Electronic Supplementary Information

Design of ternary Pt-CoZn alloy catalysts coated with N-doped carbon towards acidic oxygen reduction

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1. Supplementary Figures

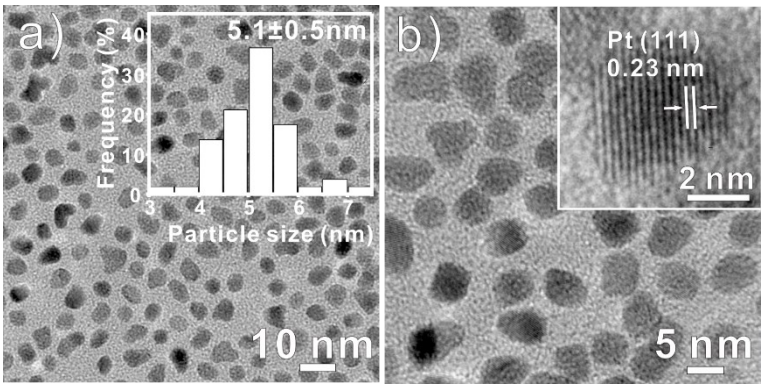

Fig. S1 (a-b) TEM images of PVP capped Pt NPs. The inset in (a) shows the particle size distribution, and the inset in (b) shows the interplanar spacing of Pt NPs.

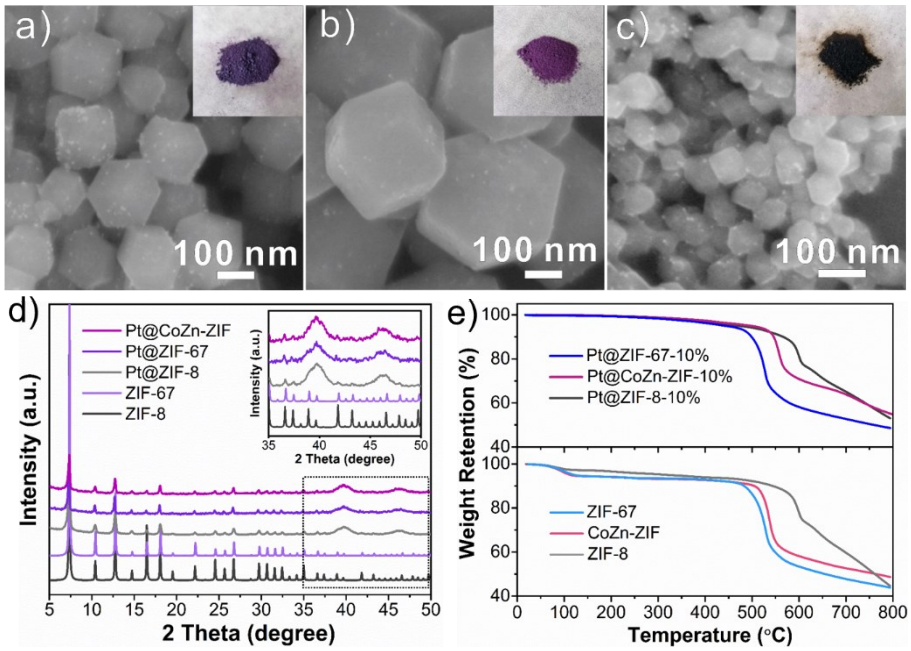

Fig. S2 SEM image and photographs of (a) Pt@CoZn-ZIF, (b) Pt@ZIF-67, and (c) Pt@ZIF-8. (d) Powder XRD patterns of precursors and ZIFs. The inset shows detail patterns from 35 to 50 degree. (e) TGA curves of precursors and ZIFs. Here the content of Pt NPs in every precursors is 10 wt_{Pt}%.

