

Supplementary Information

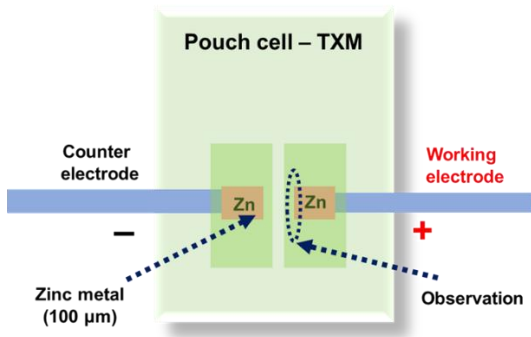
Beyond Conventional: Unveiling the Impact of Zn Anode Pre-Treatment in Aqueous Zinc Ion Batteries

Table S1. Comparison of the electrochemical performances for various pre-treated Zn anodes for ZIBs.

Methodology	Electrolyte	Overpotential	Life cycle Symmetric cell	Life cycle Full cell	Ref.
Mechanical polishing (One side)	3 M ZnSO ₄	160 mV (1 mA cm ⁻² , 1 mA h cm ⁻²)	400 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	50 cycles, 0.1 A g ⁻¹ ~53% retention Zn//Mn ₂ O ₄ ·1.31H ₂ O	1
Mechanical polishing (One side)	2 M ZnSO ₄	18 mV (1 mA cm ⁻² , 1 mA h cm ⁻²)	480 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	20 cycles, - A g ⁻¹ ~15% retention Zn//VO ₂ /CNTs	2
Mechanical polishing (Both sides)	2 M ZnSO ₄	~70 mV (1 mA cm ⁻² , 1 mA h cm ⁻²)	800 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	-	3
Electropolishing	2 M ZnSO ₄	50 mV (1 mA cm ⁻² , 25 mA h cm ⁻²)	380 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	200 cycles, 2 A g ⁻¹ ~37% retention Zn//VO ₂	4
Photolithography + Etching	3 M Zn(CF ₃ SO ₃) ₂	~100 mV (1 mA cm ⁻² , 1 mA h cm ⁻²)	500 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	10K cycles, 10 A g ⁻¹ ~82% retention Zn//PVO	5
Chemical treatment (HCl)	3 M ZnSO ₄	20 mV (1 mA cm ⁻² , 0.5 mA h cm ⁻²)	200 h (1 mA cm ⁻² , 0.5 mA h cm ⁻²)	-	6
Organic acid etching (TFA in AN)	1 M ZnSO ₄	~11 mV (4 mA cm ⁻² , 2 mA h cm ⁻²)	800 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	3000 cycles, 5 A g ⁻¹ ~40% retention Zn//α-MnO ₂	7
Chemical treatment (H ₃ PO ₄)	2 M Zn(CF ₃ SO ₃) ₂	60 mV (0.5 mA cm ⁻² , 0.1 mA h cm ⁻²)	1400 h (0.5 mA cm ⁻² , 0.1 mA h cm ⁻²)	500 cycles, 1 A g ⁻¹ ~90% retention Zn//V ₂ O ₅	8
Acid etching (HCl)	2 M ZnSO ₄	19.5 mV (1 mA cm ⁻² , 1 mA h cm ⁻²)	3000 h (1 mA cm ⁻² , 1 mA h cm ⁻²)	1000 cycles, 5 A g ⁻¹ ~72% retention Zn//V ₂ O ₅	9
Chemical treatment ((NH ₄) ₂ S ₂ O ₈)	3 M Zn(CF ₃ SO ₃) ₂	~0 mV (0.1 mA cm ⁻² , 0.1 mA h cm ⁻²)	200 h (0.1 mA cm ⁻² , 0.1 mA h cm ⁻²)	5000 cycles, 5 A g ⁻¹ ~68% retention Zn//V ₂ O ₅ .nH ₂ O	Our work

PVO: polyaniline-intercalated vanadium oxide; TFA: trifluoromethanesulfonic acid; AN: acetonitrile.

