) HRTEM image of CoP NPs@NPC.

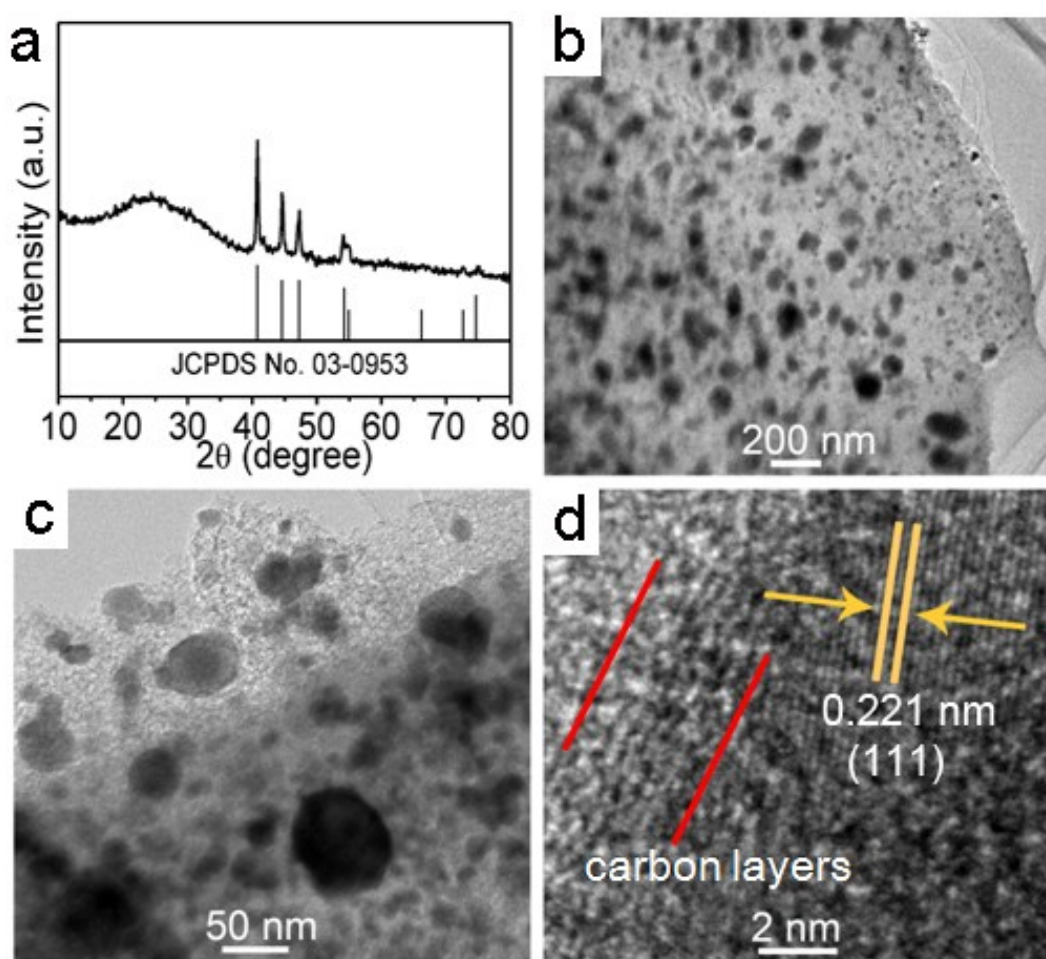


Fig. S6. (a) XRD pattern of Ni₂P NPs@NPC. (b) Low- and (c) high-magnification TEM images of Ni₂P NPs@NPC. (d) HRTEM image of Ni₂P NPs@NPC.

