Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting information

Flexible and Highly Ionic Conductive Polyzwitterionic Eutectogel for Quasi-solid State Zinc Ion Batteries with Efficient Suppression of Dendrites Growth

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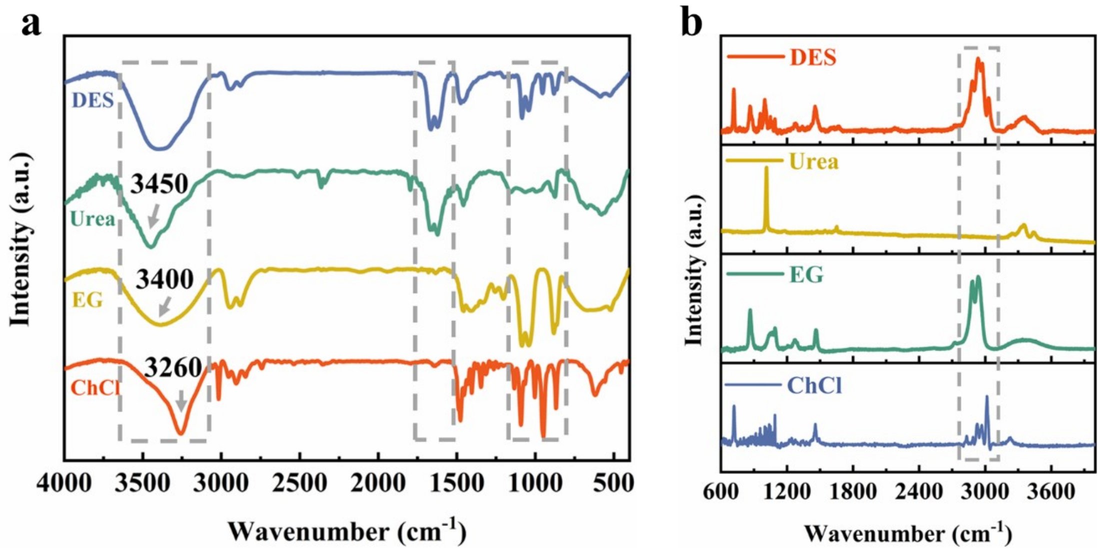

Figure S1. (a) FTIR spectra and (b) Raman spectra of DES solution and its components.

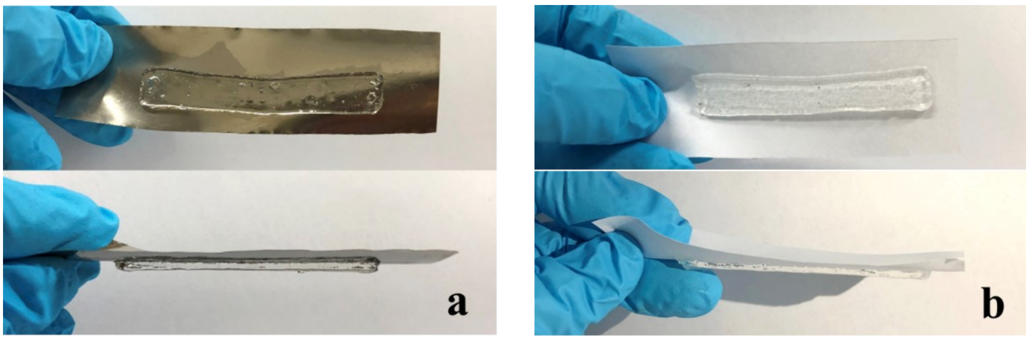

Figure S2. PSPE eutectogel has some adhesion on different substances: (a) Stainless Steel, (b) paper.