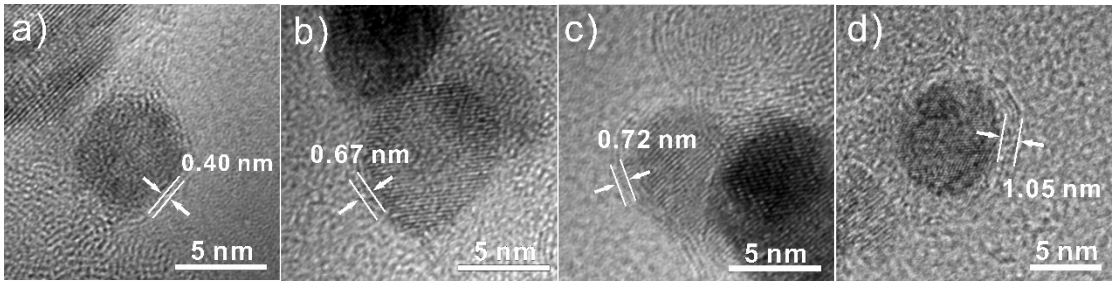

Fig. S3 (a-d) HRTEM images of alloy NPs embedded in the carbon matrix of Pt-CoZn@NC-800-10%.

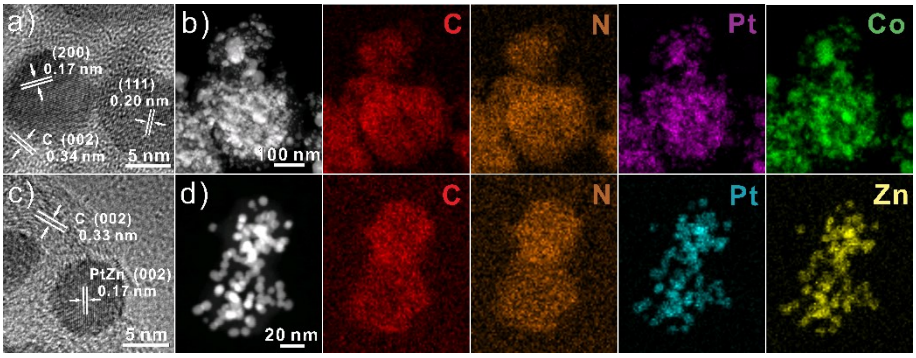

Fig. S4 (a) HRTEM image and (b) HAADF-STEM image with corresponding element mappings of Pt-Co@NC-800-10% catalyst. (c) HRTEM image and (d) HAADF-STEM image with the corresponding element mappings of Pt-Zn@NC-800-10% catalyst.

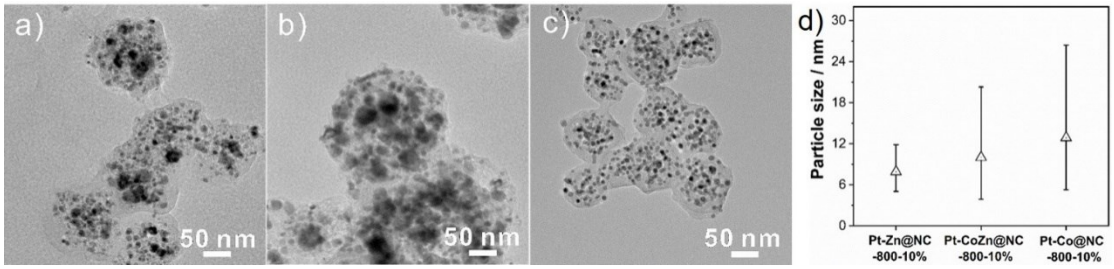

Fig. S5 TEM images of (a) Pt-CoZn@NC-800-10%, (b) Pt-Co@NC-800-10%, and (c) Pt-Zn@NC-800-10%. (d) The size distribution of alloy nanoparticles of three samples.

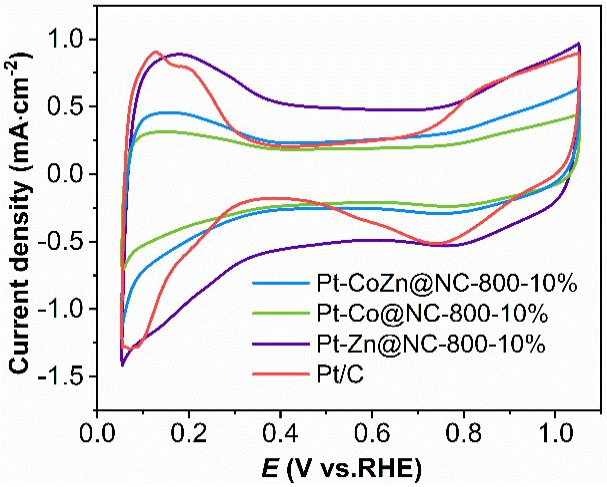

Fig. S6 CV curves of three catalysts in a N_2-saturated 0.1 M $HClO_4$ solution with scan rate of 50 $mV \cdot s^{-1}$.

