

## Electronic Supplementary Information (ESI)

### A highly active and durable CuPdPt/C electrocatalyst for an efficient hydrogen evolution reaction

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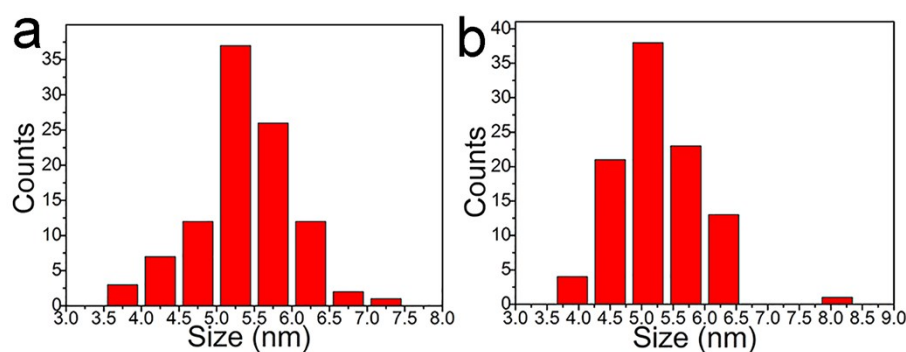
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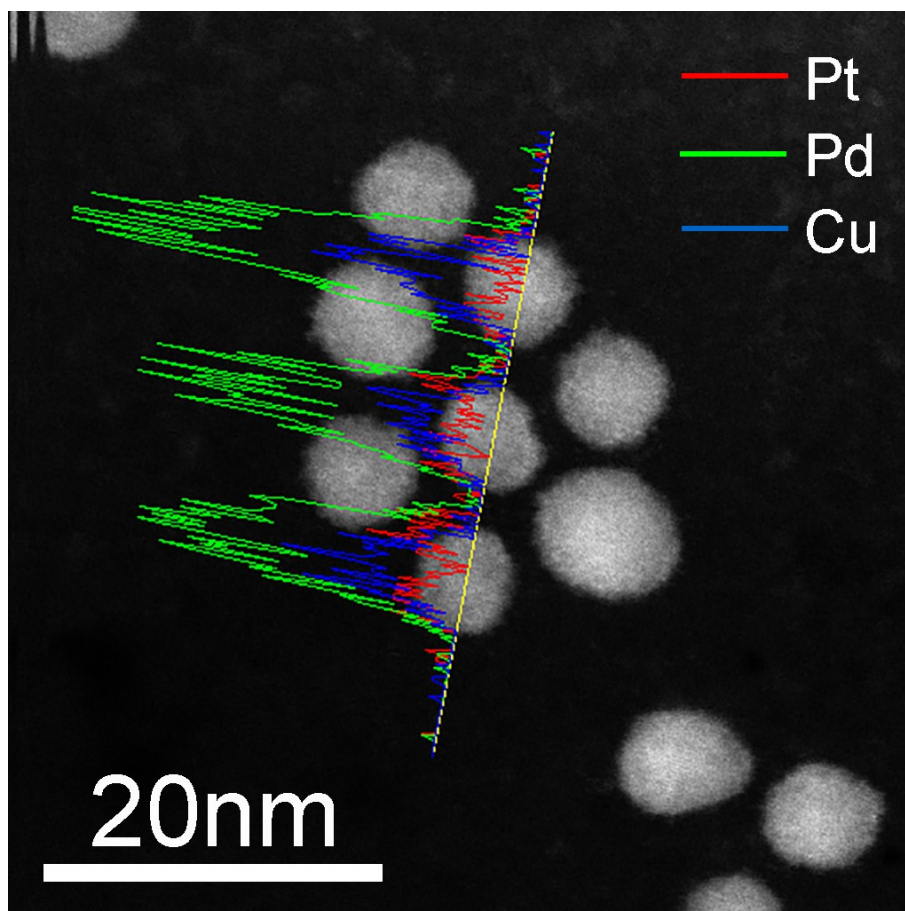
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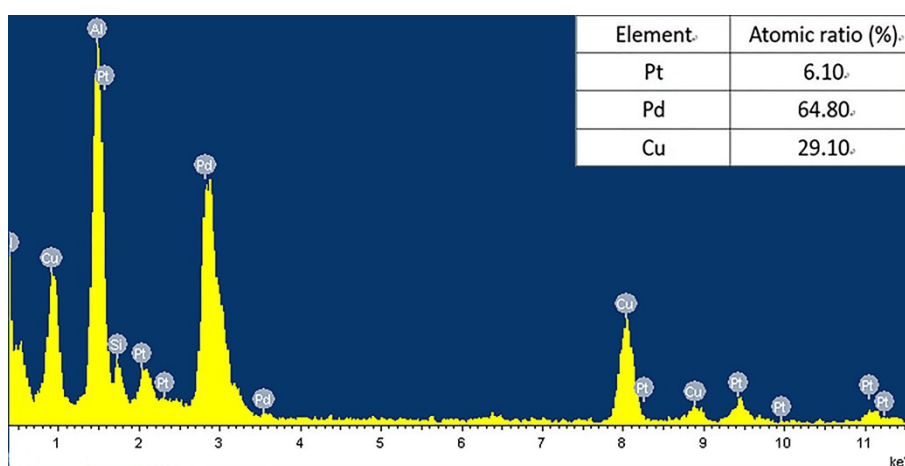
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**Fig. S1** The size-distribution histograms of the as-synthesized (a) CuPd and (b) CuPdPt nanocrystals.