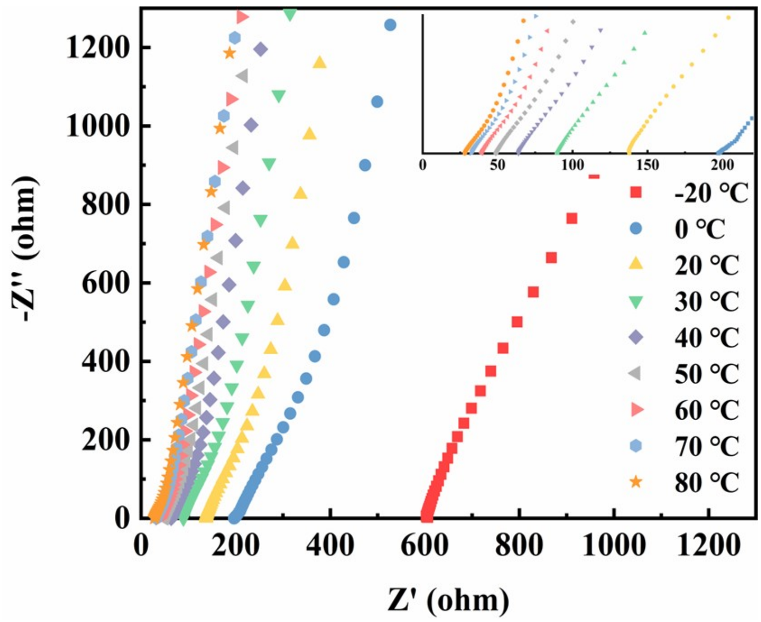

Figure S3. Ionic conductivity of the PSPE eutectogel at various temperature.

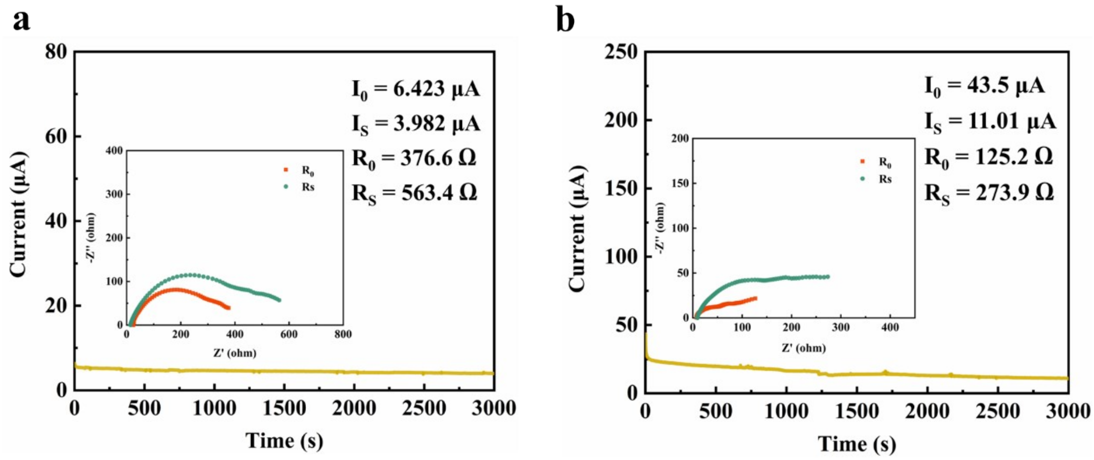

Figure S4. Zn//Zn symmetric cell in (a) PSPE and (b) ZD with an applied potential of 10 mV (inset: EIS spectra of the Zn//Zn symmetric cell).

The value of Zn^{2+} transference number ($t_{Zn^{2+}}$) was characterized by combining the chronoamperometry (CA) technology and EIS. Testing the EIS from 100 kHz to 0.01 Hz with the Zn//Zn symmetric cell before and after polarization under 10 mV for 3000 s. And $t_{Zn^{2+}}$ are calculated by Evans method:[1]

$$t_{Zn^{2+}} = \frac{I_S(\Delta V - I_O R_O)}{I_O(\Delta V - I_S R_S)}$$

Where ΔV is the applied voltage (10 mV), I_O is the initial current and I_S is the steady-state current (μA), R_O and R_S refer the initial and steady-state charge transfer resistances (Ω).

