Supporting information

Arginine Cations Inhibiting Charge Accumulation of Dendrites and Boosting Zn Metal Reversibility in Aqueous Rechargeable Battery

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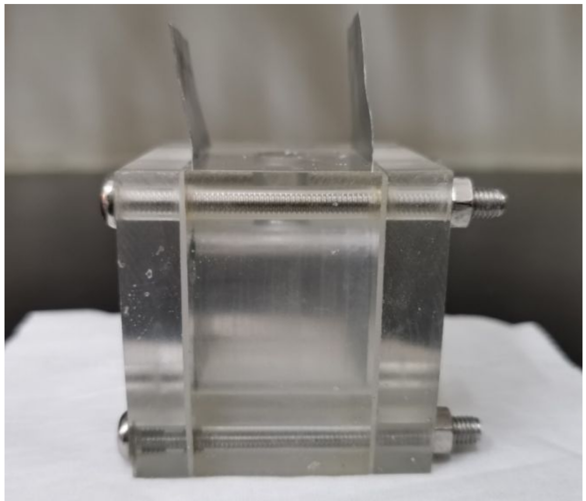

Figure S1. Photograph of the Zn electrodeposition system.

We used a polymethyl methacrylate cell as the Zn electrodeposition system. Both sides of the cell were closed without air contact. Zinc foils with flat surface and no protrusions were used as the plating bases and were fastened at both sides of the cell by two separate plates. The zinc foils were exposed in one side with the electrolyte and they were connected with the wires to conduct current. The electrolyte was injected through a small hole on the top of the cell reactor and sealed. The screws were tightened to prevent the leakage of the electrolyte. This Zn electrodeposition system is convenient and efficient.

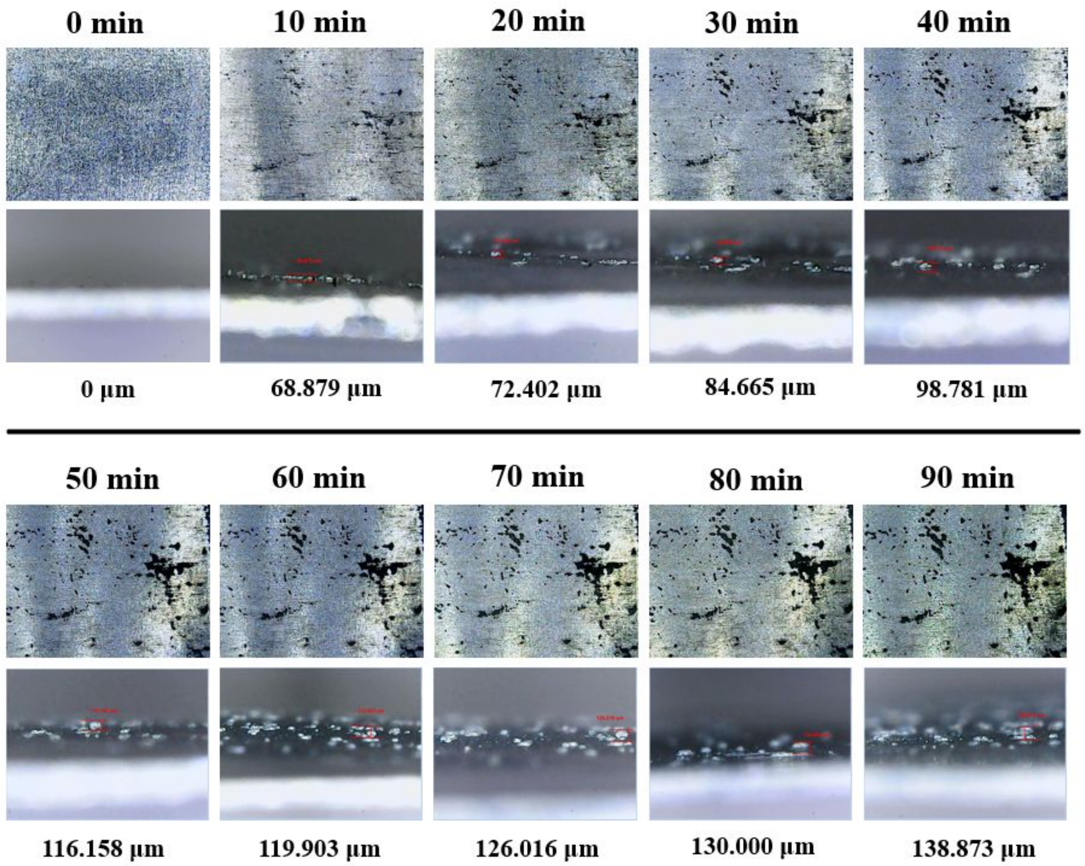

Figure S2. The planar distribution and length of Zn dendrite images of deposition process by in-situ digital electron microscope at 0.5 mA cm^{-2} in 1M $ZnSO_4$.