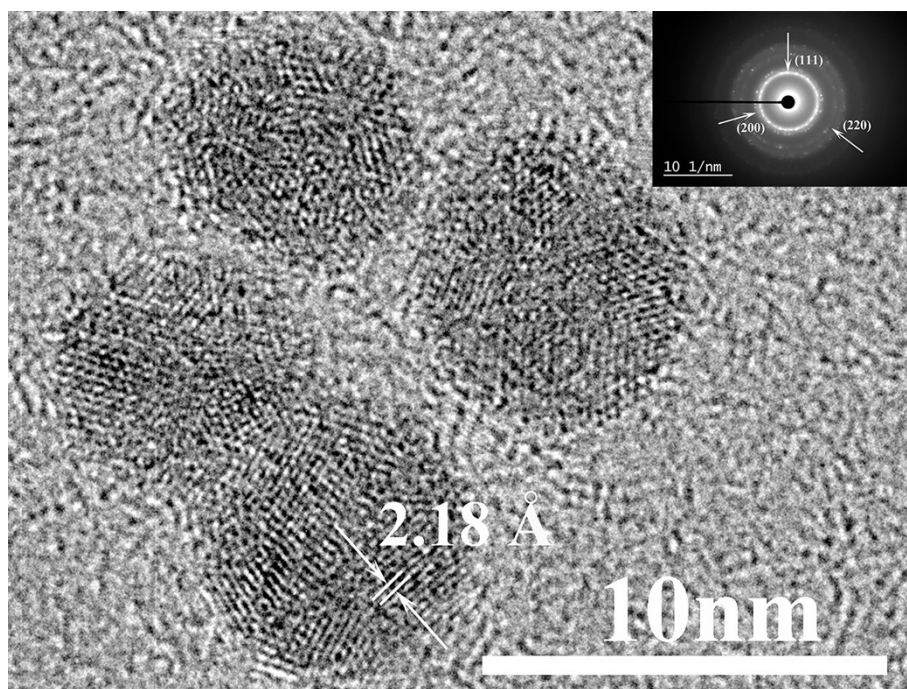
**Fig. S2** EDX line scan of the CuPdPt nanocrystals.



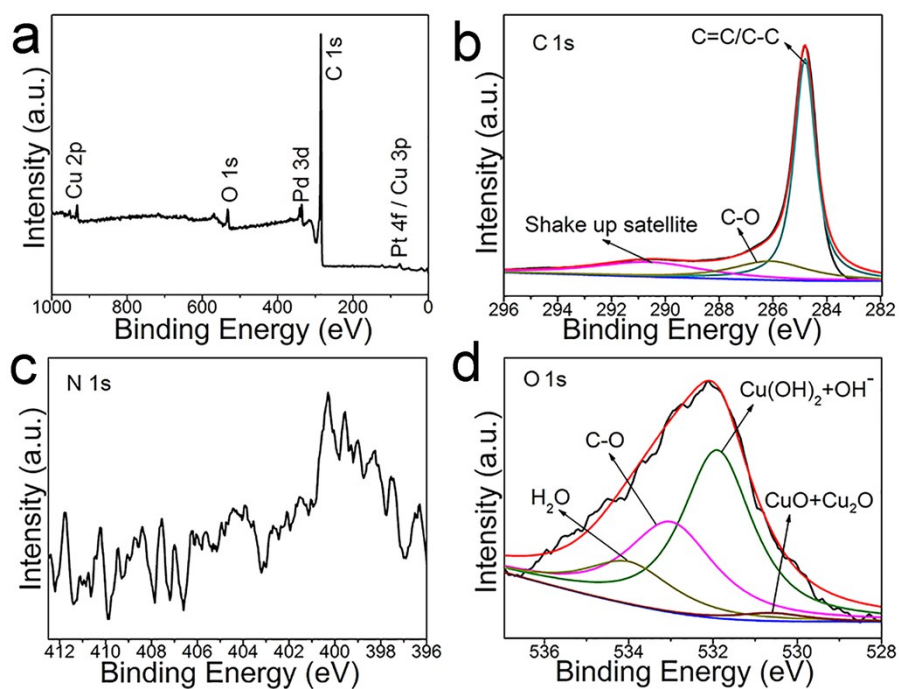
**Fig. S3** EDX spectrum of the as-synthesized CuPdPt nanocrystals shown in Fig. 3. The signal of Al arises from the TEM grid made of elemental Al.