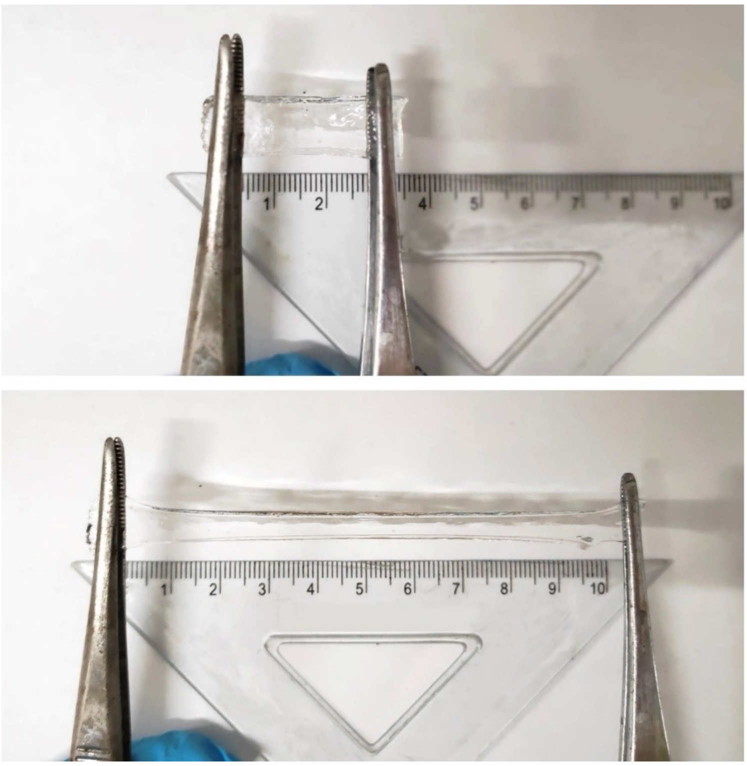

Figure S5. Photographs of PSPE eutectogel demonstrating remarkable mechanical property.

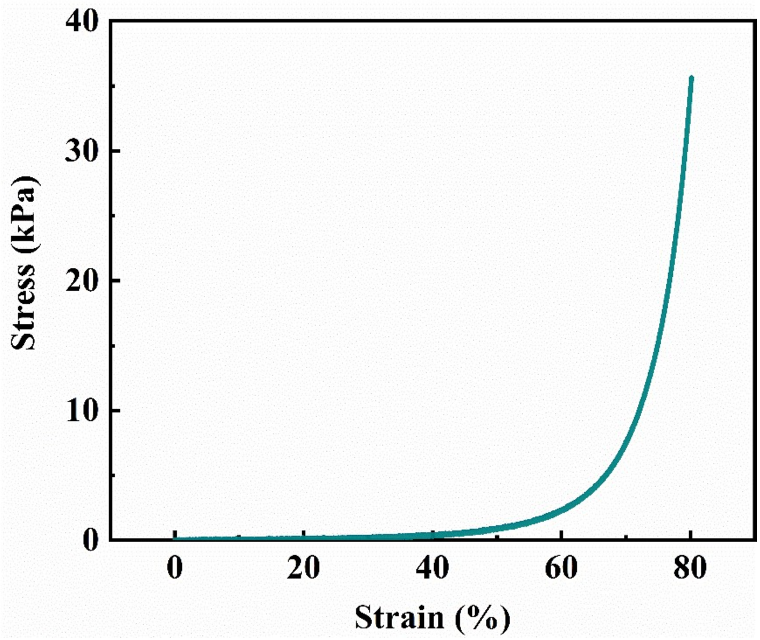

Figure S6. Compressing ability of the PSPE eutectogel.