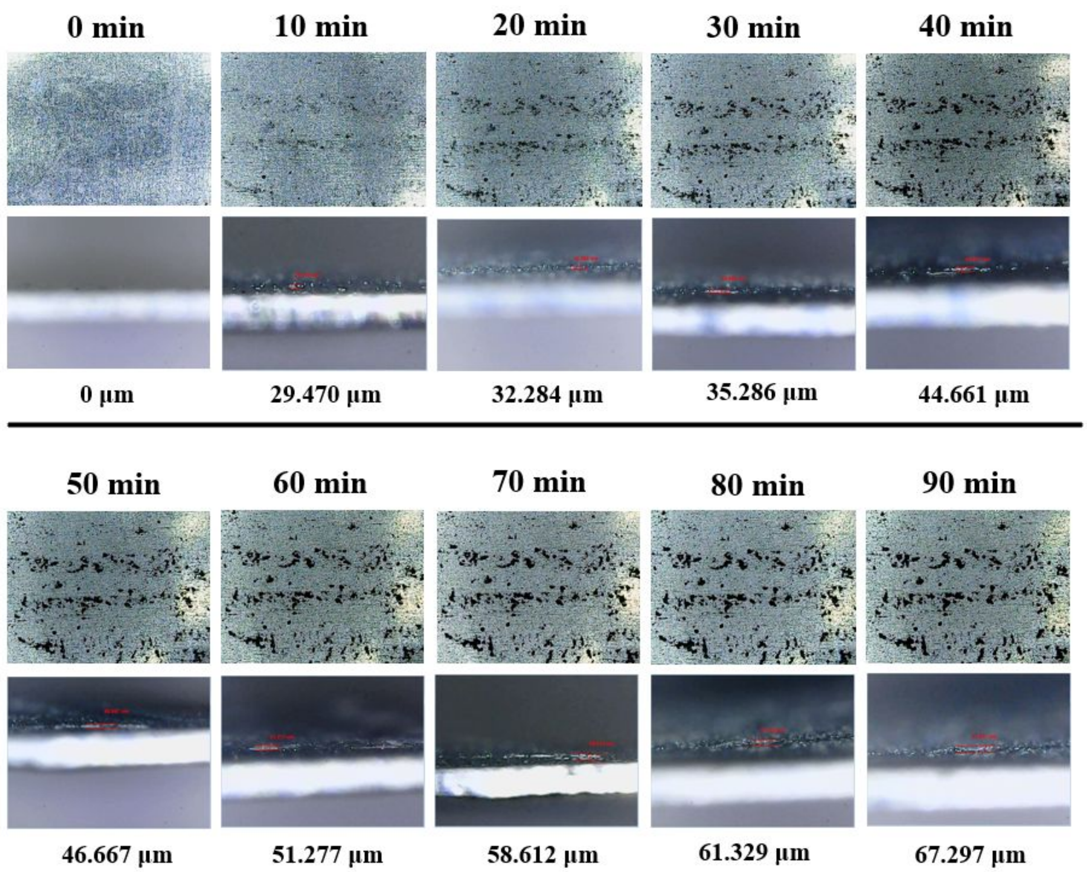

Figure S3. The planar distribution and length of Zn dendrite images of deposition process by in-situ digital electron microscope at 0.5 mA cm^{-2} in 1M $ZnSO_4$ + 0.005M Arg^+.