**Table. S1** Elemental Analyses of the CuPdPt nanocrystals by different analytical methods.

Analyses	Atomic ratio (%)		
	Pt	Pd	Cu
EDX	6.10	64.80	29.10
XPS	6.30	60.87	32.83
ICP-AES	5.72	60.54	33.74



**Fig. S4** HRTEM image and corresponding SEAD pattern of the CuPdPt nanocrystals.



**Fig. S5** XPS survey spectrum (a) and the close-up spectra of C 1s (b), N 1s (c), O 1s (d) of the CuPdPt/C catalyst.

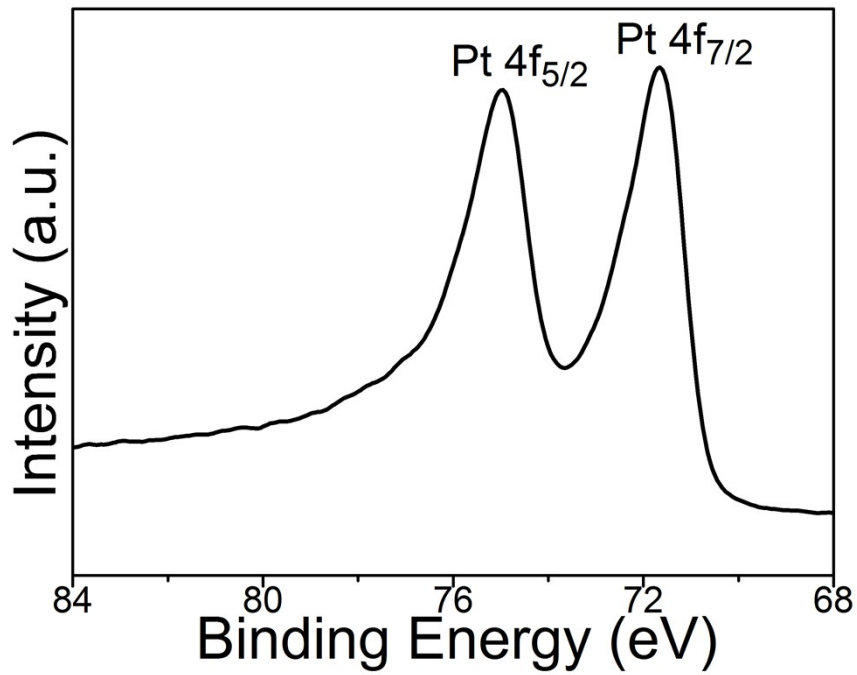


Fig. S6 The close-up XPS spectrum of Pt 4f in the commercial Pt/C (60 wt%).

