Supporting Information

Low-Cost High-Performance Hydrogen Evolution Electrocatalysts based on Pt-CoP Polyhedra with Low Pt Loading in both Alkaline and Neutral Media

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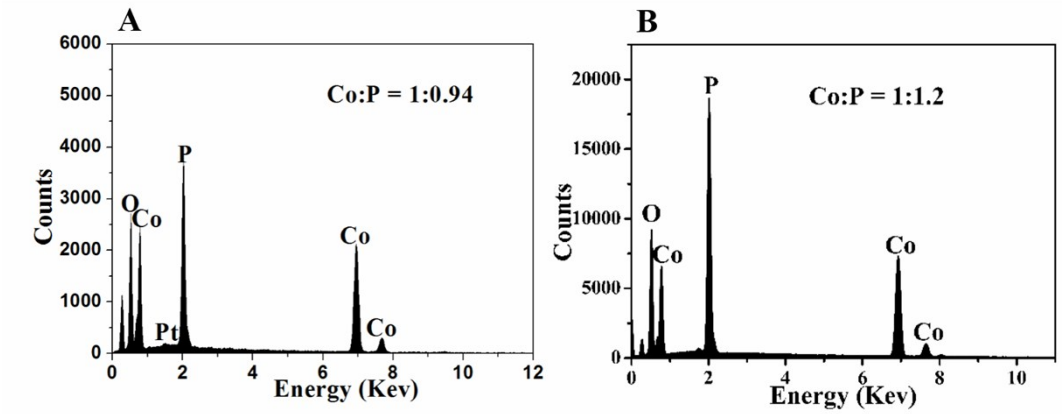

Fig. S1. EDS spectra of (A) YS-Pt-CoP polyhedra and (B) CoP hollow polyhedra.

