Energy Materials

Supporting Information

Dendrite-free Zn anodes enabled by interface engineering for non-alkaline Zn-air and Zn-ion batteries

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Figure 1. Digital photos of ZSO electrolytes with and without different concentrations of TEAB additives (0, 0.01, 0.05, 0.1 and 0.2 M).

Figure 2. The ignition test of ZSO electrolyte with 0.2 M TEAB additive.

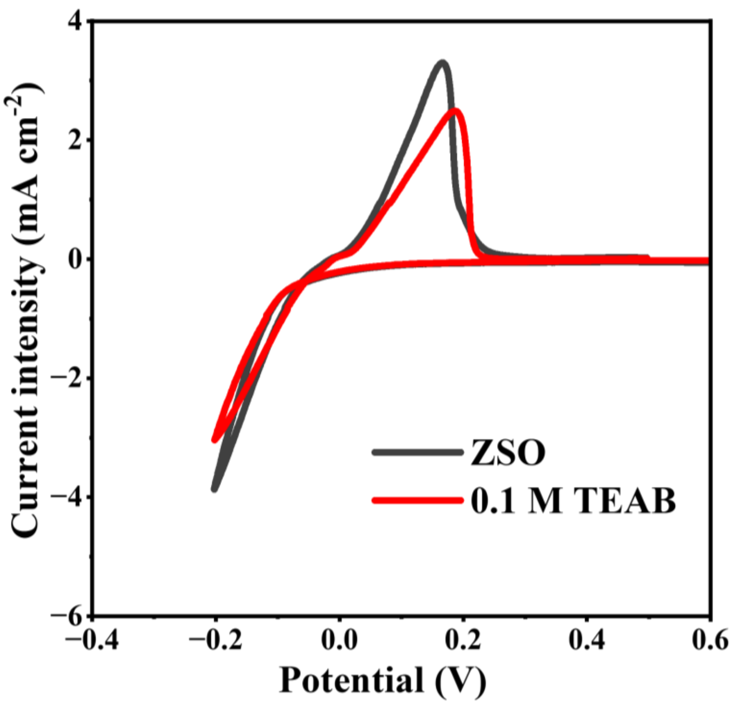

Figure 3. CV curves of Zn||Cu cells in ZSO electrolytes with and without 0.1 M TEAB additive.

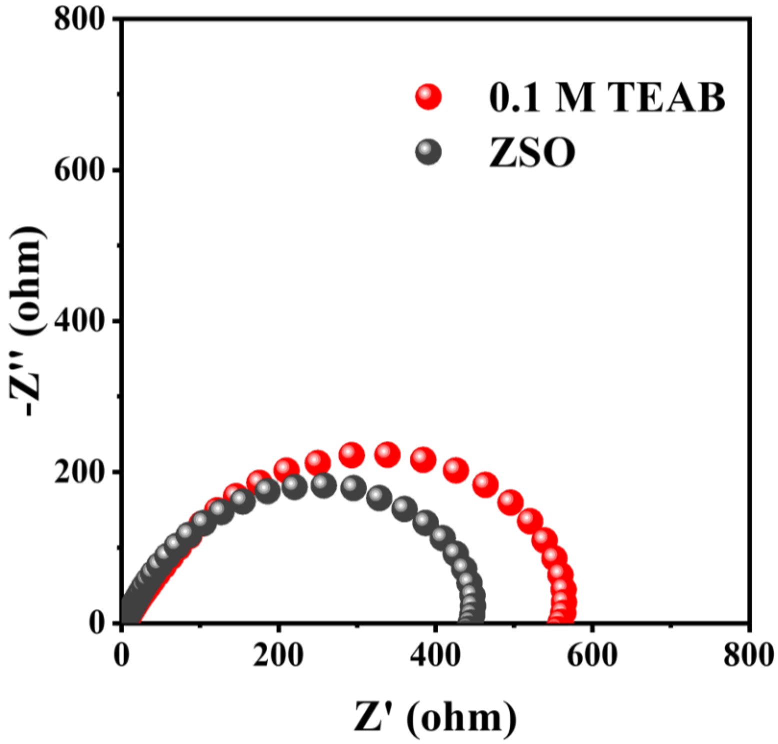

Figure 4. Nyquist plots of Zn||Zn symmetric cells in ZSO electrolytes with and without 0.1 M TEAB additive.