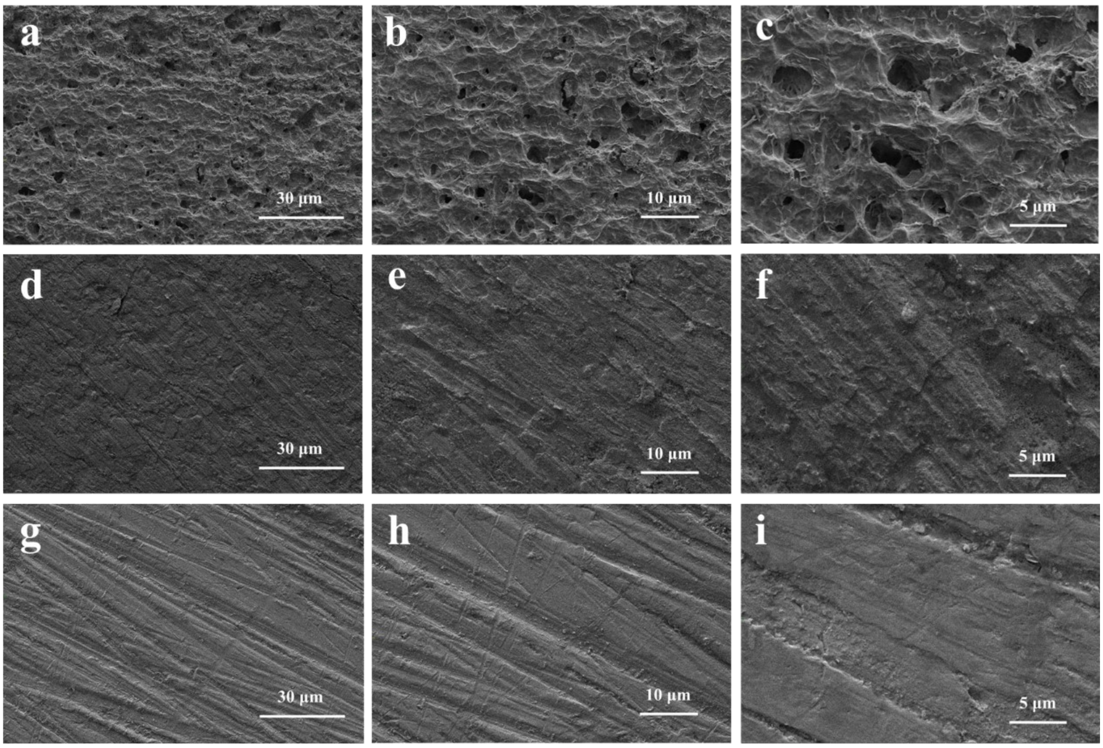

Figure S7. SEM image of Zn foil after immersing in AQ (a, b, c) and ZD (d, e, f) for 15 days, and contacting with PSPE (g, h, i) for 15 days.

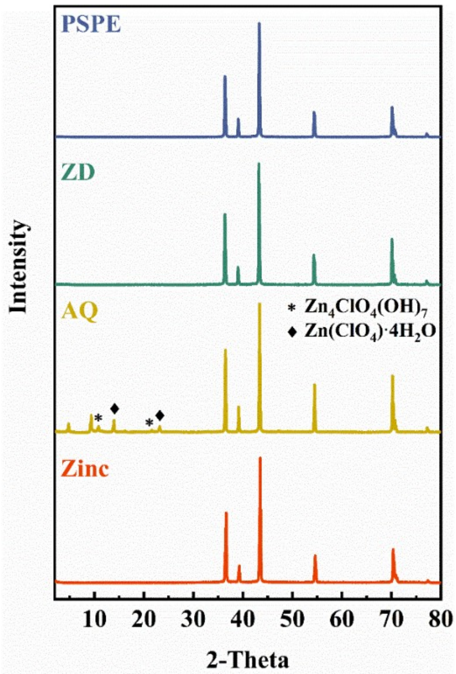

Figure S8. XRD patterns of Zn foil after immersing in AQ and ZD for 15 days, and contacting with PSPE for 15 days.