Transmission X-ray Microscopy



Device Type: Pouch Cell

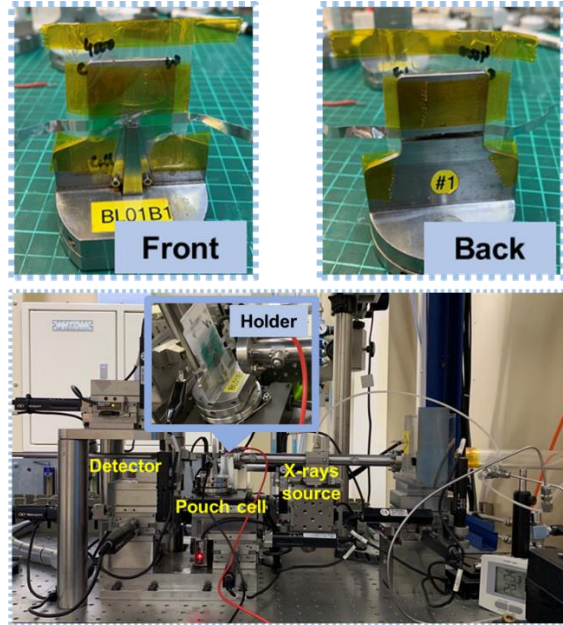


Figure S1. Experimental set-up for TXM.

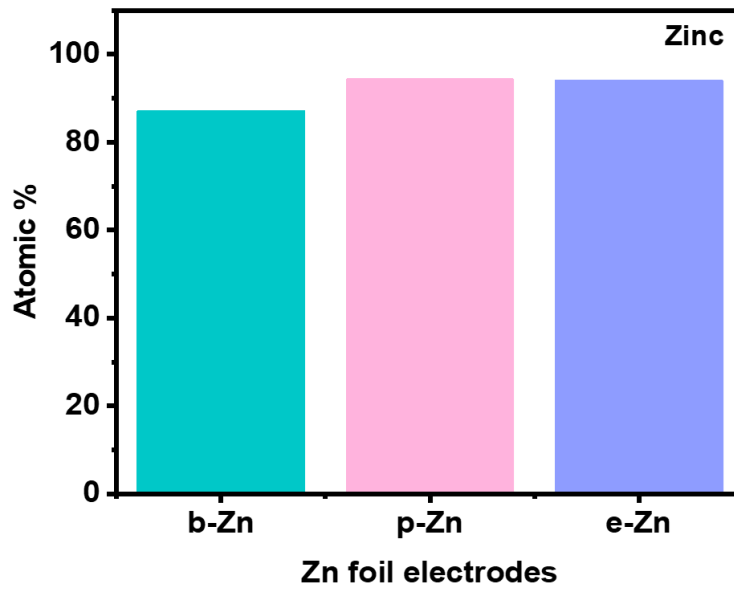


Figure S2. Comparative atomic % of zinc for b-Zn, e-Zn, and p-Zn.