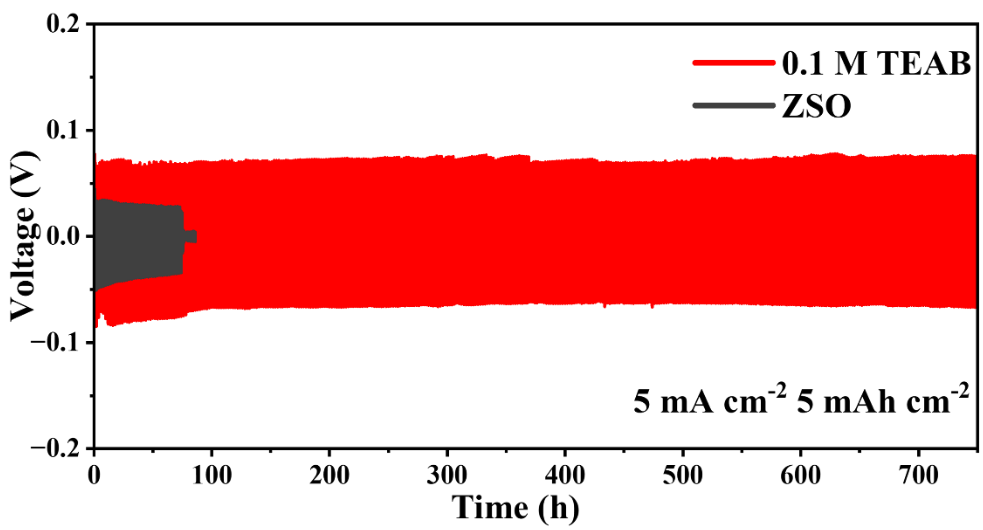

Figure 5. Cycling performance of Zn||Zn symmetrical cells in ZSO electrolytes with and without 0.1 M TEAB additive under a current density and area capacity of 5 mA cm^{-2} and 5 mAh cm^{-2}.

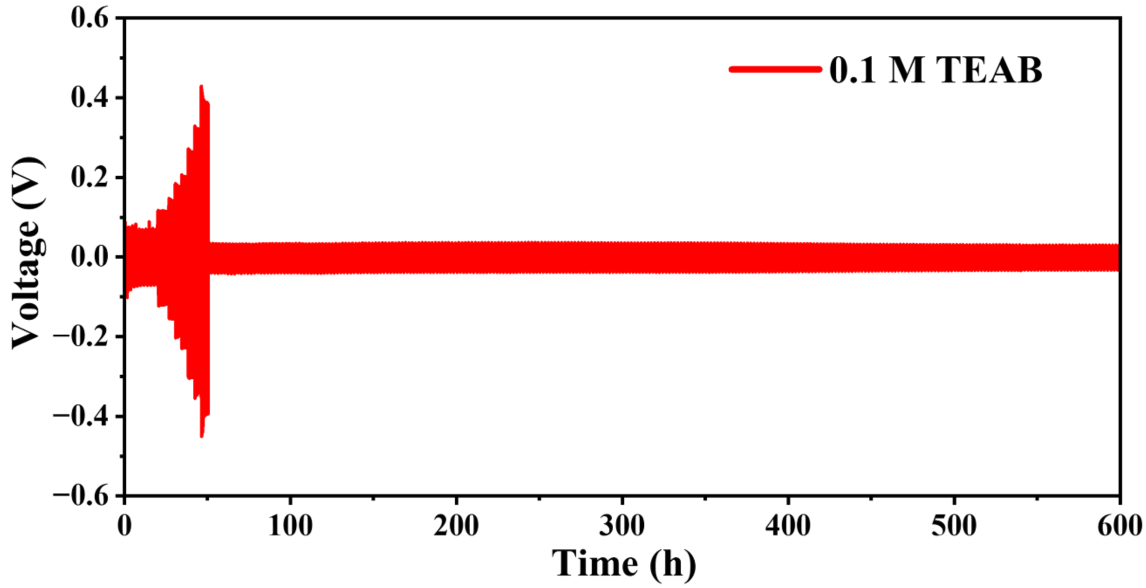

Figure 6. Rate performance of Zn||Zn symmetrical cell in ZSO electrolytes with and without 0.1 M TEAB additive at different current densities from 1 to 30 mA cm^{-2}.