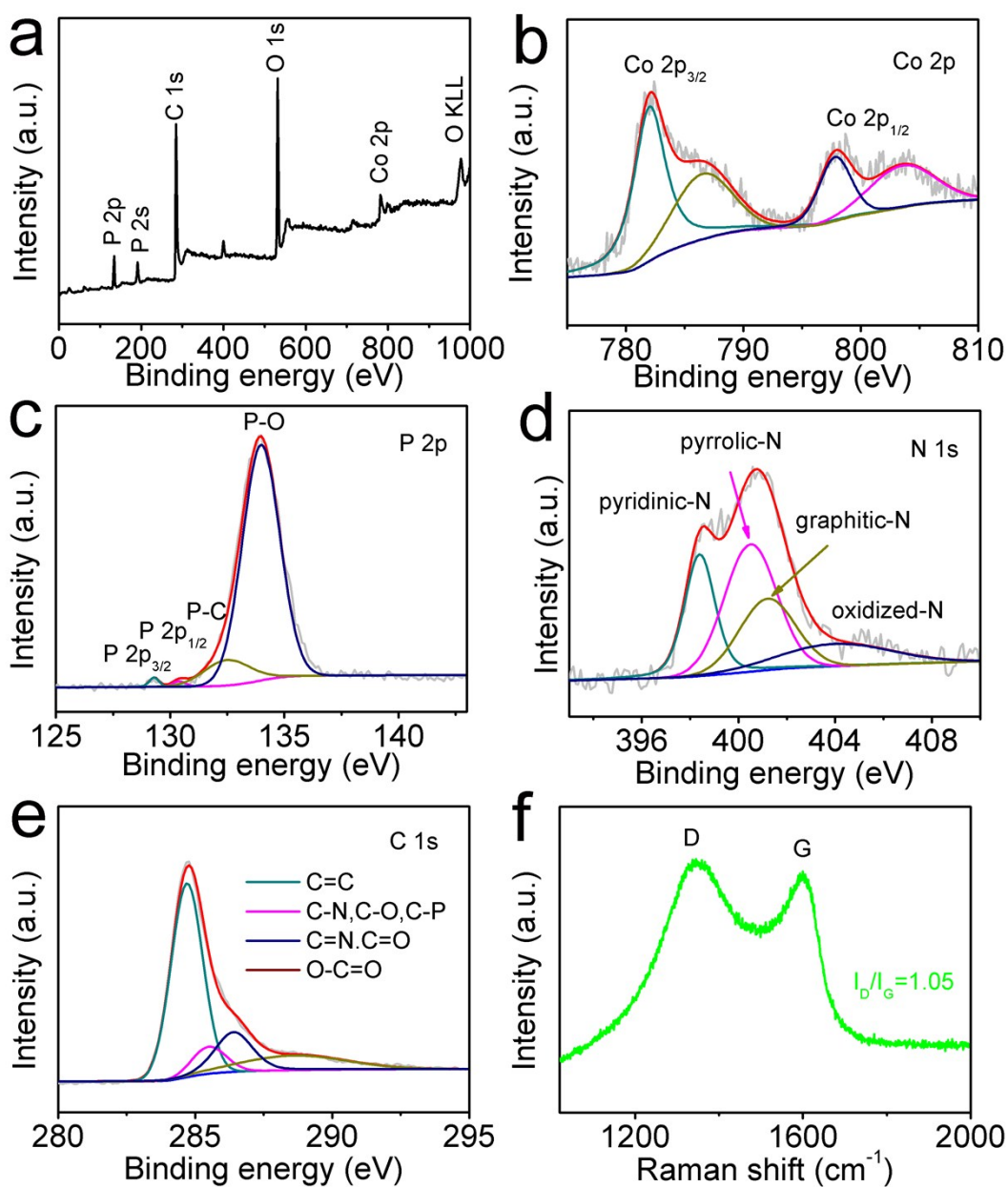


Fig. S7. (a) XPS survey spectrum of CoP NPs@NPC. (b-e) The high-resolution XPS spectra of the CoP NPs@NPC. (f) Raman spectrum of CoP NPs@NPC.