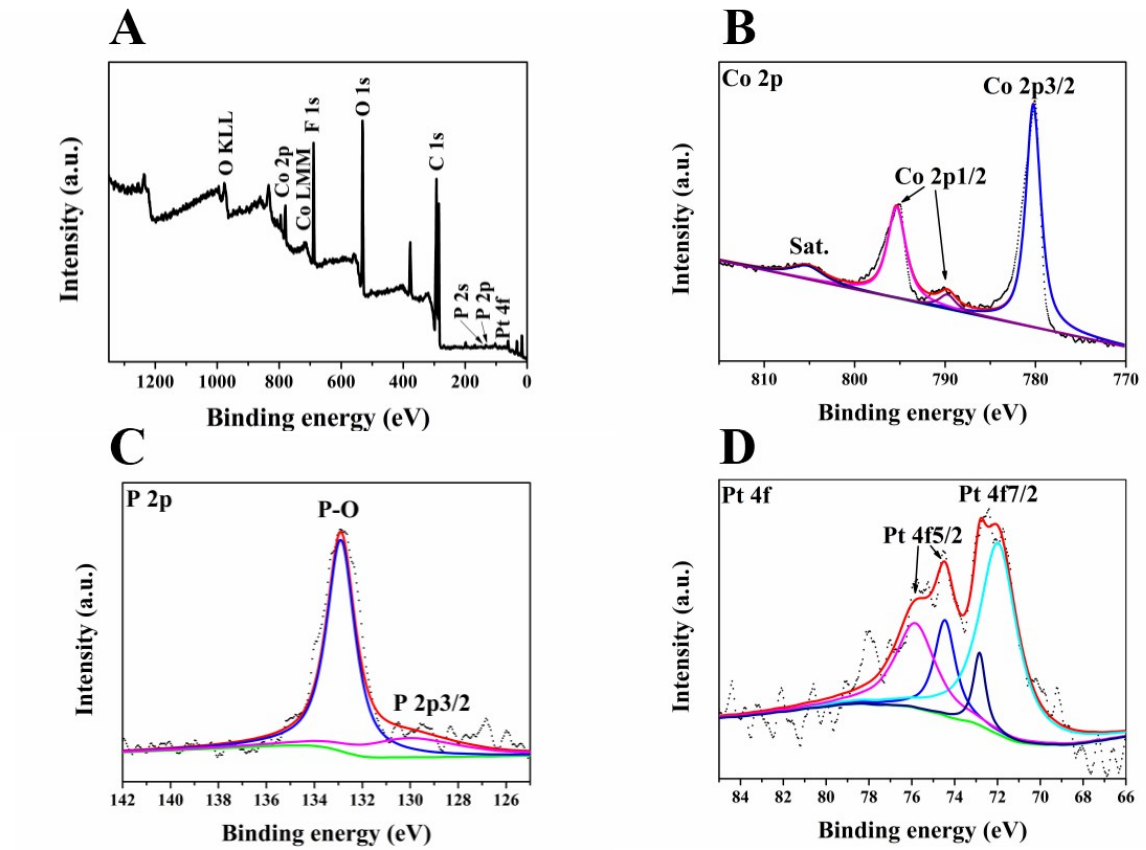

Fig. S2. (A) XPS survey spectrum for YS-Pt-CoP. XPS spectra in the (B) Co 2p, (C) P 2p, and (D) Pt 4f after electrolysis in 1 M KOH.

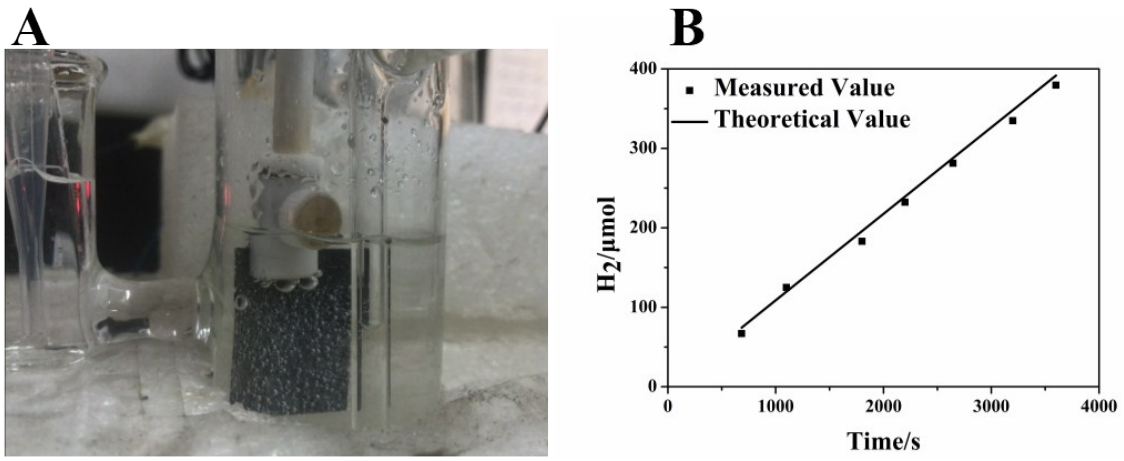

Fig. S3. (A) Digital image of H_2 bubbles attached to the carbon paper loaded with YS-Pt-CoP. (B) Electrocatalytic efficiency of H_2 production for YS-Pt-CoP at -0.3 V, measured for 60 minutes in 1 M KOH solution.