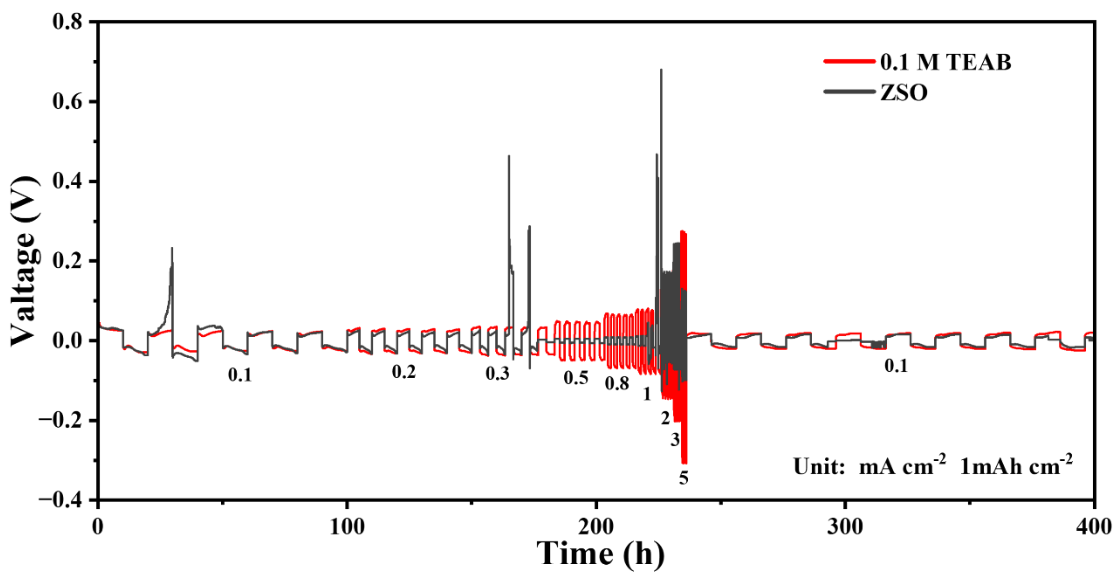

Figure 7. Rate performance of Zn||Zn symmetric cells in ZSO electrolytes with and without 0.1 M TEAB additive at different current densities ranging from 0.1 to 5 mA cm^{-2}.

In ZSO, a significant enhancement in the overpotential (from 25.1 mV to 463.4 mV) and noticeable voltage fluctuations are observed when the current density reaches 0.3 mA cm^{-2}. As the current density further increases, dendrite accumulation and side reactions lead to a substantial deterioration and a rapid short-circuit during Zn plating/stripping. In contrast, the symmetric cells with 0.1 M TEAB electrolyte demonstrate sustained stability with reasonable changes in the overpotential (24.8 mV at 0.1 mA cm^{-2} and 272.3 mV at 5 mA cm^{-2}).

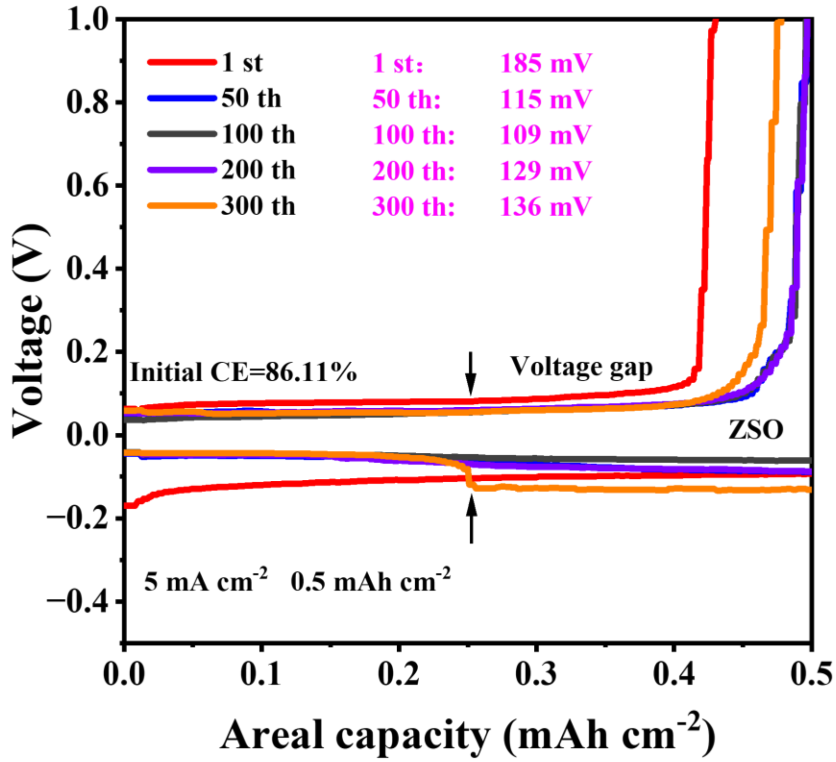

Figure 8. Corresponding voltage profiles at various cycles in the pure ZSO electrolyte.