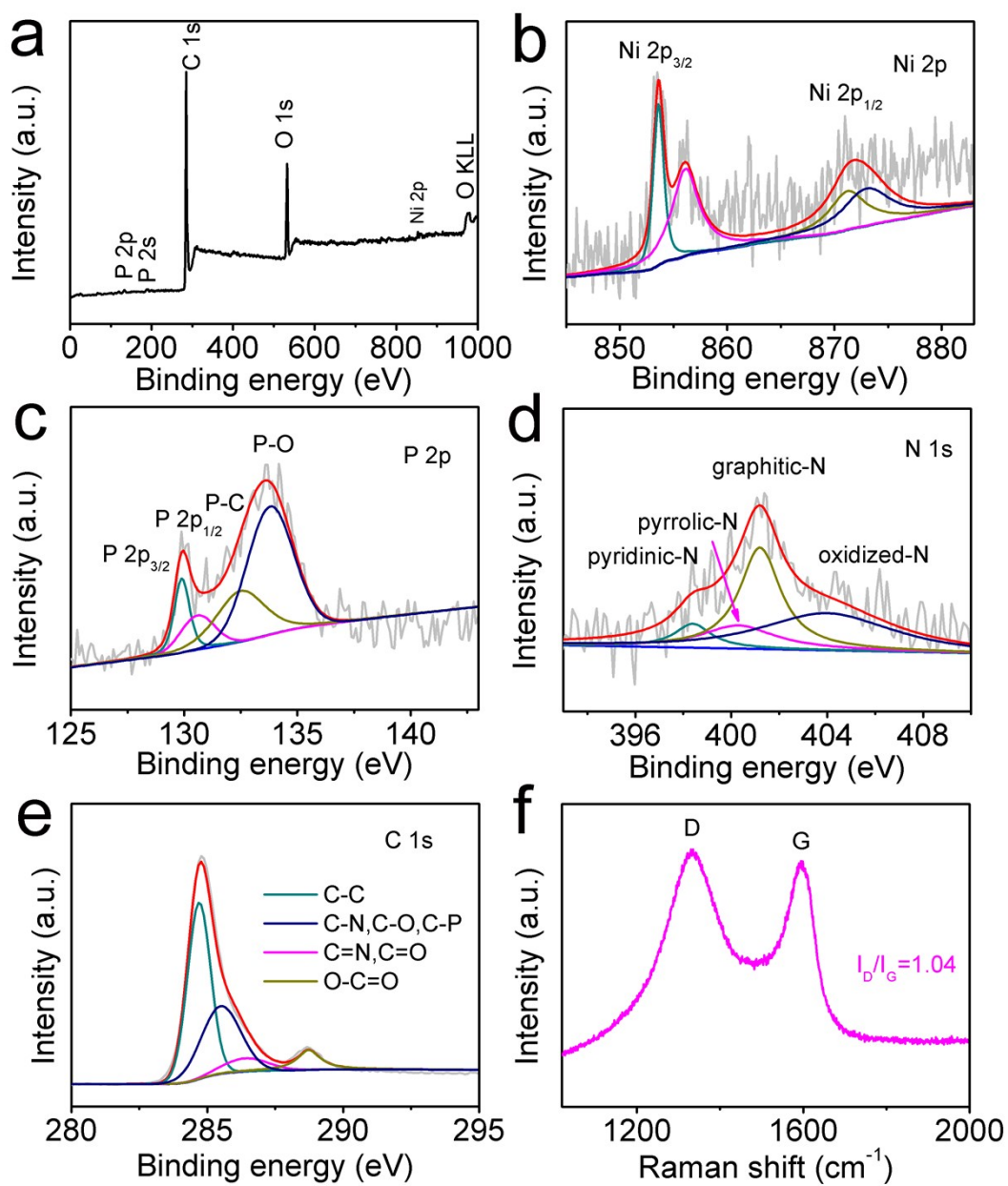


Fig. S8. (a) XPS survey spectrum of Ni_2P NPs@NPC. (b-e) The high-resolution XPS spectra of the Ni_2P NPs@NPC. (f) Raman spectrum of Ni_2P NPs@NPC.