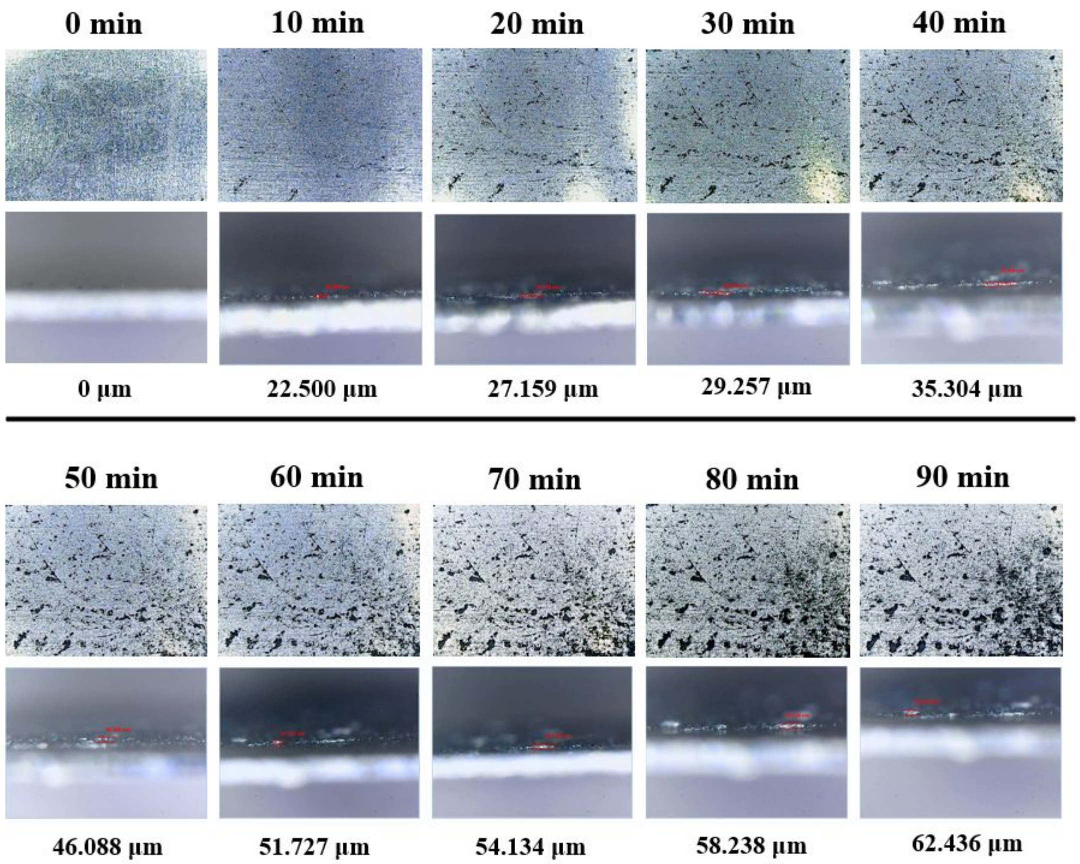

Figure S4. The planar distribution and length of Zn dendrite images of deposition process by in-situ digital electron microscope at 0.5 mA cm^{-2} in 1M $ZnSO_4$ + 0.01M Arg^+.

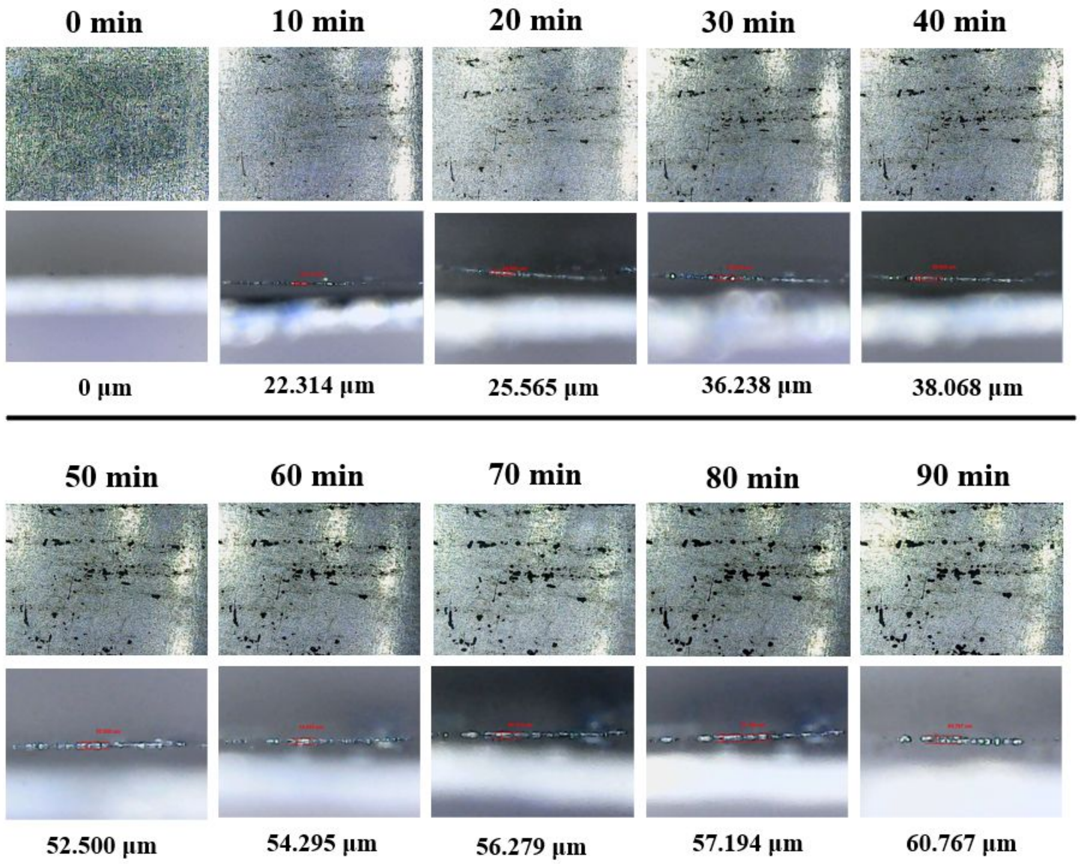

Figure S5. The planar distribution and length of Zn dendrite images of deposition process by in-situ digital electron microscope at 0.5 mA cm^{-2} in 1M $ZnSO_4$ + 0.03M Arg^{+}.