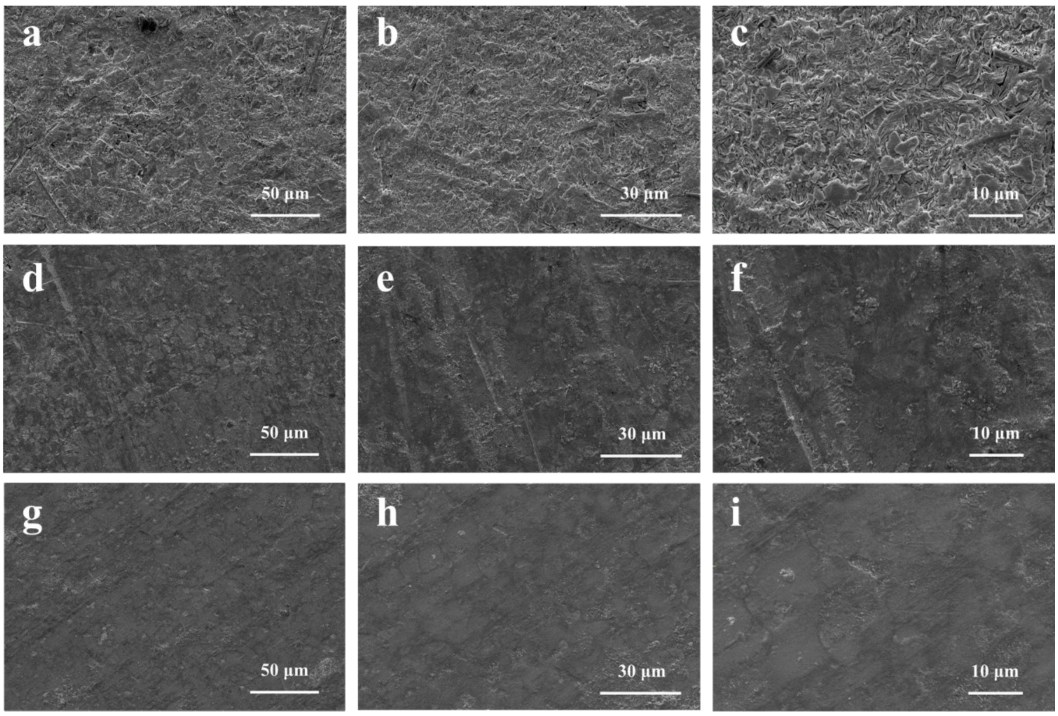

Figure S9. SEM images of the Zn metal surface in Zn//Zn cells after 2 cycles in AQ (a, b, c), ZD (d, e, f), and PSPE (g, h, i).

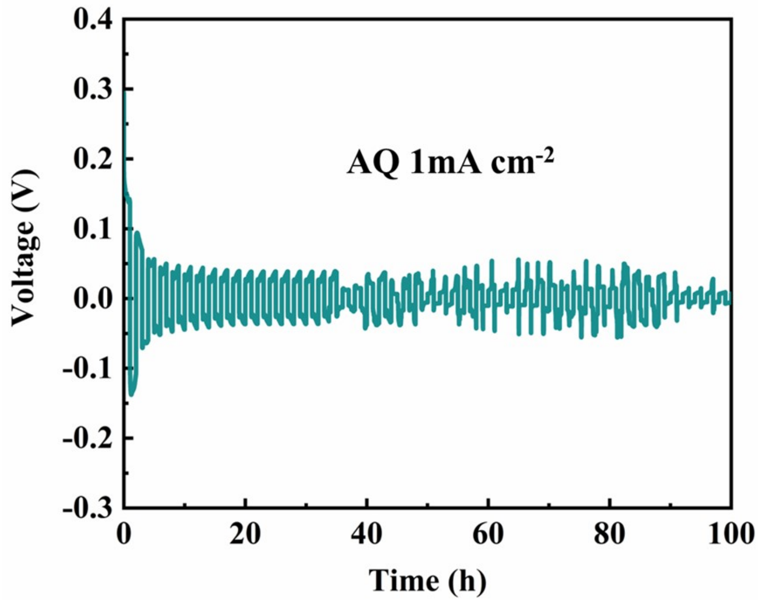

Figure S10. Galvanostatic Zn plating/stripping in Zn//Zn symmetric cells in AQ at 1 mA cm^{-2}.

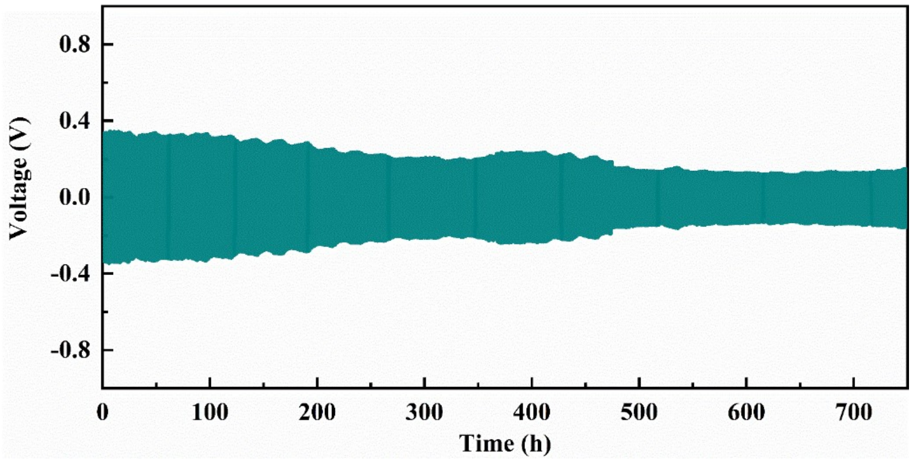

Figure S11. Galvanostatic Zn plating/stripping in Zn//Zn symmetric cells in PSPE at 2 mA cm^{-2}.