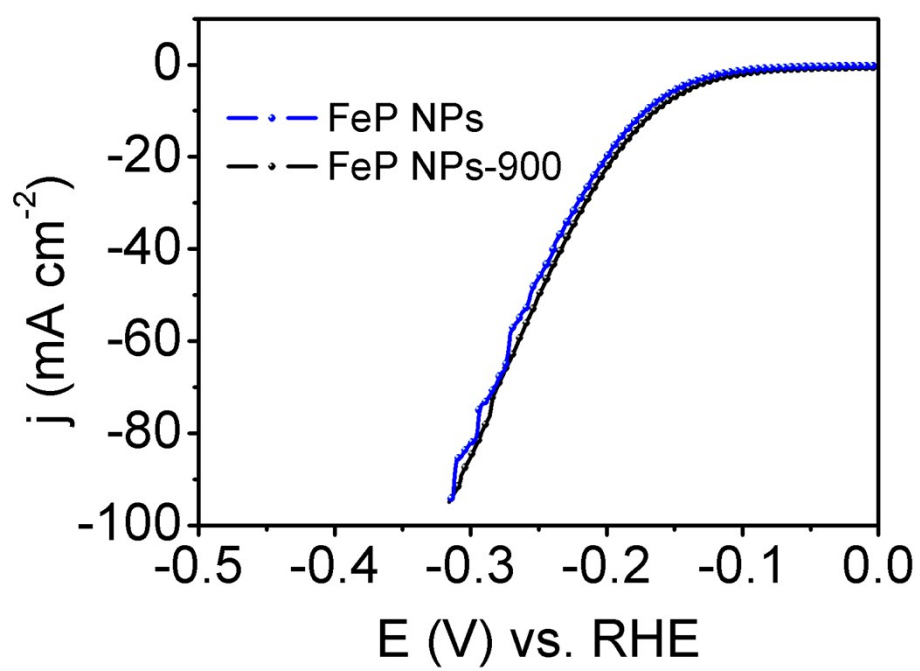


Fig. S9. Polarization curves for FeP NPs and FeP NPs-900.

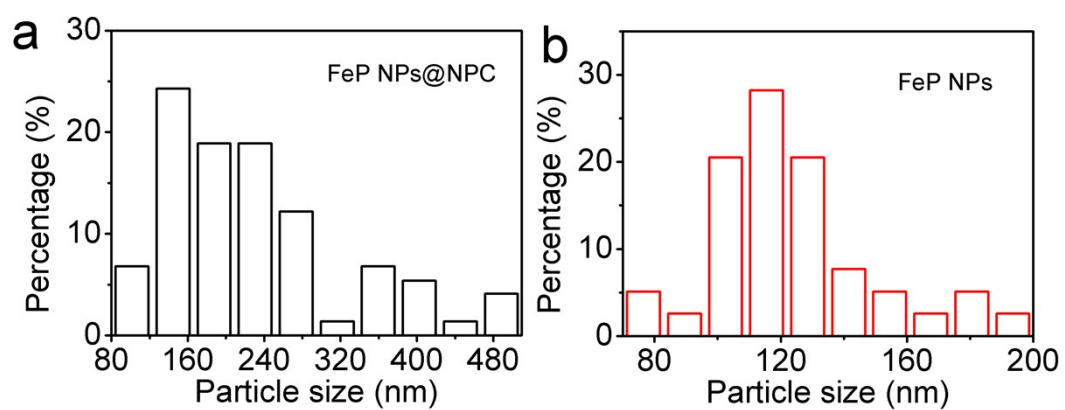


Fig. S10. Size distribution of (a) FeP in FeP NPs@NPC and (b) FeP NPs.