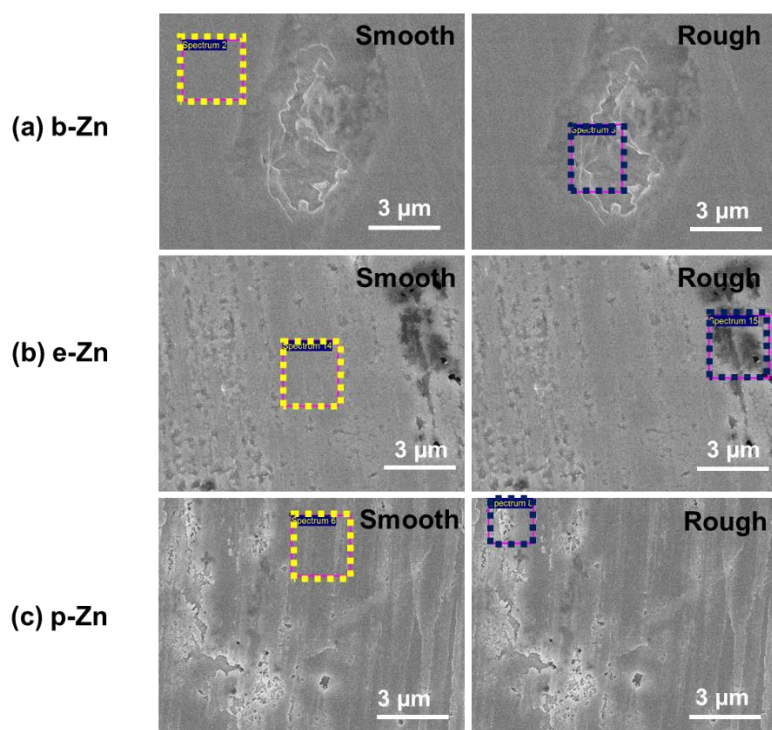


Figure S3. FESEM images of the various Zn foils: (a) b-Zn; (b) e-Zn; (c) p-Zn; for smooth surface, and rough surface, respectively.

Table S2. Comparative atomic % of bare Zn (b-Zn), polished Zn (p-Zn), and etched Zn (e-Zn) for O and Zn.

Atomic %	b-Zn		p-Zn		e-Zn	
	Zn	O	Zn	O	Zn	O
Smooth	93.16	6.84	95.99	4.01	97.45	2.55
Rough	82.91	17.09	92.56	7.44	92.42	7.58
Sum overall	87.11	12.89	94.35	5.65	94.04	5.96

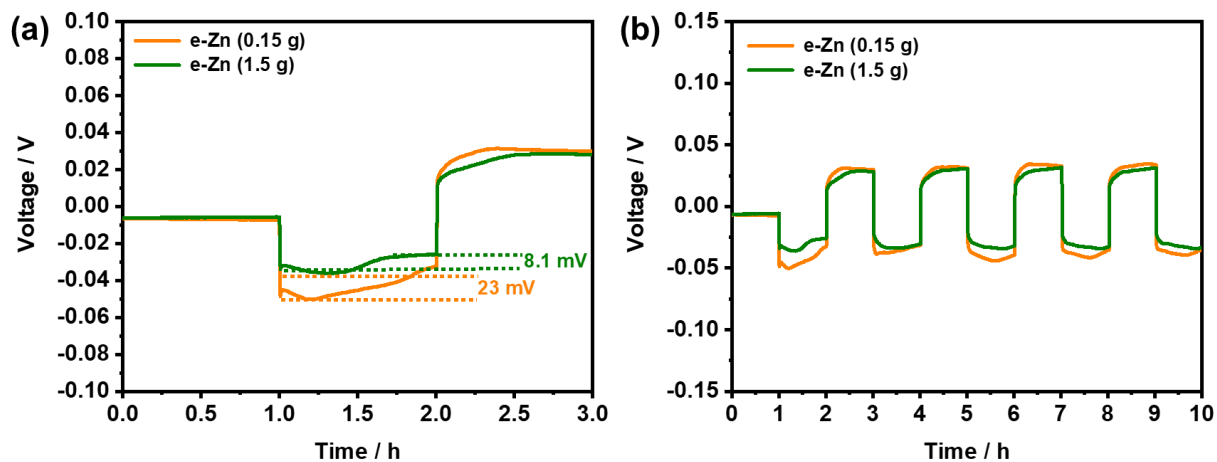


Figure S4. (a) The potential profiles of the two symmetric coin cells (e-Zn (0.15 g), e-Zn (1.5 g)) during the first plating and stripping cycle showing nucleation over-potential; (b) Electrochemical plating/stripping cycles of symmetric coin cells with the two Zn foil electrodes (e-Zn (0.15 g), e-Zn (1.5 g)) with a current density of 0.1 mA cm^{-2} for 1 h at room temperature.