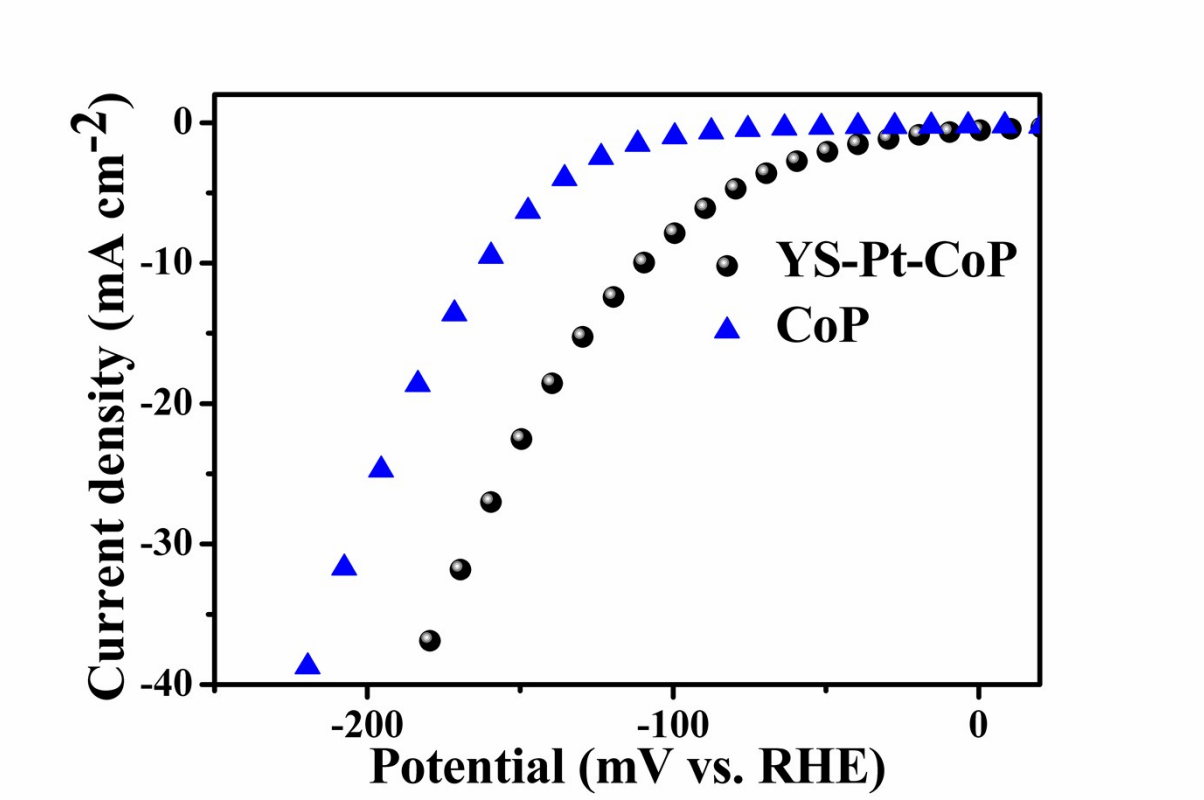

Fig. S4. LSV curves of YS-Pt-CoP and CoP in 1 M KOH without iR compensation.

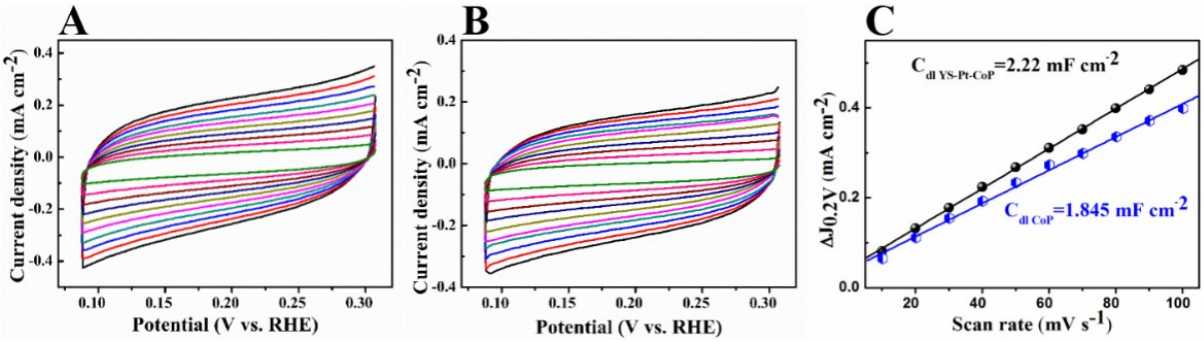

Fig. S5 (A) CVs of (A) YS-Pt-CoP and (B) CoP with various scan rates (10-100 mV s^{-1}) in 1 M KOH. (C) Capacitive current density at 0.2 V (vs. RHE) as a function of the scan rate for YS-Pt-CoP (black spheres) and CoP (blue polygons), respectively.