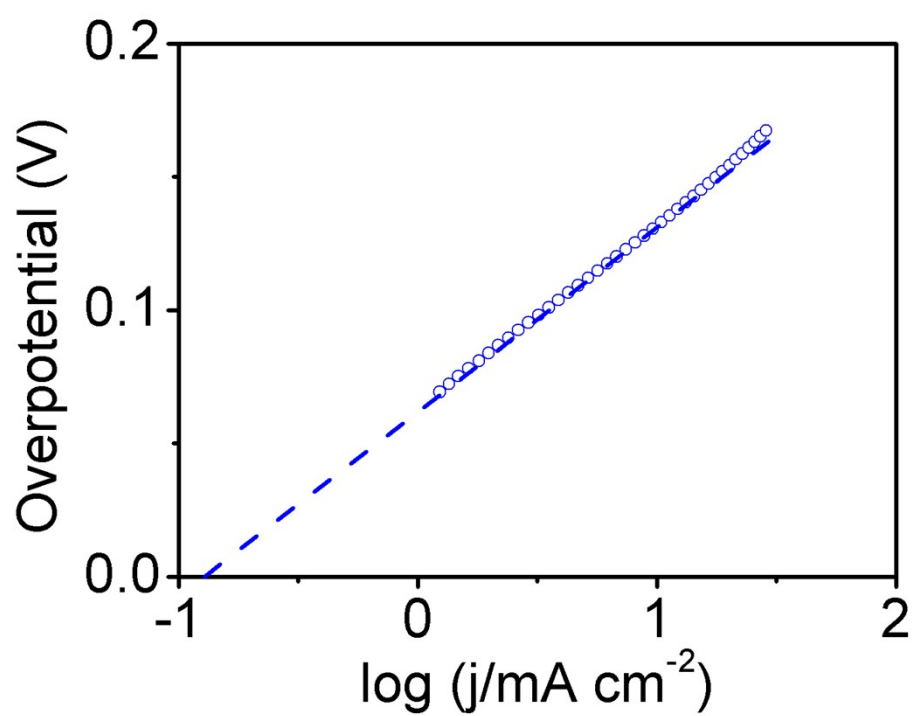


Fig. S11. Calculation of exchange current density of FeP NPs@NPC by applying extrapolation method to the Tafel plot.

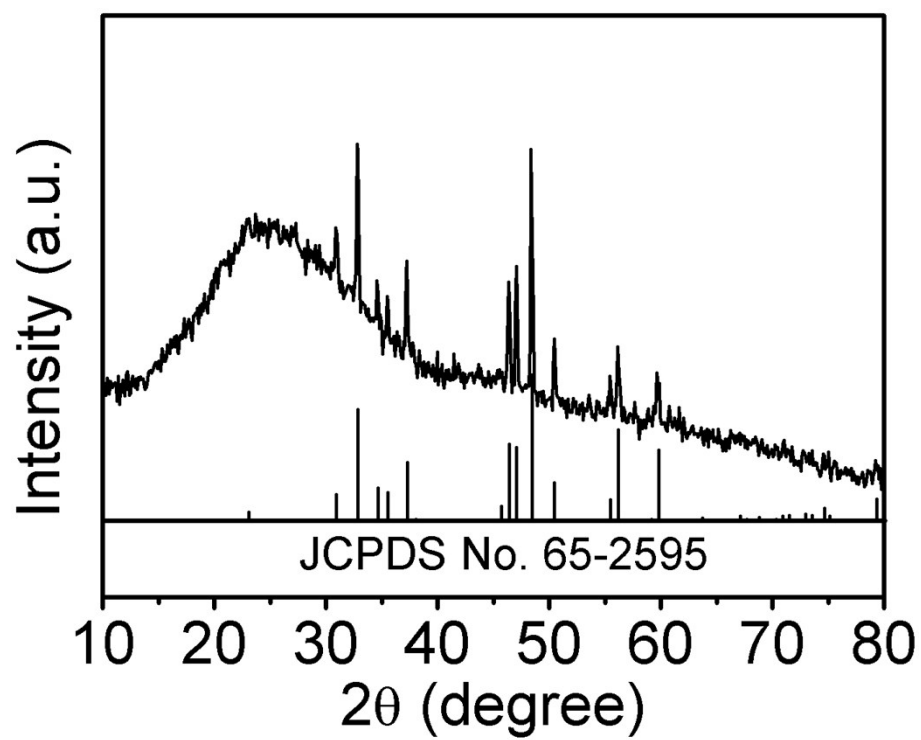


Fig. S12. XRD pattern of FeP NPs@NPC after durability test.