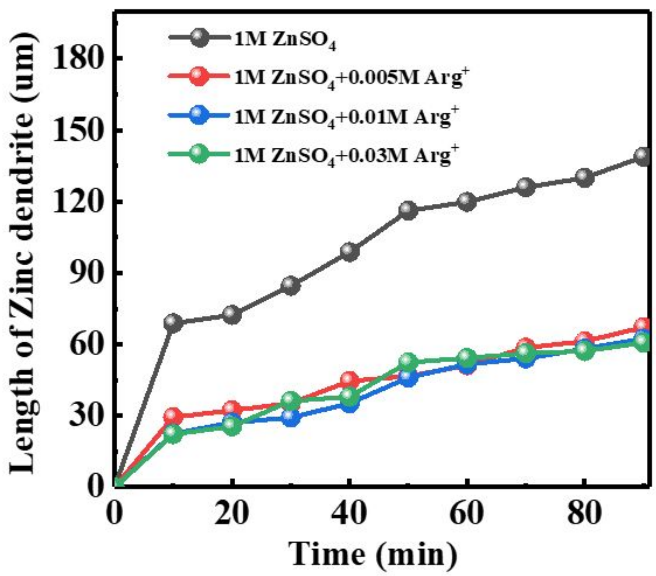

Figure S6. The growth of zinc dendrite length with increasing plating time in different electrolytes.

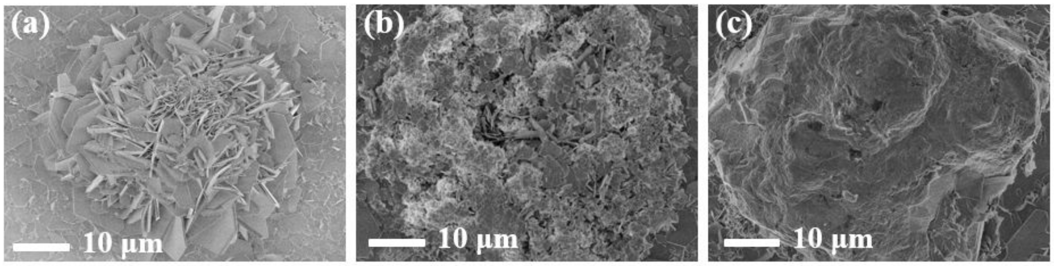

Figure S7. SEM images of Zn foil which electroplated (a) in 1M $ZnSO_4$ after 30 cycles, (b) in 1M $ZnSO_4$ + 0.005M Arg^+ after 40 cycles, (c) in 1M $ZnSO_4$ + 0.01M Arg^+ after 40 cycles at 0.5 mA cm^{-2} with a fixed capacity of 0.5 mAh cm^{-2}.

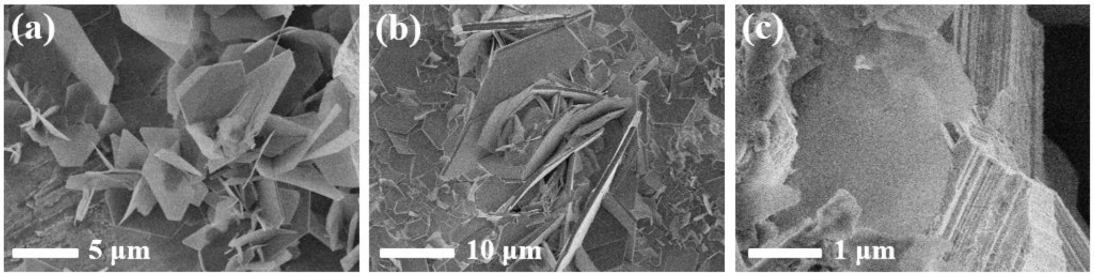

Figure S8. SEM images of Zn foil which electroplated (a, b) in 1M $ZnSO_4$, (c) in 1M $ZnSO_4$ + 0.01M Arg^+ after 1h at 0.5 mA cm^{-2}.