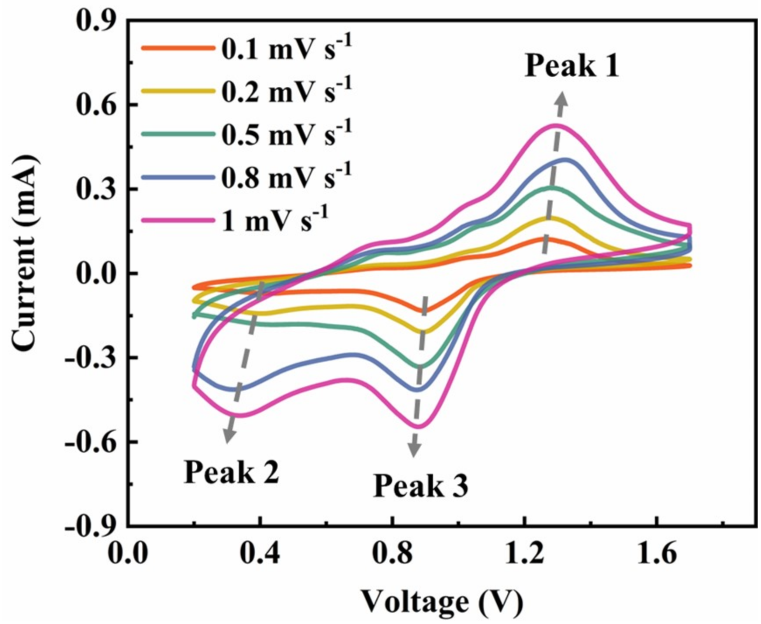

Figure S12. CV curves at different scan rates.

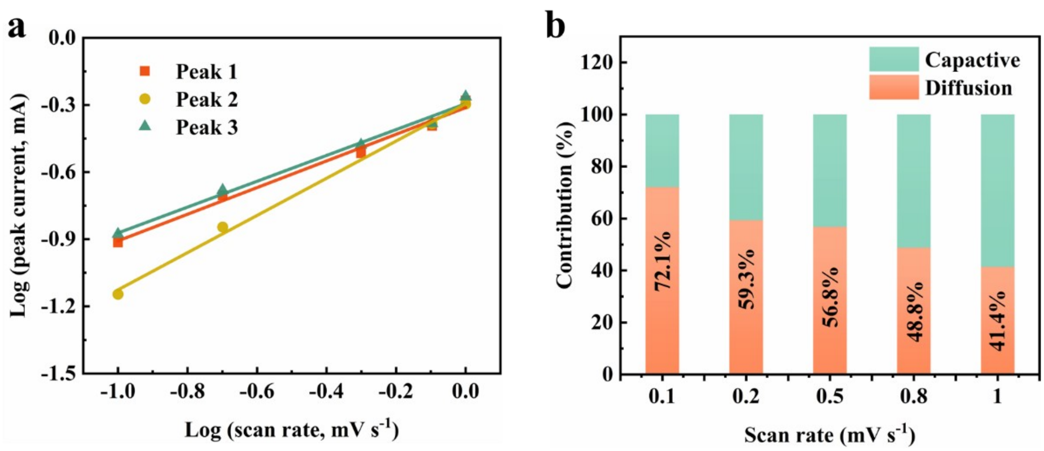

Figure S13. (a) Log (i) and log (v) plots at specific peak currents. (b) Capacity contribution ratios at various scan rates.

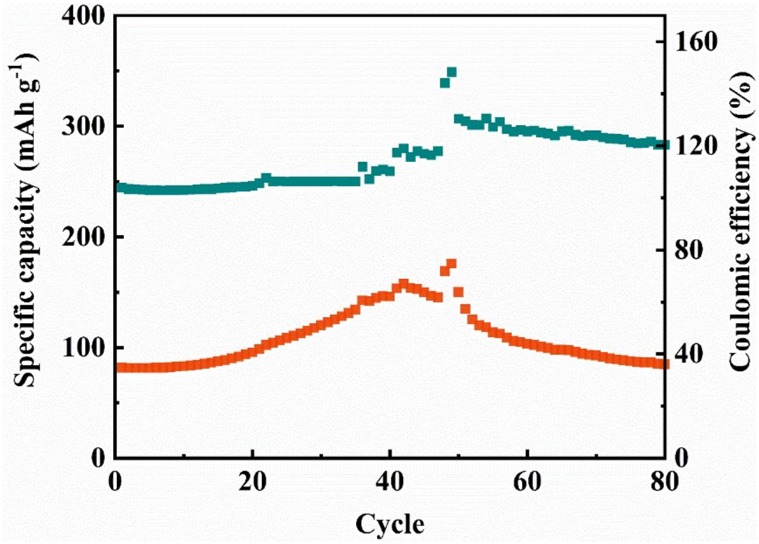

Figure S14. Cycling performance in AQ of full cell.