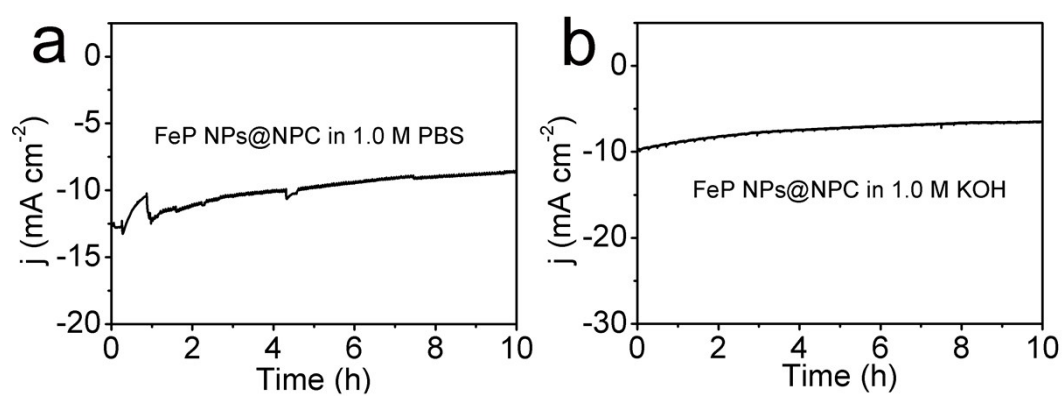


Fig. S13 Time-dependent current density curve for FeP NPs@NPC under static overpotentials of (a) 400 mV in 1.0 M PBS and (b) 220 mV in 1.0 M PBS (without iR-correction).

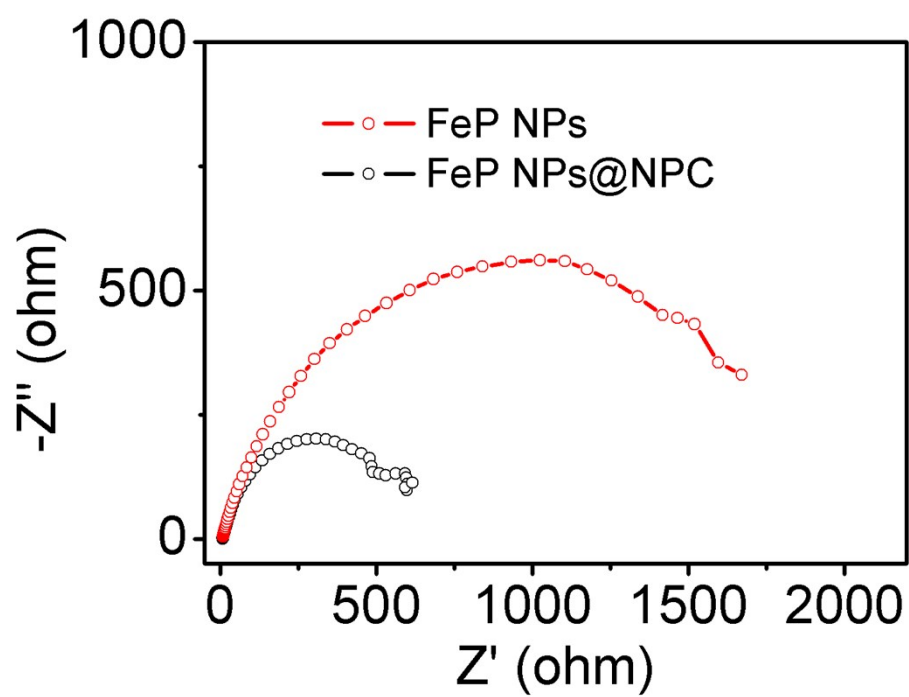


Fig. S14. Nyquist plots of FeP NPs@NPC and FeP NPs in 0.5 M H_2SO_4 .