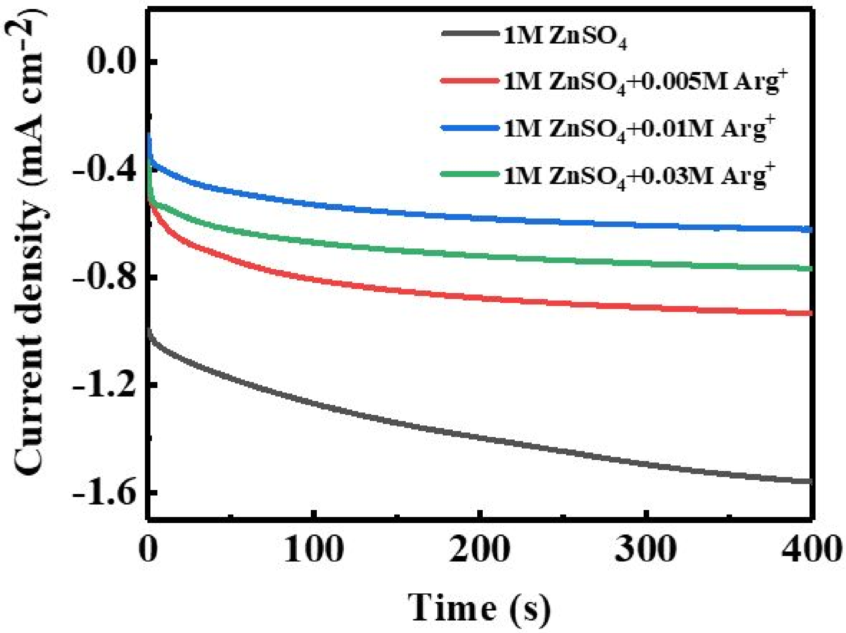

Figure S9. Chronoamperograms (CA, at a constant over-potential of −150 mV) of zinc plates in different electrolytes.

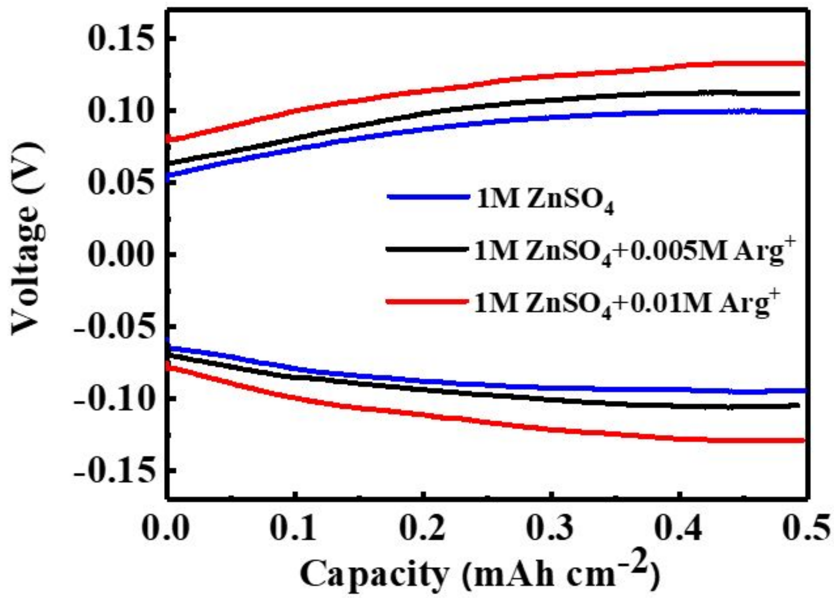

Figure S10. Voltage profiles of a zinc plating and stripping cycle in different electrolytes.