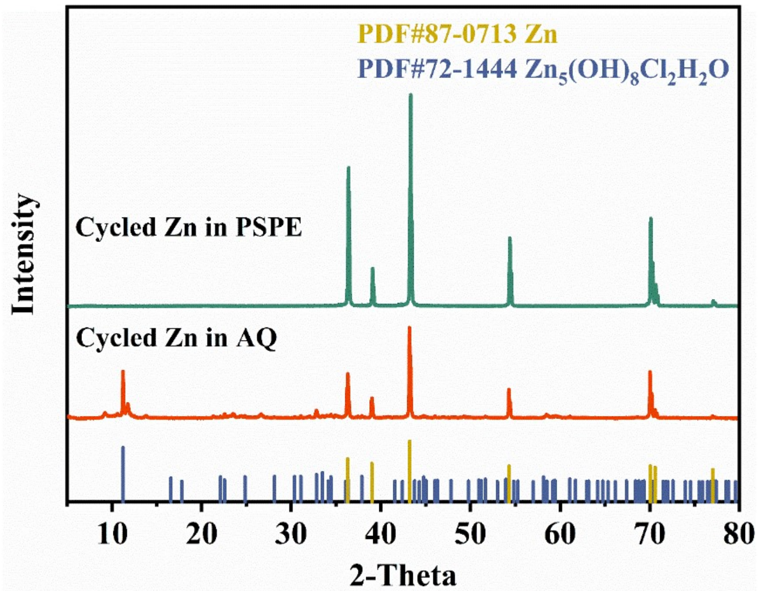

Figure S15. XRD patterns of Zn anodes of full cells after in AQ and PSPE.

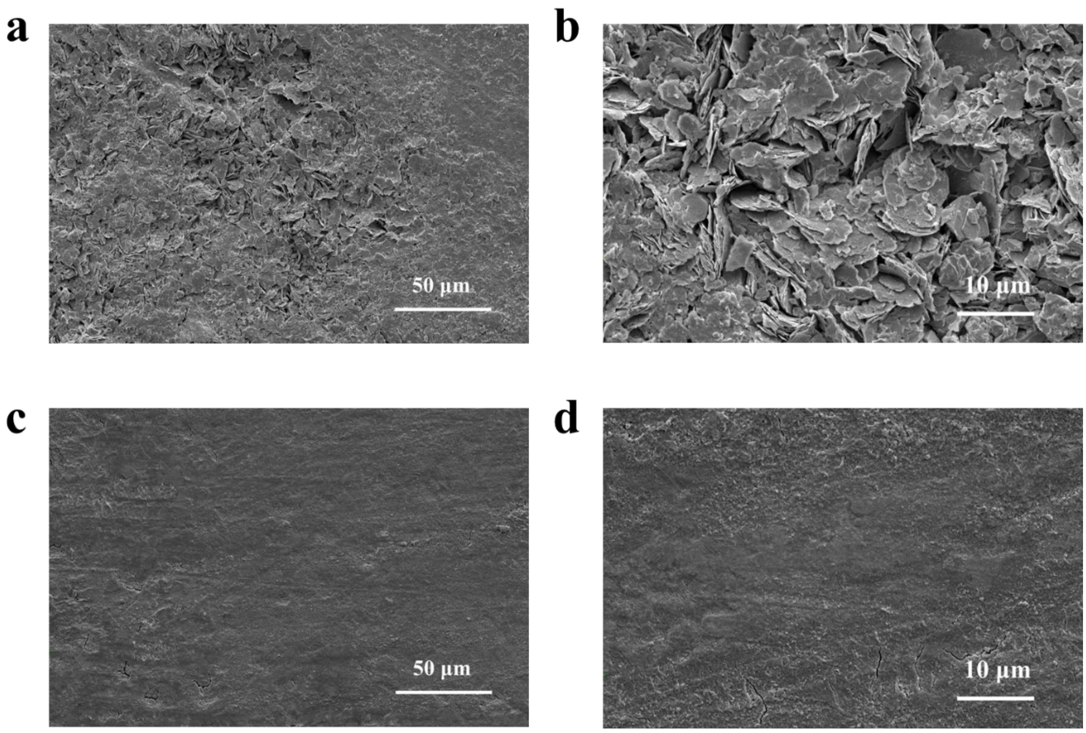

Figure S16. SEM image of Zn anode of full cells after 160 cycles in AQ (a, b) and 500 cycles in PSPE (c, d).