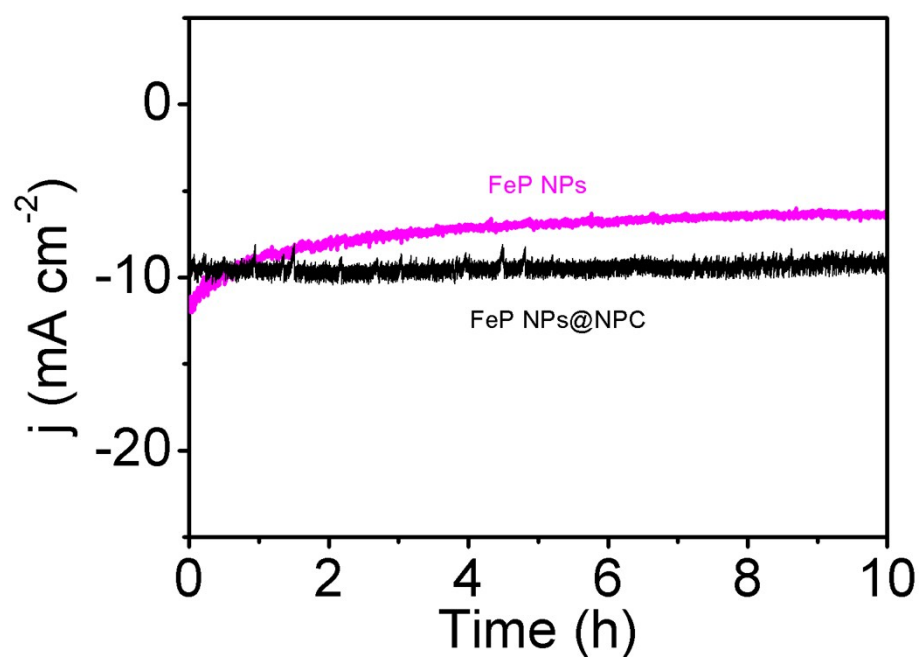


Fig. S15. Time-dependent current density curve for FeP NPs@NPC and FeP NPs.

Table S1. Comparison of HER performance in acidic media for FeP NPs@NPC with TMPs-based HER electrocatalyst.

Catalyst	Electrolyte	Loading amount (mg cm ⁻²)	Current density (<i>j</i> , mA cm ⁻²)	η at the corresponding <i>j</i> (mV)	Exchange current density (mA cm ⁻²)	Ref.
			2	83		
FeP NPs@NC	0.5 M H ₂ SO ₄	1.4	10	130	0.126	This work
			20	153		
FeP nanosheets	0.5 M H ₂ SO ₄	0.28	10	250	-	1
FeP GS	0.5 M H ₂ SO ₄	0.28	10	123	0.12	2
FeP NWs/rGO	0.5 M H ₂ SO ₄	0.204	10	107	-	3
FeP NPs/Ti	0.5 M H ₂ SO ₄	1.5	10	116	-	4
FeP NRs	0.5 M H ₂ SO ₄	0.2	10	120	0.062	5
FeP ₂ /C NPs	0.5 M H ₂ SO ₄	0.425	10	220	1.75*10 ⁻³	6
Fe _x Co _{1-x} P	0.5 M H ₂ SO ₄	2.2	10	37	-	7
Fe-CoP/Ti	0.5 M H ₂ SO ₄	1.03	10	78	-	8
Ni ₂ P hollow NPs	0.5 M H ₂ SO ₄	1.0	10	117	0.033	9
Ni ₁₂ P ₅	0.5 M H ₂ SO ₄	1.0	10	137	-	10
Ni ₂ P NPs	1.0 M H ₂ SO ₄	0.38	20	140	-	11
CoP/CNT	0.5 M H ₂ SO ₄	0.285	10	122	0.288	12
CoP hollow NPs	0.5 M H ₂ SO ₄	2.0	20	80	0.14	13
CoP nanotubes	0.5 M H ₂ SO ₄	0.2	10	129	-	14
Cu ₃ P NWs/Cu	0.5 M H ₂ SO ₄	15.2	10	143	-	15
MoP NPs	0.5 M H ₂ SO ₄	0.36	10	125	0.086	16
Bulk MoP	0.5 M H ₂ SO ₄	0.86	10	135	0.034	17
WP NPs@NC	0.5 M H ₂ SO ₄	2.0	10	102	0.25	18
WP ₂ submicroparticles	0.5 M H ₂ SO ₄	0.5	10	161	0.017	19
WP ₂ nanorods	0.5 M H ₂ SO ₄	0.285	10	148	0.013	20
WP NAs/CC	0.5 M H ₂ SO ₄	2.0	10	130	0.29	21