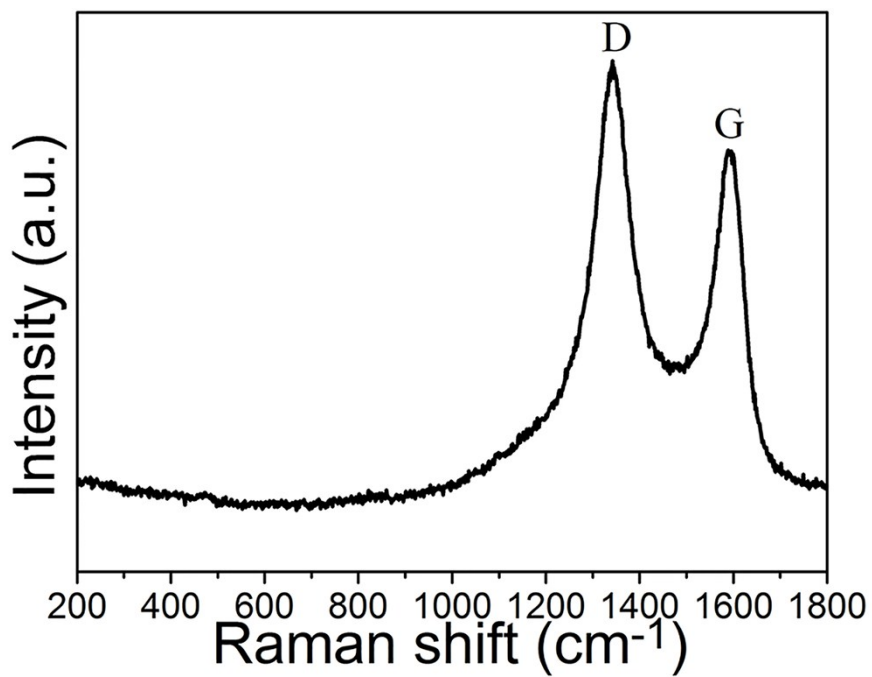
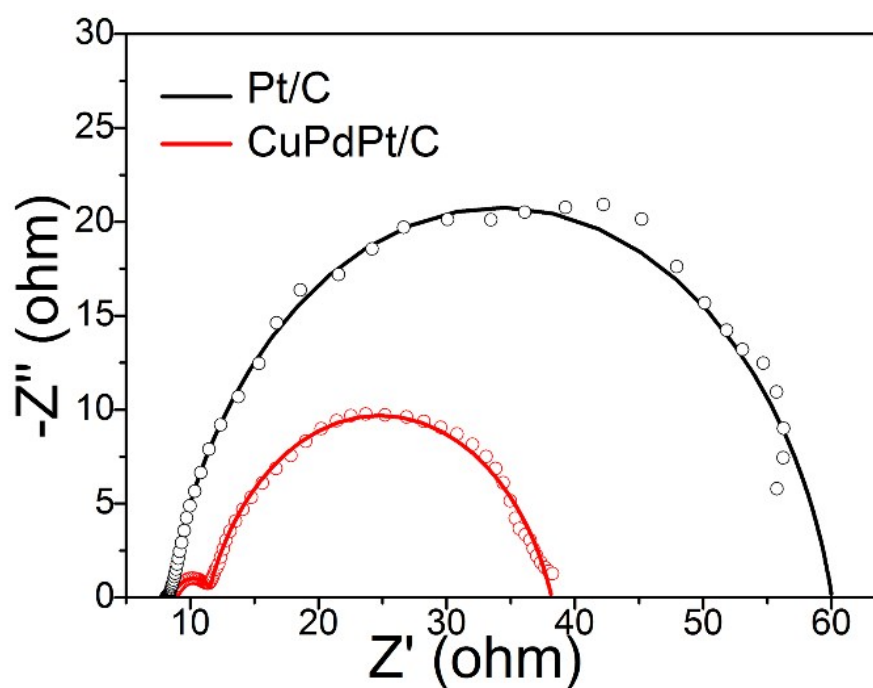


Fig. S7 Raman spectrum of the as-prepared CuPdPt/C catalyst.

**Table S2** Comparison of the HER performance for the present CuPdPt/C catalyst with other recent reported Pt-based HER electrocatalysts.