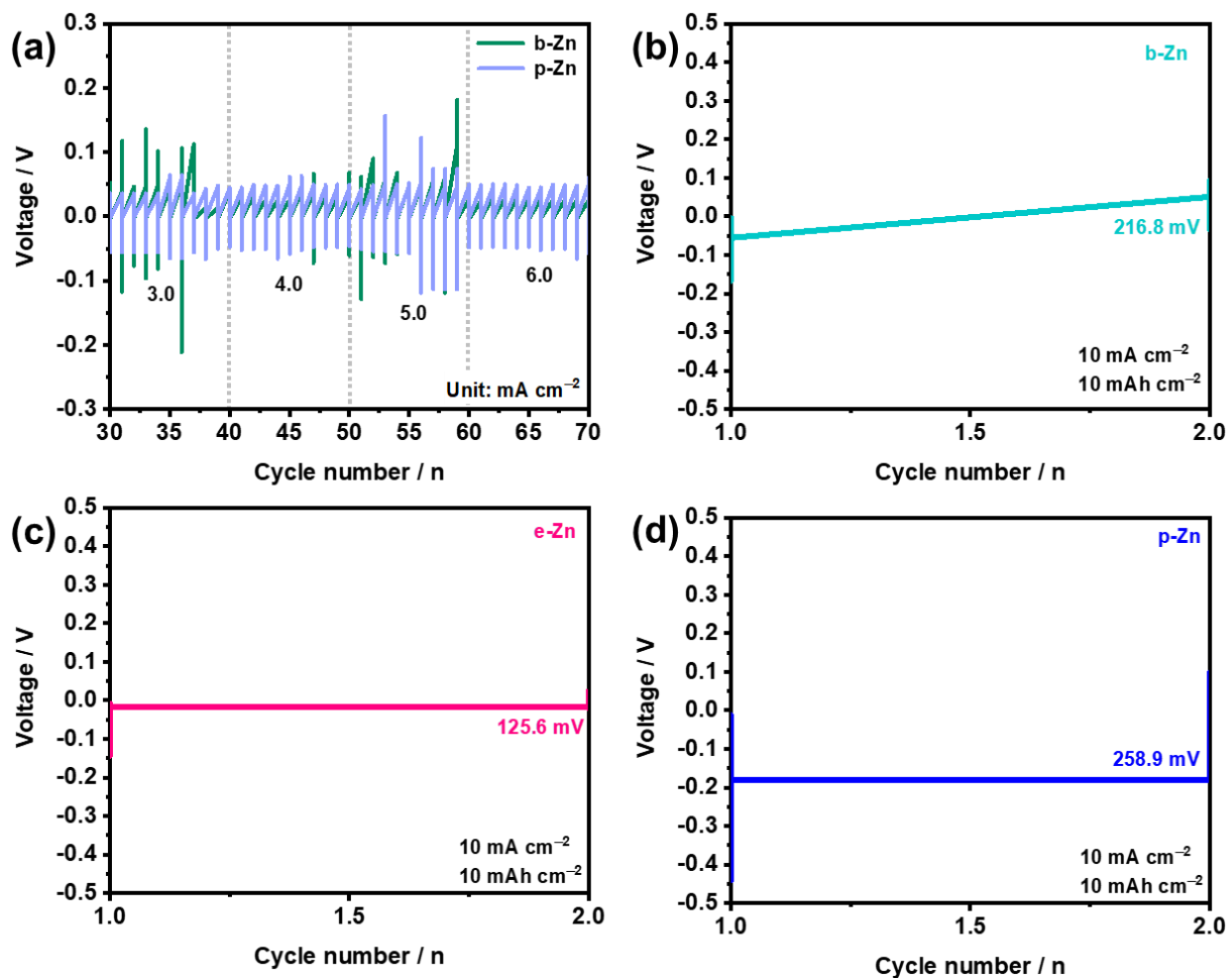


Figure S5. (a) Rate performances of b-Zn||b-Zn and p-Zn||p-Zn symmetric cell; (f) Potential profiles of the b-Zn||b-Zn, e-Zn||e-Zn, and p-Zn||p-Zn three symmetric coin cells during the initial plating/stripping cycle, illustrating nucleation overpotential at $10 \text{ mA cm}^{-2}/10 \text{ mAh cm}^{-2}$.