Table S2. Comparison of HER performance in basic media for FeP NPs@NPC with other non-precious metal HER electrocatalyst.

Catalyst	Electrolyte	Current density (j , mA cm ⁻²)	Overpotential at the corresponding j (mV)	Ref.
FeP NPs@NPC	1.0 M KOH	10	214	This work
FeP NPs/CC	1.0 M KOH	10	218	22
FeP/Fe foil	1.0 M KOH	10	194	23
FeP ₂ /Fe foil	1.0 M KOH	10	189	24
FeP NTs/CC	1.0 M KOH	10	120	24
CoP/CC	1.0 M KOH	10	209	25
Co@NC	1.0 M KOH	10	210	26
Co@NG	1.0 M KOH	10	337	27
Co-NRCNTs	1.0 M KOH	10	370	28
Co-S/FTO	1.0 M KOH	1	480	29
WP ₂ submicroparticles	1.0 M KOH	10	153	19
WP ₂ nanorods	1.0 M KOH	10	225	30
WP NAs/CC	1.0 M KOH	10	150	21
bulk Mo ₂ B	1.0 M KOH	1	250	31
Ni	1.0 M KOH	10	400	31
Ni wire	1.0 M NaOH	10	350	32
Ni-Mo alloy/Ti foil	1.0 M NaOH	10	80	32
Ni ₃ S ₂ /Ni	1.0 M KOH	10	123	33
Ni-Co-S nanosheets	1.0 M KOH	10	140	34
Zn _{0.76} Co _{0.24} S/CoS ₂	1.0 M KOH	20	238	35
Amorphous Ni-B	1.0 M KOH	20	125	36

Table S3. Comparison of HER performance in neutral media for FeP NPs@NPC with other non-precious metal HER electrocatalyst.

Catalyst	Electrolyte/pH	Current density (j , mA cm ⁻²)	Overpotential at the corresponding j (mV)	Ref.
FeP NPs@NPC	1.0 M PBS	2	163	This work
		10	386	
FeP/Ti	1.0 M PBS	10	200	4
FeP/CC	1.0 M PBS	10	202	22
FeP NPs/CC	1.0 M PBS	20	230	36
WP ₂ nanorods	1.0 M PBS	2	172	30
Co-NRCNTs	0.1 M PBS	2	380	28
bulk Mo ₂ C	pH=7	1	200	31
bulk Mo ₂ B	pH=7	1	250	31
H ₂ -CoCat/FTO	0.5 M KPi	2	385	38
Co-S/FTO	1.0 M PBS	2	83	29
CuMoS ₄ crystals	pH=7	2	210	39
Ni ₃ S ₂ /Ni	1.0 M PBS	10	220	33

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