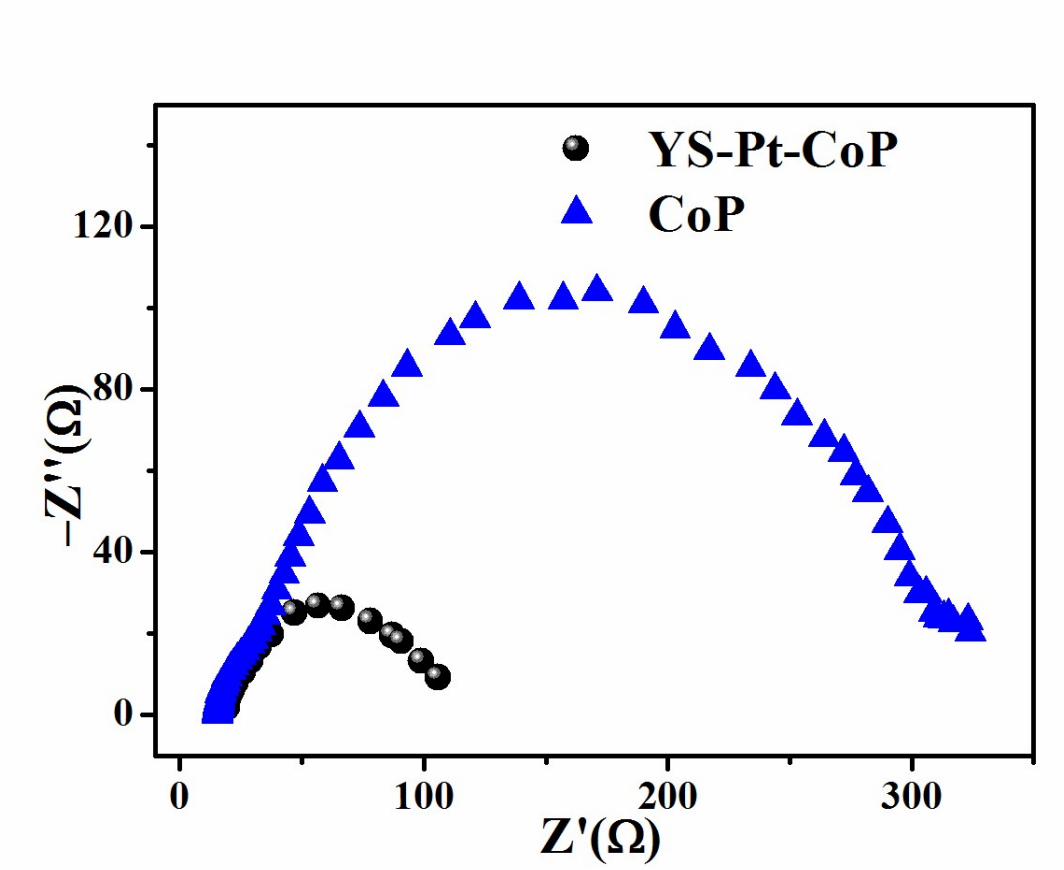

Fig. S6. Nyquist plots of YS-Pt-CoP and CoP at overpotential of 200 mV in 1 M PBS solution.

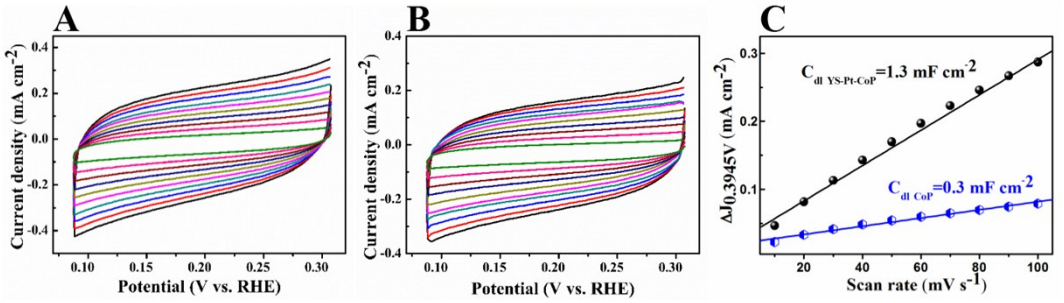

Fig. S7. CVs of (A) YS-Pt-CoP and (B) CoP with various scan rates (10-100 mV s^{-1}) in 1 M PBS solution. (C) the capacitive current densities at 0.4 V (vs. RHE) as a function of the scan rate for YS-Pt-CoP (black spheres) and CoP (blue polygons), respectively.

Table S1. Comparison of HER performance of YS-Pt-CoP polyhedra with other HER catalysts in 1 M KOH solution.