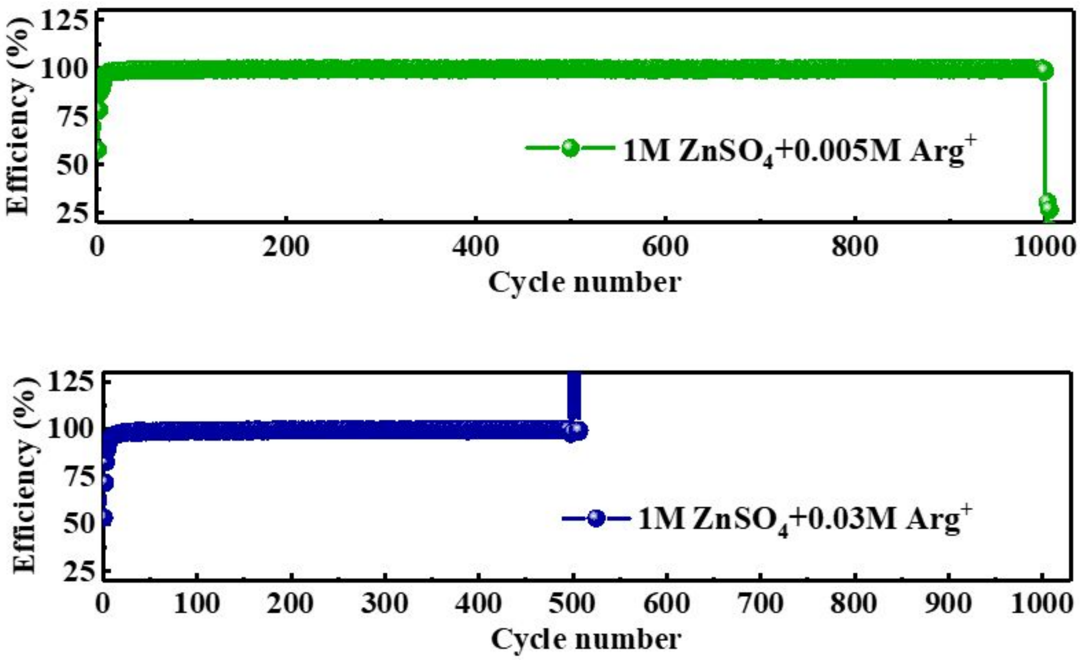

Figure S11. Coulomb efficiency (CE) of Zn/Cu cells with different electrolytes at current density of 0.5 mA cm^{-2} with a fixed capacity of 0.1 mAh cm^{-2}.

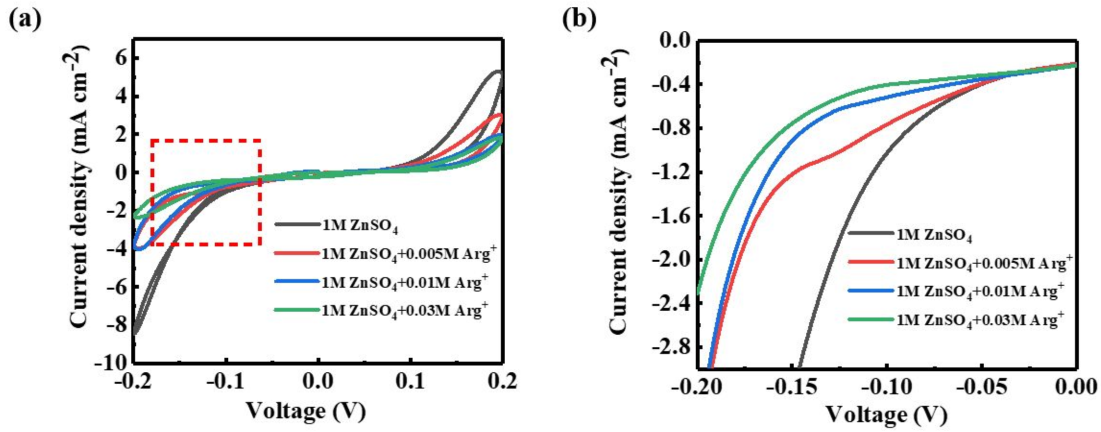

Figure S12. (a) Cyclic voltammetry (CV) curves of the bare Zn plate anodes in different electrolytes. (b) Enlarged view of dotted box area.

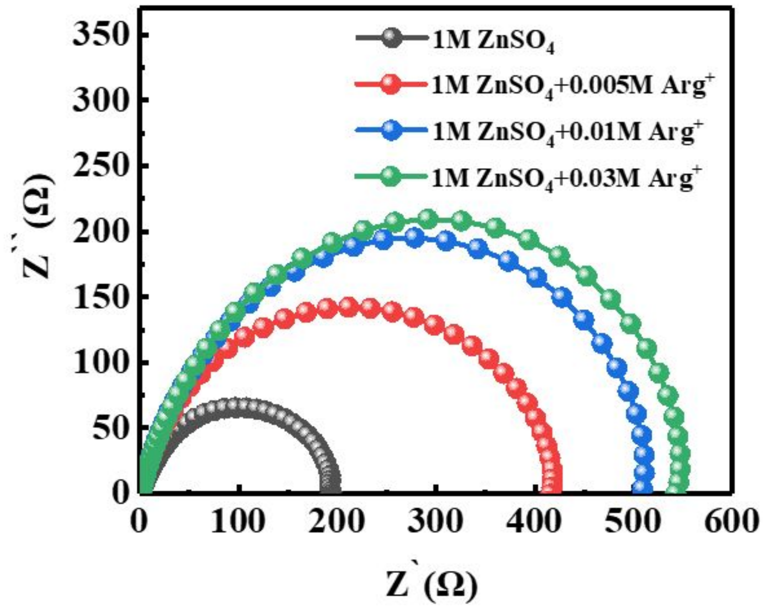

Figure S13. EIS results of the Zn symmetric cells with different electrolytes.

