Electronic Supplementary Information

Regulating and identifying structures of PdAu alloys with splendid oxygen reduction activity for rechargeable Zinc-air batteries

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Experimental Section

Synthesis of Pd_xAu_y (x + y = 100). The Pd₅₅Au₄₅ alloy was synthesized through a polymerizationpyrolysis method. In brief, 11.43 mg (0.035 mmol) potassium tetrachloropalladate (K₂PdCl₄, Sigma-Aldrich, 99.99%), 13.92 mg (0.035 mmol) sodium tetrachloroaurate dihydrate (NaAuCl₄·2H₂O, Aladdin, Au 48-50%) and 80 mg Trizma® base (C₄H₁₁NO₃, Sigma-Aldrich, \geq 99.9%) were dissolved in 50 ml deionized water to form a uniform solution. Then 200 mg dopamine hydrochloride (C₈H₁₁NO₂·HCl, Alfa Aesar, 99%) was dissolved in another 50 ml deionized water, which was dropwise added into the above metal-containing solution under magnetic stirring. After continuous stirring for 24 hours at room temperature, the desired polymer precursor was collected by centrifugal washing with water several times and freezing drying. Finally, the moderate precursor was put into a tube furnace, in which the temperature was raised to 900 °C with a ramping rate of 5 °C min⁻¹ and kept for 2 hours under 20 sccm argon (Ar) flow. When the temperature of the tube cooled down to room temperature, the resulting product was obtained. Other Pd_xAu_y materials were fabricated analogously except employing distinct Pd/Au molar ratios including 3:1, 2:1, 1:2 and 1:3 in reactants, while the total metal amount of Pd and Au was maintained at 0.07 mmol. Pd₁₀₀, Au₁₀₀, and NC were also synthesized in the same schedule except adding 0.07 mmol K₂PdCl₄, 0.07 mmol NaAuCl₄·2H₂O, and no metal ions, respectively.

Synthesis of Pd_1 -NC. The Pd₁-NC single-atom catalyst was synthesized through a one-step thermolysis method. In brief, 1.97 g (23.99 mmol) 2-Methylimidazole (C₄H₆N₂, Thermo Scientific, 97%) was dissolved in 150 ml methanol to form a uniform solution. Then 1.7 g (5.71 mmol) zinc nitrate hexahydrate (Thermo Scientific, 98%) and 3 mg (0.011 mmol) palladium nitrate dihydrate (Innochem, 99%) were dissolved in another 150 ml methanol, which was added into the above 2-Methylimidazole solution under magnetic stirring. After continuous stirring for 12 hours at room temperature, the desired precursor was collected by centrifugal washing with methanol several times and vacuum drying. Finally, the moderate precursor was put into a tube furnace, in which the temperature was raised to 1000 °C with a ramping rate of 5 °C min⁻¹ and kept for 2 hours under 20 sccm argon (Ar) flow. When the temperature of the tube cooled down to room temperature, the resulting product was obtained.

Material Characterization. XRD patterns were collected on a Philips X' Pert Pro Super diffractometer equipped with Cu K_{α} radiation (λ =1.54178 Å). TEM, HRTEM, EDX mapping, and line scanning images were recorded by using a FEI Talos F200X microscope. XPS results were

obtained on a Thermo ESCALAB 250 spectrometer. Pd K-edge and Au L₃-edge XAS measurements were conducted at the 14W1 beamline of Shanghai Synchrotron Radiation Facility (SSRF) and 1W1B beamline of Beijing Synchrotron Radiation Facility (BSRF), China. The obtained data were analyzed by Athena and Artemis.¹

In-situ SR-IRAS analyses were carried out at the infrared spectroscopy and microspectroscopy beamline (BL01B) of the Hefei Synchrotron Radiation Facility. A homemade cell with a ZnSe transmission window (cut-off energy of ≈ 625 cm⁻¹) was used. The catalyst-modified glassy carbon electrodes were employed as work electrodes. The electrolyte was O₂-saturated 0.1 M KOH. The spectra were recorded on a Bruker Hyperion 2000 infrared microscope and Bruker 70v/s FTIR spectrometer with a KBr beam splitter and liquid nitrogen-cooled mercury cadmium telluride detector. Each infrared absorption spectrum was acquired by 64 scans at a resolution of 4 cm⁻¹. The background spectrum was collected before each test to correct the data.