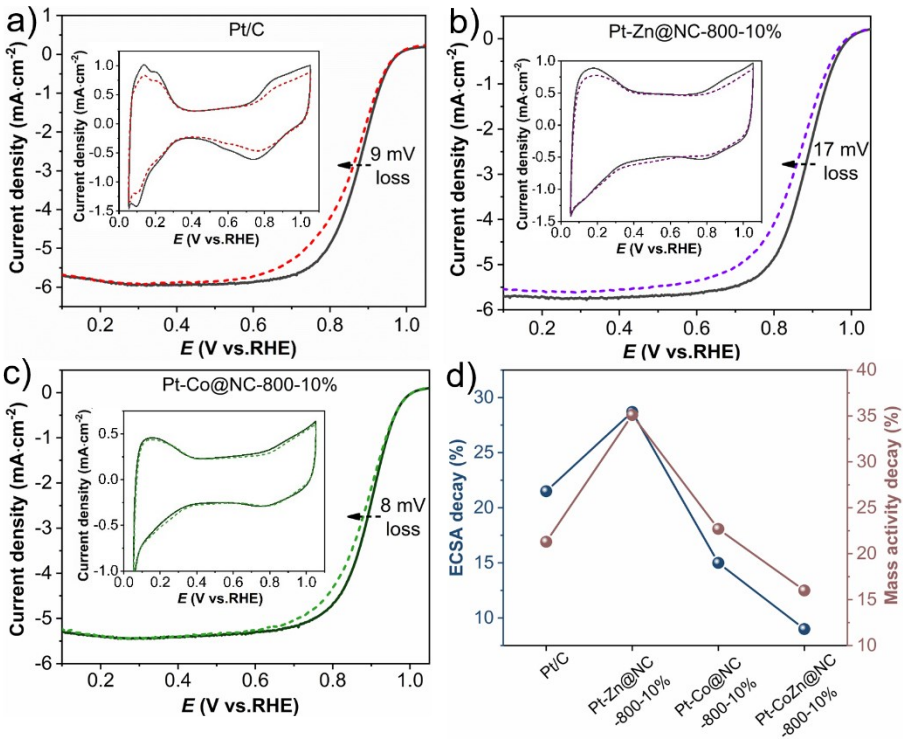

Fig. S7 ORR polarization curves of (a) the commercial Pt/C, (b) Pt-Zn@NC-800-10%, and (c) Pt-Co@NC-800-10% catalysts before and after 5,000 cycles in ADT. The insets show the change of CV results. (d) The decay of mass activity and ECSA for different catalysts during ADT.

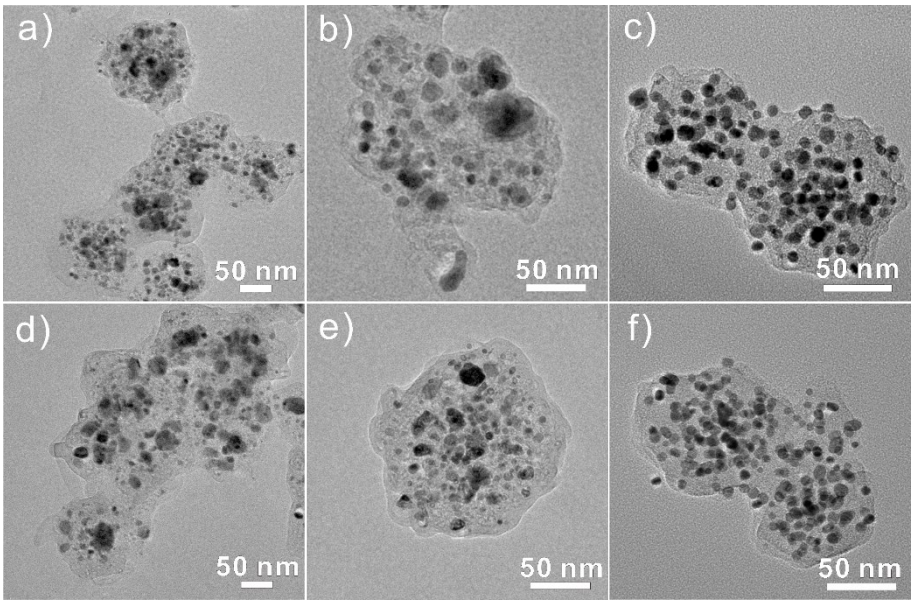

Fig. S8 TEM images of Pt-CoZn@NC-800-10% (a) before and (d) after ADT, Pt-Co@NC-800-10% (b) before and (e) after ADT, and Pt-Zn@NC-800-10% (c) before and (f) after ADT.