Nyquist plots collected at open circuit voltage over the frequency range of 300 kHz to 0.1 Hz. For the Zn/Zn cells with glass fibers, the ionic conductivity of the glass fibers separator could be calculated from the bulk electrolyte resistance. The formula of conductivity is:

$$\sigma = \frac{L}{R_u \cdot S}$$

In the above formula, L is the thickness of the glass fibre separator (0.3 mm), R_u is solution resistance (Z` with Z``= 0), S is the contact area (1 cm^{-2}). Thus, according to the calculation of the test results, σ for different electrolytes were 32.6087 mS cm^{-1}, 29.7029 mS cm^{-1}, 31.9148 mS cm^{-1}, 30.9278 mS cm^{-1}, 31.2512 mS cm^{-1} (Arg^+ content ranges from 0 M to 0.05 M).

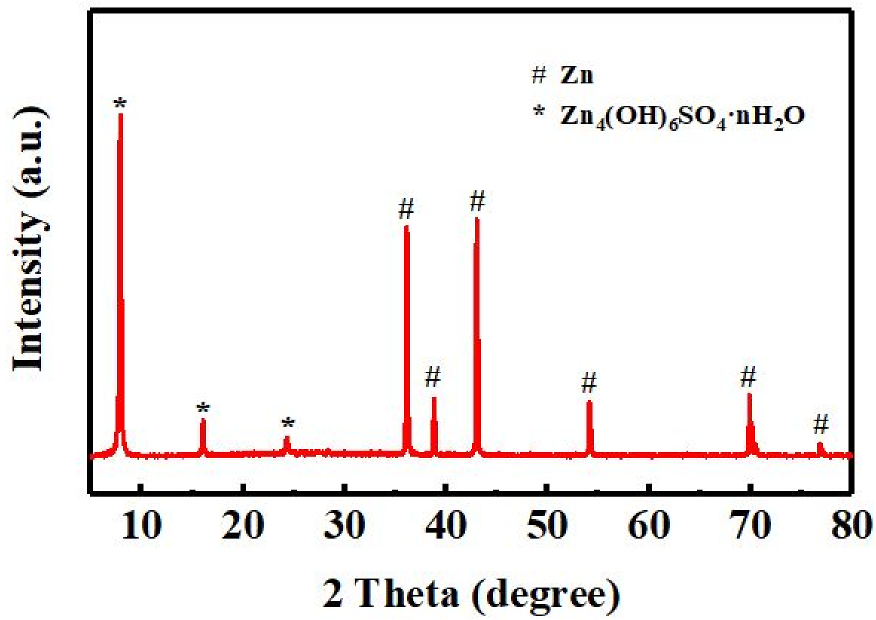

Figure S14. XRD of Zn foil after 30 cycles of electroplating.