Electrochemical Measurements. All electrochemical measurements were carried out on a CHI 760E workstation with a typical three-electrode system. A graphite rod and Hg/HgO electrode were employed as the counter electrode and reference electrode, respectively. A polished 5 mm glassy carbon electrode with 7.5 μ L electrocatalyst ink loading was used as the work electrode, which was mounted on a rotator (Pine Instruments). The ink was prepared by mixing 4 mg corresponding catalyst powder with 550 μ L deionized water, 250 μ L isopropanol and 200 μ L 0.5 wt% Nafion solution, which was contiguously sonicated for 1 hour. The electrolyte was O₂-saturated 0.1 M KOH. All potentials in this study were calibrated by a hydrogen electrode (PHY-RHE) and corrected for resistance compensation. After the pre-reduction with CA tests of 50 seconds at 0.3 V_{RHE}, LSV curves in anodic and cathodic scanning were recorded at the rotating rate of 1600 rpm.

The electron transfer numbers and kinetic current densities were calculated by K-L equations.² Then kinetic current densities were further normalized against the Pd loading amounts and electrochemical active surface area (ECSA) to obtain mass activity and specific activity. ECSA was determined from charges associated with underpotentially deposited H (H_{upd}) stripping and oxide reduction.^{3,4} For commercial 20 wt% Pt/C, the CV curve was recorded at 20 mV s⁻¹ in Ar-saturated 0.5 M H₂SO₄, and the desorption peak area of H_{upd} was employed to access ECSA assuming the charge density of one monolayer hydrogen coverage was 210 μ C cm⁻². For Pd_xAu_y, CV curves were recorded in Ar-saturated 0.1 M KOH, and Pd oxide reduction peaks were adapted

assuming the charge density for reducing one monolayer PdO was 424 μ C cm⁻². ADTs were carried out by cycling between 0.6 and 1.0 V_{RHE} at 100 mV s⁻¹.

ZABs were assembled with the polished Zn plate as anode and catalyst ink-coated carbon paper/hydrophobic layer/Ni foam composite as air cathode. For primary ZAB tests, the electrolyte was 6.0 M KOH and the loading amount of both Pd₅₅Au₄₅ and commercial 20 wt% Pt/C was 1 mg cm⁻². For rechargeable tests, 6.0 M KOH with 0.2 M zinc acetate was used as the electrolyte. Pd₅₅Au₄₅ and commercial RuO₂ or Pt/C and RuO₂ with a mass ratio of 1:1 was dispersed as the ink. The total loading amount on carbon paper was 2 mg cm⁻². The galvanostatic discharge/charge cycling measurements were carried out at 5 mA cm⁻² on a LAND system with a cycling interval of 40 minutes (20 minutes for discharging and 20 minutes for charging) under the ambient condition.

DFT calculations. DFT calculations were conducted on the Vienna Ab-initio Simulation Package (VASP) within the projector augmented wave (PAW) method.^{5,6} Perdew-Burke-Ernzerhof (PBE) was used as the exchange and correlation functional.⁷ The plane-wave cutoff energy and vacuum layer were set to 450 eV on the $3 \times 2 \times 1$ k-point mesh and 20 Å, respectively. Structural optimizations for 4×4 metallic (111) unite cells were performed by minimizing the forces on all atoms to below 0.02 eV Å⁻¹ and the energy to below 10^{-6} eV. The Gibbs free energies were calculated at 300 K using the computational hydrogen electrode (CHE) model of $\Delta G = \Delta E_{DFT}$ $+ \Delta E_{ZPE} - T\Delta S$, where ΔE_{DFT} was the difference of electronic energy calculated with VASP, ΔE_{ZPE} was the difference of zero-point energy (ZPE) and T ΔS was the entropy contribution.⁸



Fig. S1 The morphology of $Pd_{55}Au_{45}$ precursor. (a) The TEM image. (b) The particle size distribution plot.



Fig. S2 The XRD pattern of $Pd_{55}Au_{45}$ precursor.



Fig. S3 The electronic structure of $Pd_{55}Au_{45}$ precursor. (a) Pd 3*d* and Au 4*d* XPS spectra. (b) Au 4*f* XPS spectra. (c) C 1*s* and (d) N 1*s* XPS spectra.



Fig. S4 (a) TEM image and (b) XRD pattern of NC.