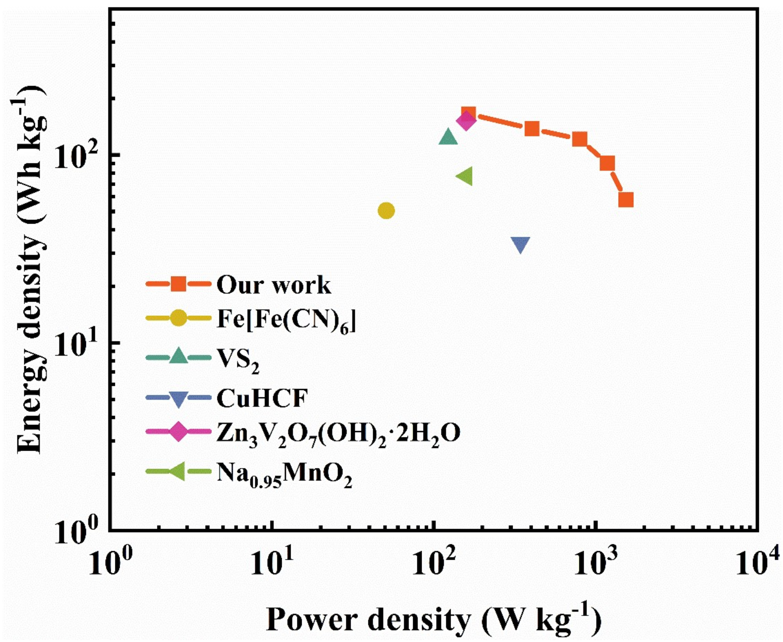

Figure S17. Comparison of energy density and power density of the PSPE eutectogel based zinc ion batteries on reported electrolyte systems and cathode materials.[2-6]

Table S1. Comparison of the water retention of various hydrogels for Zn ion batteries

Gel	Temperature (°C)	Humidity (%)	Time (h)	Weight retention (%)	Ref.
IL-PAM	50	10	9	73	7
carrageenan/PAM	60	37	74	45	8
PAAm−alginate	30	26	72	15	9
PAM	60	10	24	23	10
PSPE	60	10	55	87.9	This work

References

1. Z. Xing, G. Xu, X. Xie, M. Chen, B. Lu, J. Zhou and S. Liang, *Nano Energy*, 2021, **90**, 106621.
2. P. He, M. Yan, G. Zhang, R. Sun, L. Chen, Q. An and L. Mai, *Adv. Energy Mater.*, 2017, **7**, 1601920.
3. Z. Liu, P. Bertram and F. Endres, *J Solid State Electrochem*, 2017, **21**, 2021-2027.
4. R. Trocoli and F. La Mantia, *ChemSusChem*, 2015, **8**, 481-485.
5. C. Xia, J. Guo, Y. Lei, H. Liang, C. Zhao and H. N. Alshareef, *Adv. Mater.*, 2018, **30**, 1705580.
6. B. Zhang, Y. Liu, X. Wu, Y. Yang, Z. Chang, Z. Wen and Y. Wu, *Chem. Commun.*, 2014, **50**, 1209-1211.
7. J. Huang, X. Chi, Y. Du, Q. Qiu and Y. Liu, *ACS Appl. Mater. Interfaces*, 2021, **13**, 4008-4016.
8. J. Wu, Z. Wu, H. Xu, Q. Wu, C. Liu, B.-R. Yang, X. Gui, X. Xie, K. Tao, Y. Shen, J. Miao and L. K. Norford, *Mater. Horiz.*, 2019, **6**, 595-603.

9. T. Liu, M. Liu, S. Dou, J. Sun, Z. Cong, C. Jiang, C. Du, X. Pu, W. Hu and Z. L. Wang, *ACS Nano*, 2018, **12**, 2818-2826.
10. C. Li, X. Deng and X. Zhou, *Polymers*, 2020, **12**, 2670.