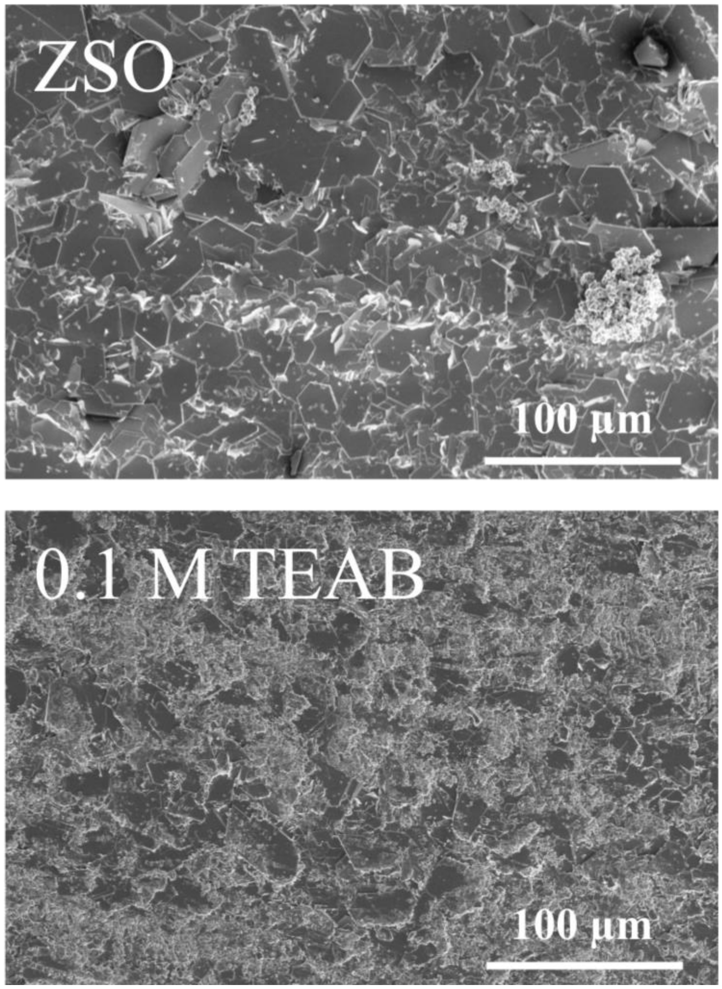

Figure 9. SEM images of bare Zn foils soaked for a week in ZSO electrolytes with and without 0.1 M TEAB additive.