Fig. S5 The morphology and composition of $Pd_{77}Au_{23}$. (a) TEM and (b) HRTEM images. (c) The EDX mapping pictures and (d) spectrum. (e) The particle size distribution plot. (f) The EDX line scanning profile of a single nanoalloy particle, the insert is scanning direction.



Fig. S6 The morphology and composition of Pd₆₆Au₃₄. (a) TEM and (b) HRTEM images. (c) The EDX mapping pictures and (d) spectrum. (e) The particle size distribution plot. (f) The EDX line scanning profile of a single nanoalloy particle, the insert is scanning direction.



Fig. S7 The morphology and composition of Pd₅₅Au₄₅. (a) The TEM image. (b) The EDX mapping pictures and (c) spectrum.



Fig. S8 The morphology and composition of $Pd_{32}Au_{68}$. (a) TEM and (b) HRTEM images. (c) The EDX mapping pictures and (d) spectrum. (e) The particle size distribution plot. (f) The EDX line scanning profile of a single nanoalloy particle, the insert is scanning direction.



Fig. S9 The morphology and composition of $Pd_{26}Au_{74}$. (a) TEM and (b) HRTEM images. (c) The EDX mapping pictures and (d) spectrum. (e) The particle size distribution plot. (f) The EDX line scanning profile of a single nanoalloy particle, the insert is scanning direction.



Fig. S10 The morphology and composition of Pd_{100} . (a) TEM and (b) HRTEM images. (c) The EDX mapping pictures and (d) spectrum. (e) The particle size distribution plot.



Fig. S11 The morphology and composition of Au_{100} . (a) TEM and (b) HRTEM images. (c) The EDX mapping pictures and (d) spectrum. (e) The particle size distribution plot.



Fig. S12 The structure of Pd_xAu_y. (a) Experimental and (b) DFT-calculated XRD spectra.

According to the Bragg equation, the lattice distances of (111) planes (marked as d_{111}) were calculated based on the corresponding diffraction angles in experimental and DFT-exported XRD spectra. Given that d_{111} and lattice parameters (marked as a_n) followed the relation of $a_n = 1.73 \times d_{111}$ for face-centered cubic phases, a_n of Pd_xAu_y could be obtained. Thus, the lattice expansion degrees of Pd (σ_{Pd}) were evaluated by the equation of $\sigma_{Pd} = (a_n - a_b) \times 100\% / a_b$, where a_b referred to the lattice parameter of bulk Pd (0.389 nm, JCPDS No. 46-1043).³ Moreover, lattice parameters of binary Pd-Au systems could also be estimated by the Vegard's law, which was $a_n = a_b \times x_b + a_c \times (1 - x_b)$, where x_b represented the molar percentages of Pd and a_c was the lattice parameter of bulk Au (0.408 nm, JCPDS No. 04-0784).⁹ Hence σ_{Pd} was calculated based on the Vegard equation as well.



Fig. S13 XPS survey spectra of Pd_xAu_y .



Fig. S14 C 1s XPS spectra of Pd_xAu_y and NC.



Fig. S15 N 1s XPS spectra of Pd_xAu_y and NC.



Fig. S16 The k^3 -weighted k-space Pd K-edge spectra.



Fig. S17 The k^3 -weighted k-space Au L₃-edge spectra.



Fig. S18 CV curves in Ar-saturated 0.1 M KOH, and LSV curves with anodic and cathodic scanning in O₂-saturated 0.1 M KOH of (a) Pd₁₀₀, (b) Pd₇₇Au₂₃, (c) Pd₆₆Au₃₄, (d) Pd₃₂Au₆₈, and (e) Pd₂₆Au₇₄.



Fig. S19 CV curves in Ar-saturated 0.1 M KOH, and LSV curves with anodic and cathodic scanning in O_2 -saturated 0.1 M KOH of (a) Au_{100} and (b) NC.



Fig. S20 LSV curves of Pd_xAu_y , NC and commercial 20 wt% Pt/C in the cathodic direction.



Fig. S21 The Tafel plot of NC.



Fig. S22 The CV curve of commercial 20 wt% Pt/C.



Fig. S23 (a) Specific activities and mass activities of $Pd_{55}Au_{45}$ and commercial 20 wt% Pt/C. (b) The corresponding half-wave potentials and mass activities before and after ADTs.



Fig. S24 CA tests for methanol toxicity durability evaluations of $Pd_{55}Au_{45}$ and commercial 20 wt% Pt/C at 1600 rpm.