Catalysts	Loading (mg cm^{-2})	Overpotential@10 (mV@mA cm^{-2})	Tafel Slope (mV/dec)	Mass activity at η=40 mV (A mg^{-1})	Stability	References
$Ni_{1.5}Co_{1.4}P$@Ru	0.28	52	49	-	6 h (100% of 0.052 V at 10 mA cm^{-2})[b]	18
RuCoP	Ru, ca. 0.06	23	37	0.35[a]	150 h (little degradation of 0.023 V at 10 mA cm^{-2})	20
RuP_2@NPC nanoparticle	1.0 (Ru, 0.233)	52	69	0.03	2000 cycles (100%)	S1
RuP_x@NPC	0.199 (Ru, 0.0257)	74	70	0.194	1000 cycles (negligible degradation)	S2
CoP/NC	0.306	129	58	-	24 h (negligible loss of current density at 0.10 V)	S3
Pt-$Co(OH)_2$/CC	Pt, 0.39	32	70	0.033	1000 cycles (88.5%)	S4
Pt nanowire/SL-$Ni(OH)_2$	Pt, 0.016	70	-	0.05	4000 s (95.7% of 0.077 V)	S5
CoP hollow polyhedra	**0.28**	**154**	**57**	-	-	**This work**
Pt/C	**0.28 (Pt, 0.056)**	**32**	**33**	**0.237**	**-**	**This work**
YS-Pt-CoP polyhedra	**0.28 (Pt, 0.011)**	**48**	**54**	**0.697**	**1,000 cycles (100%), 44 h (little attenuation of 0.048 V at 10 mA cm^{-2})**	**This work**

[a] "0.35" means that Pt mass activity of the samples based on the corresponding noble metal mass is estimated to be 0.35 A mg^{-1} from the literature. [b] "6 h (100% of 0.052 V at 10 mA cm^{-2})" means that the HER operating potential of the corresponding catalyst remained 100% of its initial value of 0.052 V after 6 h for obtaining j_{HER}= 10 mA cm^{-2}. [c] "10000 cycles (100%)" means that the HER polarization curve of the corresponding catalyst remained unchanged after 10000 potential cycles.

Table S2. Comparison of HER performance of YS-Pt-CoP with other HER catalysts in neutral environment.

Catalysts	Loading (mg cm^{-2})	Overpotential@10 mA cm^{-2} (mV)	Tafel Slope (mV/dec)	Mass activity At η=40 mV (A mg^{-1})	Stability	References
RuP_2@NPC	Ru, ca. 0.233	57	87	0.027[b]	2000 cycles (100%)[c]	S1
RuP_x@NPC	0.199 (Ru, 0.0257)	110	59	0.0257	1000 cycles (negligible degradation)	S2
Pt-$Co(OH)_2$/CC[a]	Pt, 0.39	84	-	0.009	1000 cycles (100%)	S4
CoP@BCN	0.4	122	59	-	2000 cycles (100%)	S6
Ni_2P	0.246	164	81	-	20 h (94.2% of the initial current density)	S7
MoP NPs@NC	2.0	136	71	-	10000 cycles (negligible degradation)	S8
$Ni_{0.5}$-NCNFs-Pt[a]	0.28 (Ru, 0.023)	84	38	0.087	Little decrease after 1000 cycles	S9
CoP hollow polyhedra	**0.28**	**172**	**81**	-	-	**This work**
Pt/C	**0.28 (Pt, 0.056)**	**33**	**35**	**0.237**	-	**This work**
YS-Pt-CoP polyhedra	**0.28 (Pt, 0.011)**	**88**	**74**	**0.3**	**44 h (little attenuation of 0.09 V at 10 mA cm^{-2})**[d]	**This work**

[a] The electrolyte of Pt-$Co(OH)_2$/CC and $Ni_{0.5}$-NCNFs-Pt is 0.1 M PBS solution while the electrolyte of other catalysts is 1 M PBS solution. [b] "0.027" means that mass activity of the samples based on the corresponding noble metal mass is estimated to be 0.027 A mg^{-1} from the literature. [c] "2000 cycles (100%)" means that the HER polarization curve of the corresponding catalyst remained unchanged after 2000 potential cycles. [d] "44 h (little attenuation of 0.09 V at 10 mA cm^{-2})" means that the corresponding catalyst exhibited little degradation for obtaining j= 10 mA cm^{-2}.

References

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