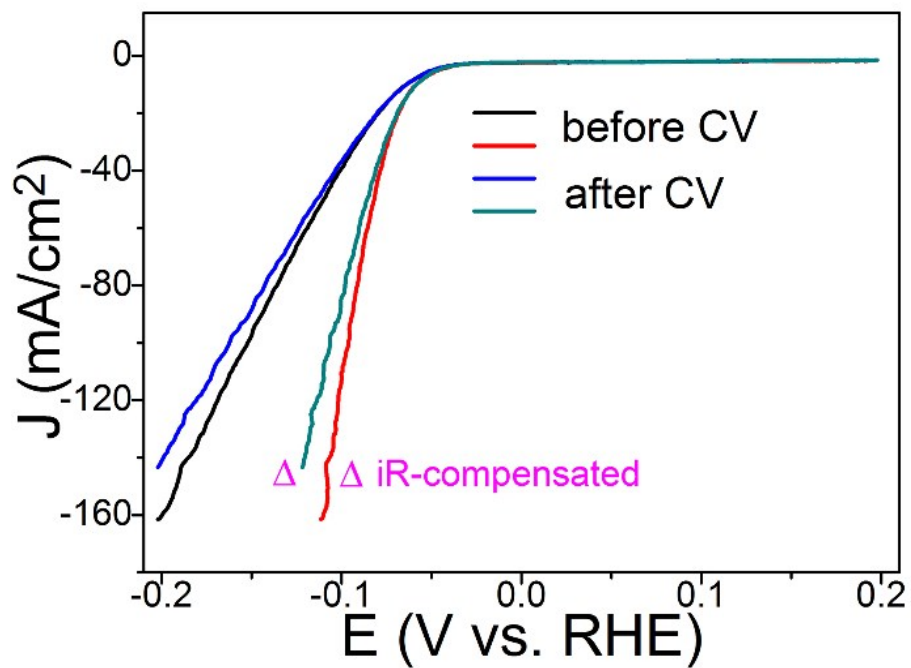
Catalyst	Electrolyte	Onset potential (mV)	Tafel slope (mV/dec)	$\eta_{10}$ (mV)	Exchange current density(mA/cm <sup>2</sup> )	Reference
Pt/BCF	0.5 M H <sub>2</sub> SO <sub>4</sub>	N/A	32	55	N/A	<i>Catal. Today</i> , 2016, <b>262</b> , 141-145
PtFeCo TriStar	0.5 M H <sub>2</sub> SO <sub>4</sub>	N/A	21/22/24 /25	N/A	N/A	<i>Adv. Mater.</i> , 2016, <b>28</b> , 2077-2084
Pt-Ni/C	0.1 M KOH	N/A	59	N/A	N/A	<i>J. Mater. Chem. A</i> , 2016, <b>4</b> , 12392-12397
Pt <sub>13</sub> Cu <sub>73</sub> Ni <sub>14</sub> /CNF@CF	1 M H <sub>2</sub> SO <sub>4</sub>	N/A	38	N/A	N/A	<i>ACS Appl. Mater. Interfaces</i> , 2016, <b>8</b> , 3464-3472
Pt-Pd-rGO	0.5 M H <sub>2</sub> SO <sub>4</sub>	N/A	10/22/25	N/A	N/A	<i>Angew. Chem. Int. Ed.</i> , 2014, <b>53</b> , 12120-12124
Pt/MoS <sub>2</sub>	0.5 M H <sub>2</sub> SO <sub>4</sub>	N/A	40	N/A	N/A	<i>Nat. Commun.</i> , 2013, <b>4</b> , 1444
CuPdPt/C	0.5 M H <sub>2</sub> SO <sub>4</sub>	~-25	25	55	0.07	Present work



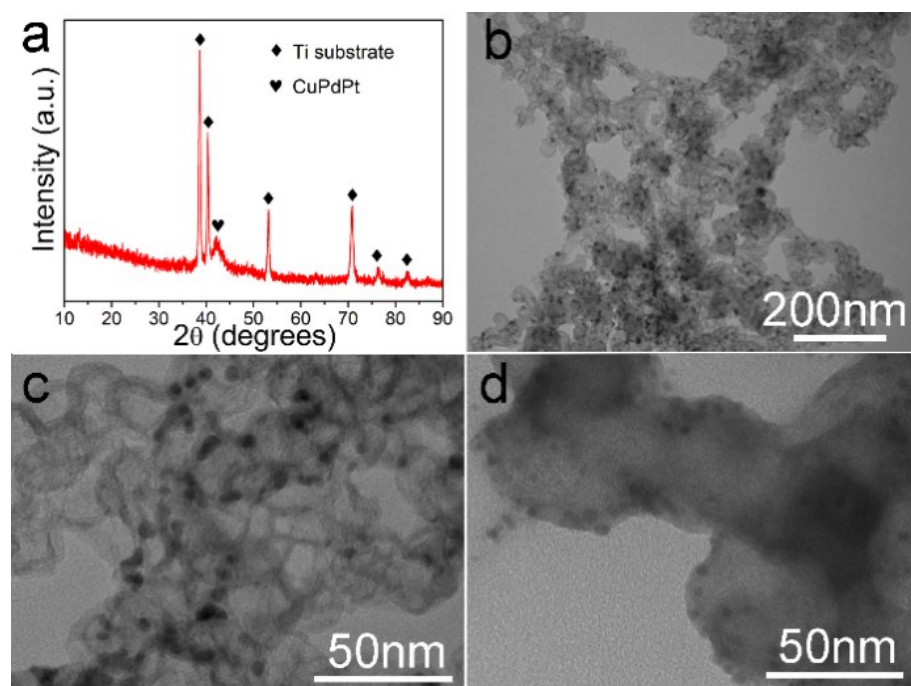
**Fig. S8** Nyquist plots of the CuPdPt/C and commercial Pt/C catalysts at an overpotential of 50 mV.