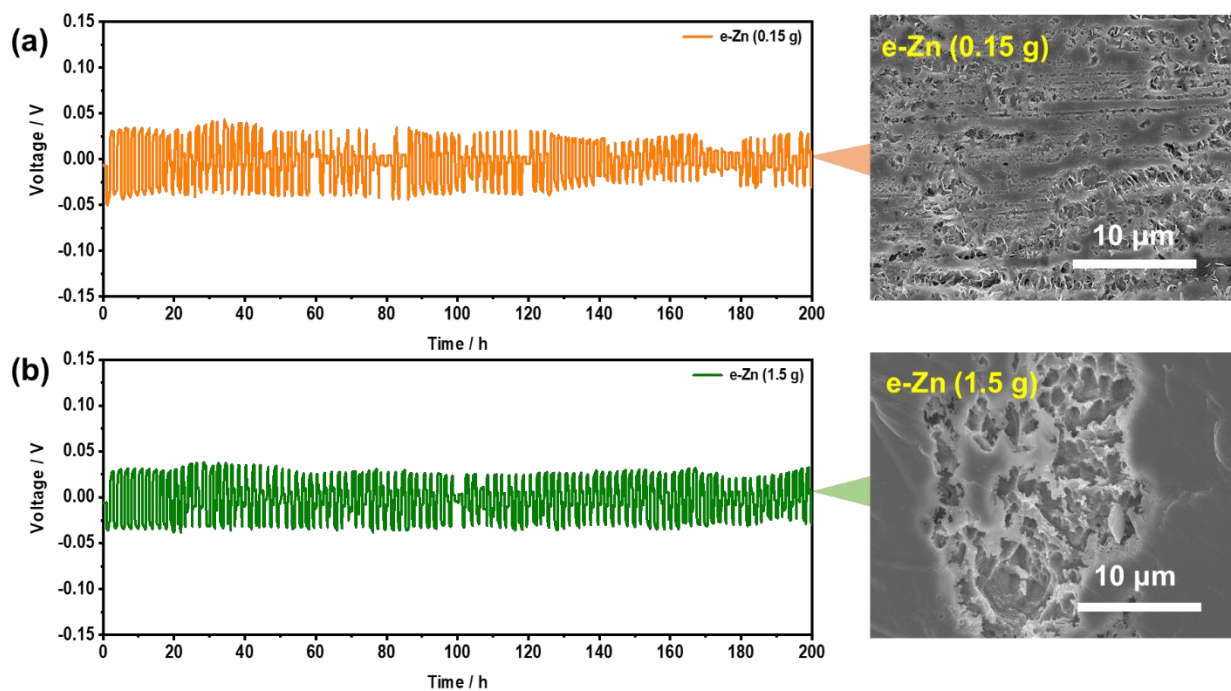


Figure S6. Galvanostatic charge/discharge curve under the current density of 0.1 mA cm^{-2} for (a) e-Zn (0.15 g) and (b) e-Zn (1.5 g).