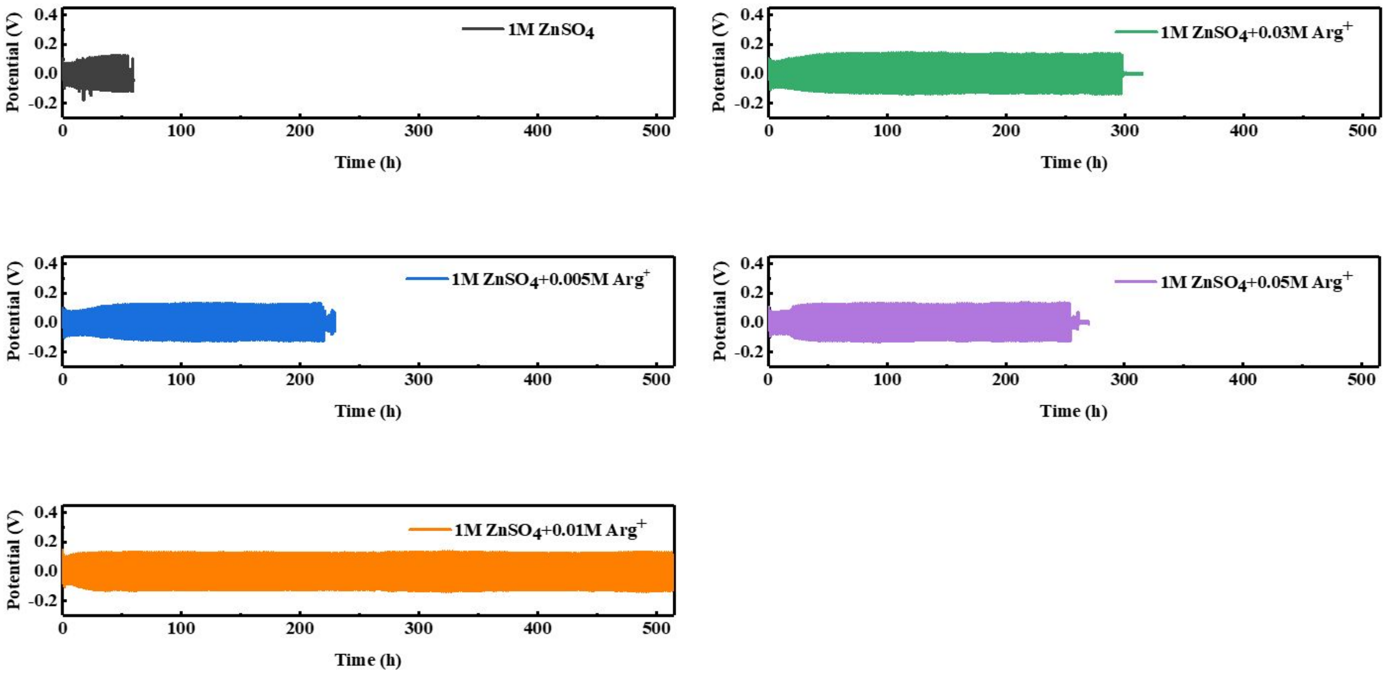

Figure S15. Cycling lifespan of Zn/Zn symmetrical cells in different electrolytes at 0.5 mA cm^{-2} with a fixed capacity of 0.5 mAh cm^{-2}.

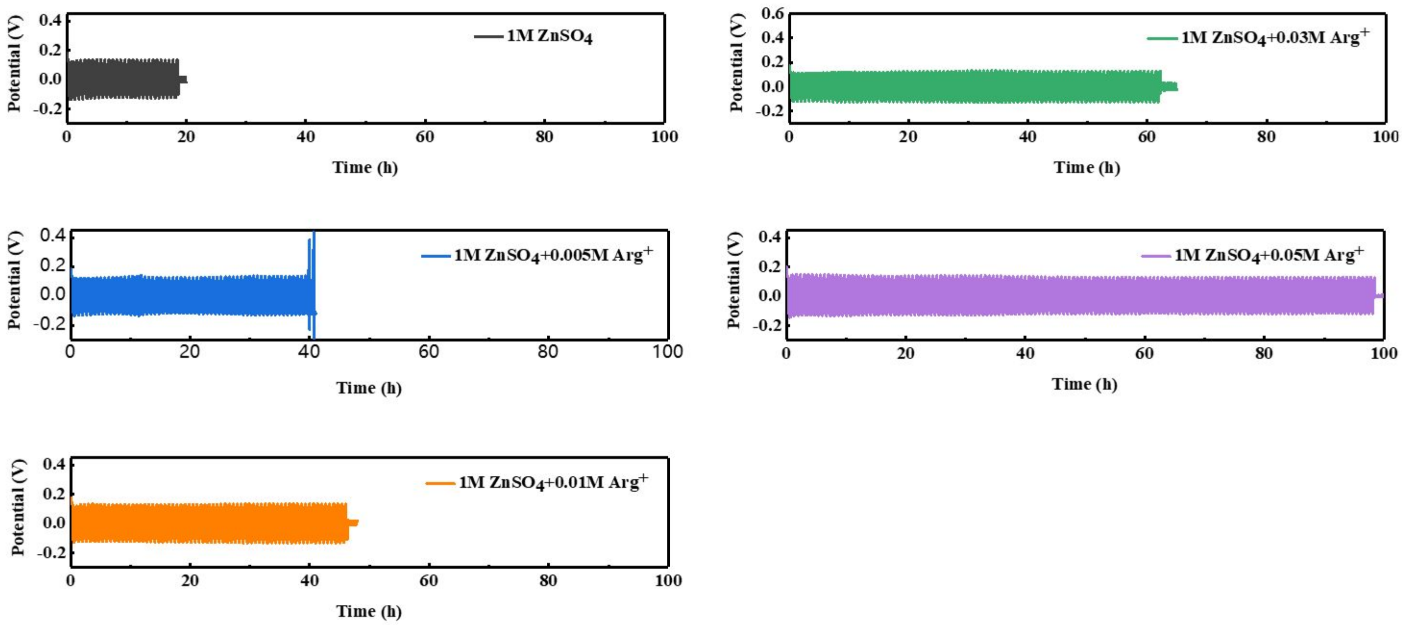

Figure S16. Cycling lifespan of Zn/Zn symmetrical cells in different electrolytes at 1.5 mA cm^{-2} with a fixed capacity of 0.5 mAh cm^{-2}.

Table S1. Price and Toxicity Comparison of electrolyte additives mentioned in other literatures

	Price	Toxicity	Ref.
Sodium dodecyl benzene sulfate	Cheap	Highly toxic	*Adv. Funct. Mater.* **2019**, 29, 1903605.
Diethyl ether	Cheap	Toxic	*Nano Energy* **2019**, 62, 275-281.
Polyethylene glycol	Cheap	Non-toxic	*ChemElectroChem* **2018**, 5, 2409-2418.
Sodium dodecyl sulfate	Costly	Highly toxic	*J. Mater. Chem. A* **2017**, 5, 730-73
Arginine	Cheap	Non-toxic	This work