Fig. S25 Calculated electron transfer numbers. (a) LSV curves of $Pd_{55}Au_{45}$ at various rotating speeds. (b) The corresponding electron transfer numbers estimated by K-L equations. (c) LSV curves of Pd_{100} at various rotating speeds. (d) The corresponding electron transfer numbers estimated by K-L equations. (e) LSV curves of Au_{100} at various rotating speeds. (f) The corresponding electron transfer numbers estimated by K-L equations.



Fig. S26 In-situ SR-IRAS spectra of $Pd_{26}Au_{74}$ (left) and the respective integrated areas of -O-Oand -OOH (right).



Fig. S27 Rate-determining steps of various catalysts. (a) The rate-determining step of Pd-based catalysts. (b) The rate-determining step of Au_{100} . (c) The rate-determining step of 20 wt% Pt/C.



Fig. S28 The structure and performance of Pd_1 -NC. (a, b) HAADF-STEM images. (c) EDX mapping images. (d) XRD pattern. (e) Pd 3*d* XPS spectrum. (f) Free energy diagrams. The insert is the adsorption model of *OOH on Pd₁-NC (Pd: cyan, C: grey, N: blue, O: red, H: white). (g) LSV curves collected at various rotating speeds. (h) The corresponding electron transfer numbers estimated by K-L equations. (i) Summary of kinetic current densities and half-wave potentials.



Fig. S29 Digital photo of the ZABs.



Fig. S30 Galvanostatic discharge/charge curves of rechargeable ZABs with $Pt/C + RuO_2$ cathode.



Fig. S31 Line scanning profiles of $Pd_{55}Au_{45}$ after the cyclic stability test.

Sample	Average particle size (nm)		
Pd ₁₀₀	103.59 ± 2.05		
Pd ₇₇ Au ₂₃	9.79 ± 0.52		
Pd ₆₆ Au ₃₄	10.52 ± 0.28		
Pd ₅₅ Au ₄₅	9.15 ± 0.21		
Pd ₃₂ Au ₆₈	8.73 ± 0.33		
Pd ₂₆ Au ₇₄	6.60 ± 0.05		
Au ₁₀₀	4.86 ± 0.07		
Pd ₅₅ Au ₄₅ precursor	8.30 ± 0.17		

Table S1. Average particle sizes of Pd_xAu_y .

G 1	Atomic ratio of	EDX				
Sample	Pd/Au in reactants	Mass concentration of Pd (wt%)	Mass concentration of Au (wt%)	Atomic ratio of Pd/Au		
Pd ₁₀₀	100/0	12.84%	_	100/0		
Pd ₇₇ Au ₂₃	75/25	12.41%	6.92%	77/23		
Pd ₆₆ Au ₃₄	67/33	13.20%	12.43%	66/34		
Pd ₅₅ Au ₄₅	50/50	6.92%	10.67%	55/45		
Pd ₃₂ Au ₆₈	33/67	4.81%	19.18%	32/68		
Pd ₂₆ Au ₇₄	25/75	3.37%	17.92%	26/74		
Au ₁₀₀	0/100		12.97%	0/100		

Table S2. Mass concentrations and atomic ratios of Pd_xAu_y .

N-	Slab energy					
INO.	Pd ₇₇ Au ₂₃	Pd ₆₆ Au ₃₄	Pd ₅₅ Au ₄₅	Pd ₃₂ Au ₆₈	Pd ₂₆ Au ₇₄	
1	-293.65	-283.43	-262.17	-242.54	-227.77	
2	-293.68	-284.60	-263.75	-242.04	-228.60	
3	-293.59	-283.19	-261.99	-241.99	-228.56	
4	-292.63	-282.75	-263.85	-241.49	-226.74	
5	-293.18	-284.60	-264.21	-241.03	-229.37	
6	-294.06	-284.17	-260.97	-241.16	-228.99	
7	-292.97	-283.78	-263.43	-241.24	-226.95	
8	-292.97	-284.04	-263.58	-241.03	-227.32	
9	-293.84	-283.84	-262.45	-240.94	-227.52	
10	-294.63	-285.10	-264.37	-243.06	-229.48	

Table S3. Slab energy values of Pd_xAu_y .