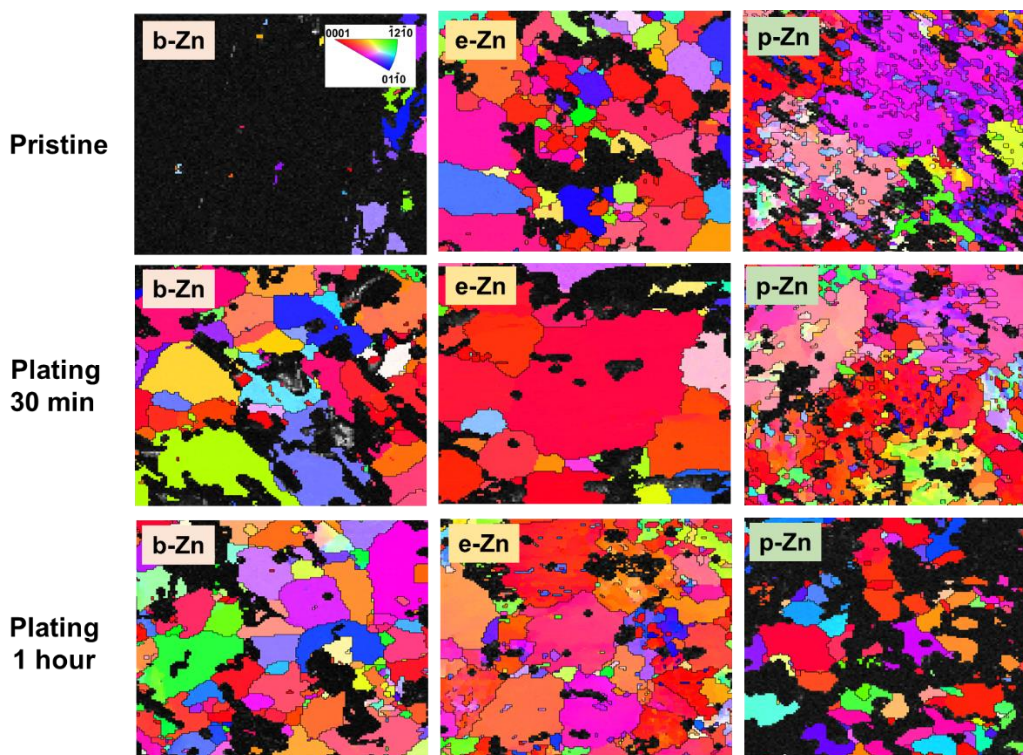


Figure S7. EBSD orientation maps for b-Zn, e-Zn, and p-Zn of pristine and after 30 min and 1 hour of plating. Inset is the inverse pole figures (IPF) triangle map, in which the red color represents the (002) crystallographic direction.

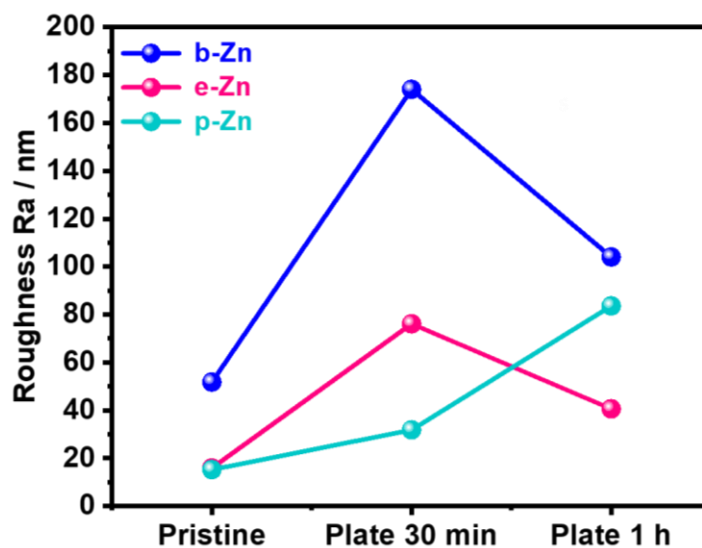


Figure S8. The roughness Ra values evolution of the three samples during the plating process.

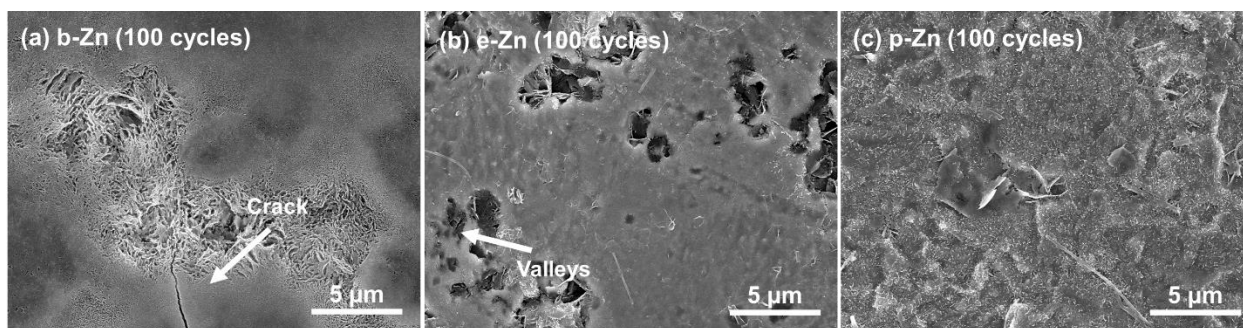


Figure S9. SEM images of (a) b-Zn; (b) e-Zn; and (c) p-Zn after 100 cycles at $0.1 \text{ mA cm}^{-2}/0.1 \text{ mAh cm}^{-2}$.

References

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