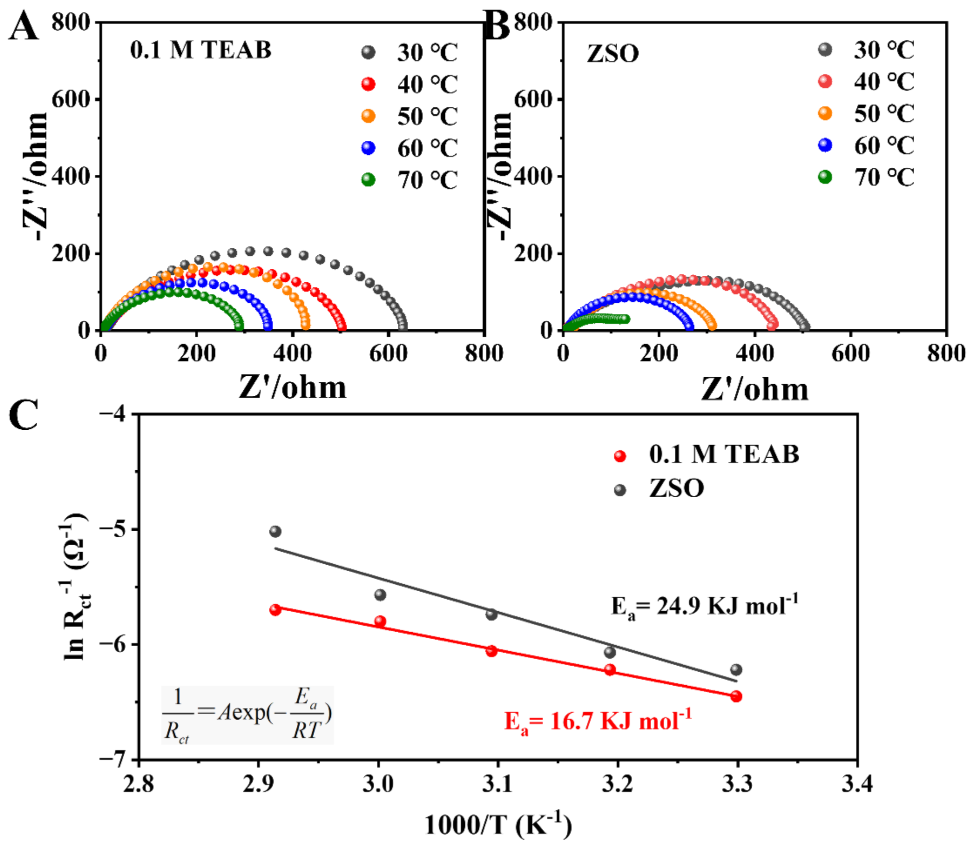

Figure 10. Nyquist plots of Zn||Zn symmetric cells at different temperatures: (A) ZSO +0.1 M TEAB additive and (B) ZSO. (C) Corresponding Arrhenius curves and comparison of activation energies of ZSO electrolytes with and without 0.1 M TEAB additive.

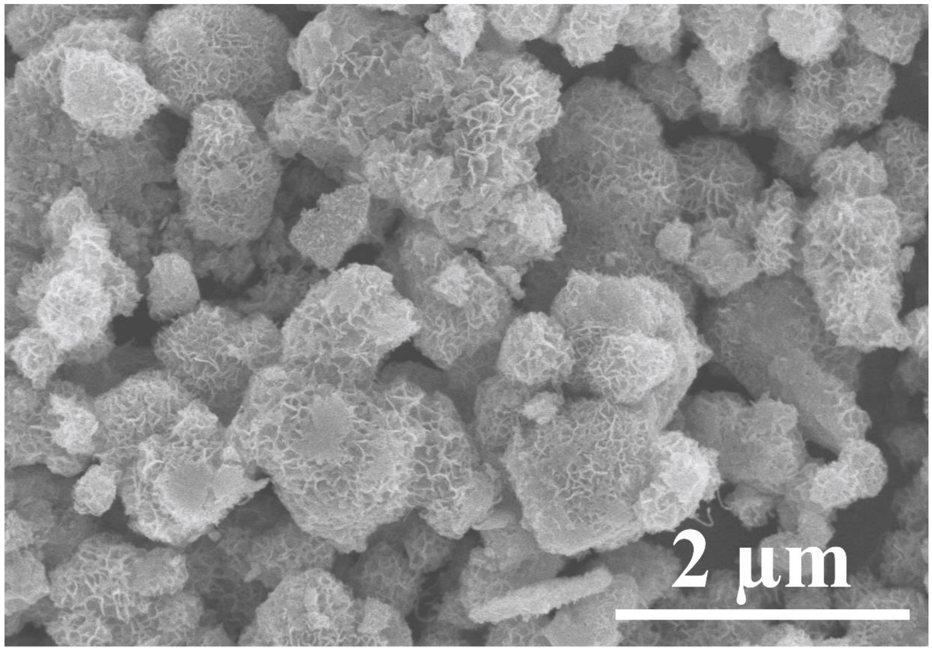

Figure 11. SEM image of the cathode materials δ-MnO_2.