Sample	R-factor#1	Path ^{#2}	C.N.#3	R (Å)#4	$\Delta E_0 (eV)^{\#5}$	$\sigma^2 (10^{-3} \text{ Å}^2)^{\#6}$
Pd foil	0.0034	Pd-Pd	12.0*	2.73 ± 0.01	$\textbf{-6.2}\pm0.6$	4.8 ± 0.5
Pd ₁₀₀	0.0089	Pd-Pd	11.3 ± 1.2	2.73 ± 0.01	$\textbf{-5.7}\pm0.7$	5.1 ± 0.6
Dd Au	0.0085	Pd-Pd	5.2 ± 1.4	2.75 ± 0.04	$\textbf{-6.4} \pm 1.6$	4.0 ± 1.0
Pd ₇₇ Au ₂₃	0.0085	Pd-Au	2.0 ± 1.1	2.74 ± 0.04	$\textbf{-9.8} \pm 2.1$	2.2 ± 0.7
Pd ₆₆ Au ₃₄	0.0027	Pd-Pd	4.9 ± 1.1	2.75 ± 0.03	-5.1 ± 1.4	5.5 ± 1.1
		Pd-Au	4.7 ± 1.0	2.74 ± 0.03	-7.8 ± 1.6	6.0 ± 1.1
Pd ₅₅ Au ₄₅	0.0064	Pd-Pd	3.4 ± 0.9	2.79 ± 0.04	-3.1 ± 1.4	4.6 ± 0.9
		Pd-Au	5.7 ± 1.4	2.79 ± 0.04	-1.7 ± 1.2	5.0 ± 1.1
Pd ₃₂ Au ₆₈	0.0044	Pd-Pd	1.4 ± 0.9	2.79 ± 0.04	-3.2 ± 1.2	3.2 ± 0.8
		Pd-Au	8.1 ± 1.2	2.79 ± 0.03	$\textbf{-4.5}\pm1.3$	6.0 ± 1.2
Pd ₂₆ Au ₇₄	0.0096	Pd-Pd	1.2 ± 1.0	2.77 ± 0.04	-7.9 ± 1.6	2.1 ± 0.7
		Pd-Au	8.3 ± 1.5	2.79 ± 0.04	$\textbf{-4.9} \pm 1.3$	5.3 ± 1.1

Table S4. The fitting results of Pd K-edge FT-EXAFS spectra.

^{#1}Degree of curve coincidence

^{#2}Scattering path

^{#3}Coordination number

^{#4}Bond length

#5Energy shift

^{#6}Debye-Waller factor

*Fixed coordination number according to the standard crystal structure

Sample	R-factor#1	Path ^{#2}	C.N.#3	R (Å)#4	$\Delta E_0 (eV)^{\#5}$	$\sigma^2 (10^{-3} \text{ Å}^2)^{\#6}$
Au foil	0.0026	Au-Au	12.0*	2.86 ± 0.01	5.1 ± 0.4	8.2 ± 0.3
	0.0041	Au-Au	4.5 ± 1.0	2.77 ± 0.03	3.0 ± 1.6	6.2 ± 1.0
Pu ₇₇ Au ₂₃		Au-Pd	6.5 ± 1.1	2.77 ± 0.02	5.0 ± 2.0	4.7 ± 0.8
Pd ₆₆ Au ₃₄	0.0040	Au-Au	5.3 ± 0.9	2.76 ± 0.03	1.3 ± 2.0	7.2 ± 1.3
	0.0049	Au-Pd	6.0 ± 1.1	2.78 ± 0.02	5.1 ± 2.2	4.8 ± 0.9
Pd ₅₅ Au ₄₅	0.0025	Au-Au	6.5 ± 1.0	2.79 ± 0.03	2.7 ± 1.4	6.5 ± 0.9
		Au-Pd	4.7 ± 0.8	2.79 ± 0.02	5.9 ± 1.5	5.3 ± 0.8
Pd ₃₂ Au ₆₈	0.0025	Au-Au	8.3 ± 1.4	2.81 ± 0.02	4.5 ± 1.3	7.3 ± 1.1
		Au-Pd	3.0 ± 0.9	2.80 ± 0.02	5.3 ± 1.4	5.6 ± 0.9
Pd ₂₆ Au ₇₄	0.0032	Au-Au	9.4 ± 1.8	2.82 ± 0.03	4.2 ± 1.9	8.8 ± 1.4
		Au-Pd	2.5 ± 0.9	2.80 ± 0.03	3.8 ± 1.7	6.4 ± 1.2
Au ₁₀₀	0.0032	Au-Au	11.5 ± 0.6	2.86 ± 0.01	2.8 ± 0.4	8.3 ± 0.4

Table S5. The fitting results of Au L₃-edge FT-EXAFS spectra.