Z' is real impedance, and Z'' is imaginary impedance.

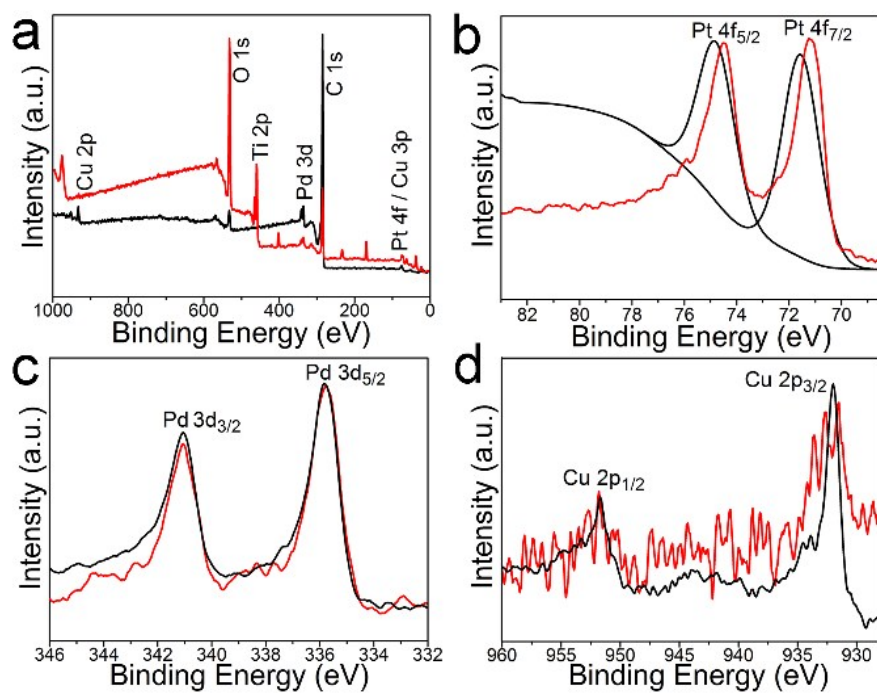




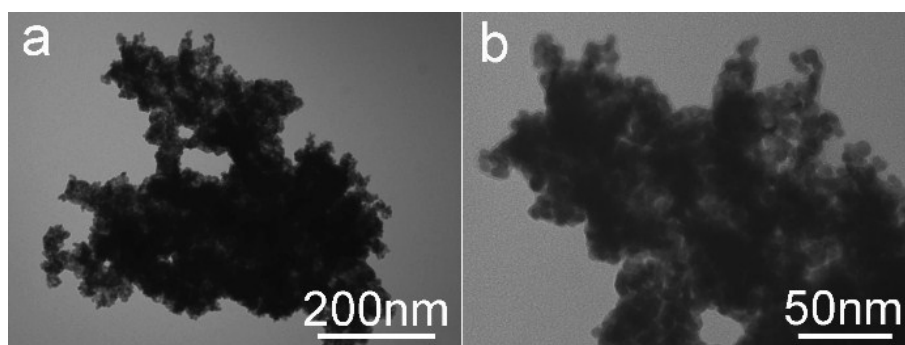
**Fig. S9** Durability test for the commercial 60 wt% Pt/C catalyst before and after iR-compensation, respectively.



**Fig. S10** XRD pattern (a) and TEM images (b-d) of the spent catalyst after HER stability test.



**Fig. S11** Comparison of XPS spectra for the catalyst before (black) and after (red) HER stability test: survey spectrum (a), spectra of Pt 4f (b), Pd 3d (c) and Cu 2p (d), respectively.



**Fig. S12** TEM images of the CuPdPt nanocrystals directly loaded on Ti substrate after HER stability test.