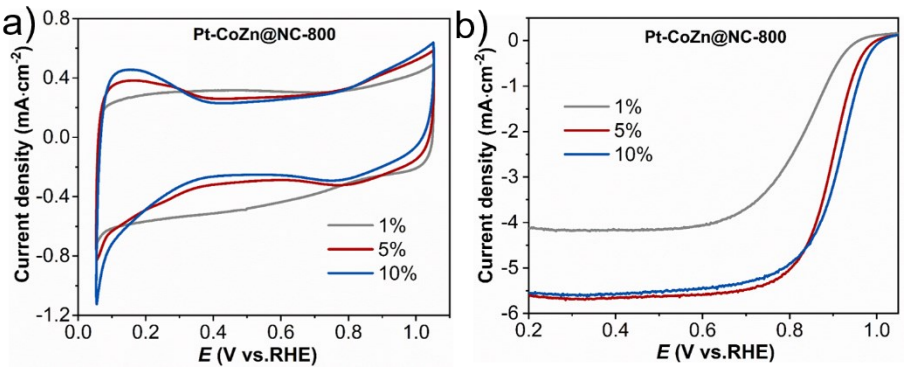

Fig. S9 (a) CV curves and (b) polarization curves of Pt-CoZn@NC-800 catalysts with different Pt loading amounts.

2. Supplementary Tables

Table S1. Pt, Co, and Zn content of different catalysts test by ICP-MS.

Samples	Wt_{Pt}%	Wt_{Co}%	Wt_{Zn}%
Pt-CoZn@NC-800-10%	18.3	31.9	9.3
Pt-Co@NC-800-10%	16.5	15.8	0
Pt-Zn@NC-800-10%	17.2	0	12.2
Pt-CoZn@NC-800-5%	7.4	25.6	1.6
Pt-CoZn@NC-800-1%	1.1	14.9	0.4
Pt-CoZn@NC-900-10%	9.7	20.5	~0
Pt-CoZn@NC-700-10%	19.3	21.1	6.4

Table S2. ECSA, mass activity and specific activity for ORR test of different catalysts at 0.9 V vs. RHE.

Samples	ECSA/ $m^2 \cdot g_{Pt}^{-1}$	Mass activity / $mA \cdot \mu g^{-1}$	Specific activity / $mA \cdot cm^{-2}$
Pt-CoZn@NC-800-10%	24.7	0.37	1.50
Pt-Co@NC-800-10%	17.8	0.23	1.29
Pt-Zn@NC-800-10%	40.5	0.17	0.42
Pt-CoZn@NC-800-5%	10.5	0.23	2.19
Pt-CoZn@NC-800-1%	-	0.04	-
Pt-CoZn@NC-900-10%	10.3	0.10	0.97
Pt-CoZn@NC-700-10%	8.6	0.12	1.40
Pt/C	56.5	0.13	0.23

Table S3. Proportion of N species for Pt-CoZn@NC-10% catalysts derived at different temperatures.

Temperatures/℃	Graphite N/%	Pyridinic N/%	Pyrrolic N/%	Oxidized N/%
700	30.6	19.4	48.6	1.4
800	45.1	21.5	29.6	3.8
900	50.3	10.2	34.6	5.0

Table S4. The onset potentials (E_{onset}) and half-wave potentials ($E_{1/2}$) for ORR test of different catalysts.

Samples	E_{onset} /V	$E_{1/2}$ /V
Pt-CoZn@NC-800-10%	1.012	0.917
Pt-Co@NC-800-10%	0.994	0.889
Pt-Zn@NC-800-10%	0.994	0.886
Pt-CoZn@NC-800-5%	0.999	0.896
Pt-CoZn@NC-800-1%	0.959	0.836
Pt-CoZn@NC-900-10%	0.999	0.859
Pt-CoZn@NC-700-10%	0.992	0.862
Pt/C	0.972	0.878