^{#1}Degree of curve coincidence

^{#2}Scattering path

^{#3}Coordination number

^{#4}Bond length

#5Energy shift

^{#6}Debye-Waller factor

*Fixed coordination number according to the standard crystal structure

Catalyst	Half-wave potential (V vs. RHE)	Mass activity at 0.9 V _{RHE} (A g ⁻¹ Pd/Pt)	Tafel slope (mV dec ⁻¹)	Scanning direction	Reference
Pd ₅₅ Au ₄₅	0.93	962.6	14.5	Anodic	This work
Pd-Sb RHs/C ¹⁰	0.93	710.0	51.7	Anodic	<i>Adv. Mater.</i> , 2022, 34 , 2206528.
PdNiMnO-PF ¹¹	0.84	67.8	64.4	—#	<i>Energy Environ. Sci.</i> , 2022, 15 , 1573-1584.
Pd/FeCo12	0.84	91.0	57.5	#	<i>Adv. Energy Mater.</i> , 2021, 11 , 2002204.
$Pt_{0.2}Pd_{1.8}Ge^{13}$	0.95	322.0	41.3	Anodic	J. Am. Chem. Soc., 2022, 144, 11859-11869
$Ag_{0.1}Pd_{0.9}^{14}$	0.91	46.2	51.2	#	<i>Nat. Commun.</i> , 2021, 12 , 620.
Pd ₈ ¹⁵	0.90	340.0	65.5	—#	Angew. Chem. Int. Ed., 2022, 61 , e202208751.
Pd ₃ Pb UPINs/C ¹⁶	0.91	590.0	55.6	Anodic	Angew. Chem. Int. Ed., 2021, 60 , 10942-10949.
<i>O</i> -PdFe@C _m ¹⁷	0.89	69.6	36.4	Anodic	<i>Adv. Funct. Mater.</i> , 2022, 32 , 2203921.
$\frac{Pd_{17}Se_{15}}{NPs/C^{18}}$	0.89	460.0	57.8	#	Nano Lett., 2021, 21 , 3805-3812.

 Table S6. Comparison of ORR performances for Pd-based electrocatalysts.

#: not mentioned

Catalyst	Peak power density (mW cm ⁻²)	Specific capacity (mAh g ⁻¹)	Cycling stability	Reference
Pd ₅₅ Au ₄₅	237.7	821.4	2000 h (3000 cycles)	This work
PdMo bimetallene/C ³	154.2	798.0	~117 h (350 cycles)	<i>Nature</i> , 2019, 574 , 81- 85.
SA-PtCoF ¹⁹	125.0	808.0	240 h (120 cycles)	Energy Environ. Sci., 2020, 13 , 884-895.
Pt ₁ -FeO _x /CN ²⁰	192.3	804.6	300 h (450 cycles)	Angew. Chem. Int. Ed., 2022, 61 , e202213366.
Pd/FeCo ¹²	117.0	821.0	200 h (400 cycles)	Adv. Energy Mater., 2021, 11 , 2002204.
Pt-SCFP/C-12 ²¹	122.0	790.4	80 h (240 cycles)	Adv. Energy Mater., 2020, 10 , 1903271.
PdNi/Ni@N-C ²²	108.5	719.2	200 h (600 cycles)	<i>Energy Storage Mater.</i> , 2021, 42 , 118-128.
Ni SAs-Pd@NC ²³	134.2	719.2	230 h (700 cycles)	J. Mater. Chem. A, 2022, 10 , 6086-6095.
$La_{0.7}Sr_{0.3}Co_{0.9}Pd_{0.03}O_{2.85}{}^{24}$	52.0	740.0	60 h (60 cycles)	ACS Appl. Mater. Interfaces, 2020, 12 , 40355-40363.
Pd ₄₅ Pt ₄₄ Ni ₁₁ SpNSs/C ²⁵	206.0	701.8	220 h (660 cycles)	<i>J. Mater. Chem. A</i> , 2022, 10 , 3808-3817.

 Table S7. Comparison of Zn-air battery performances for Pd and Pt-based electrocatalysts.

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