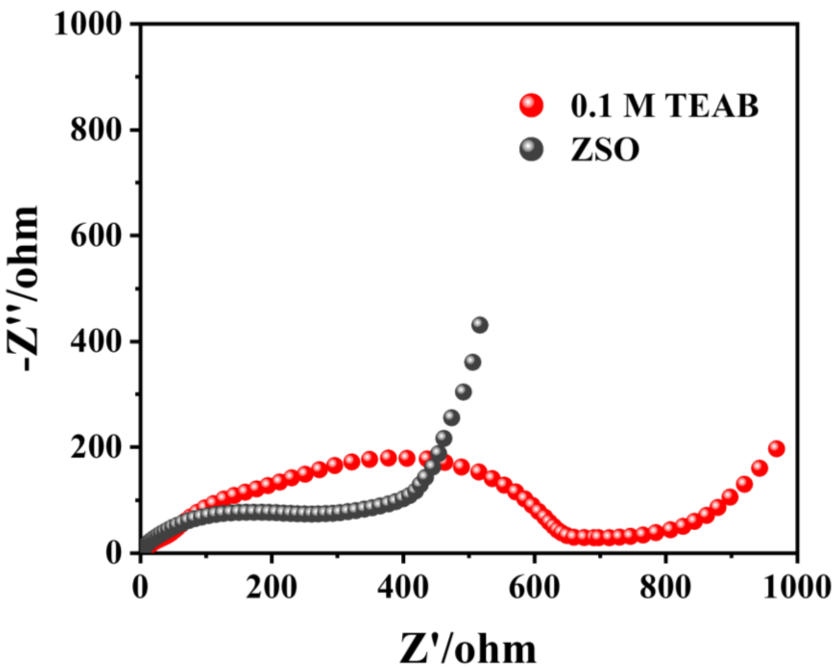

Figure 12. EIS of Zn||MnO_2 full cells in ZSO electrolytes with and without 0.1 M TEAB additive.

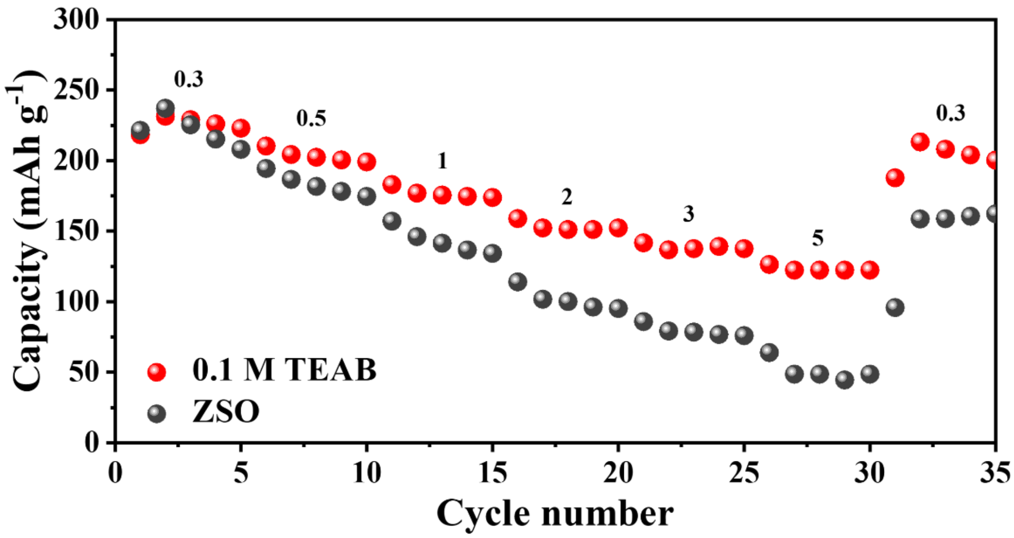

Figure 13. Rate performance of Zn||MnO_2 full cells in ZSO electrolytes with and without 0.1 M TEAB additive.

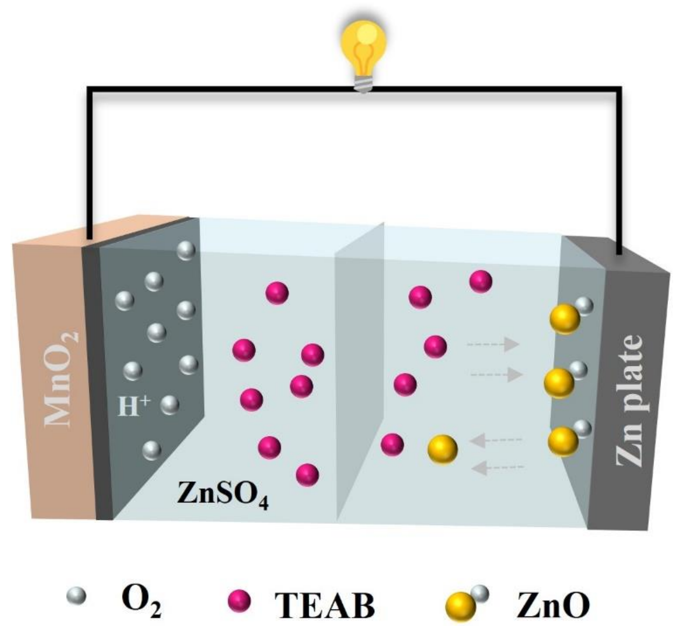

Figure 14. The schematic diagram of Zn||air cell.

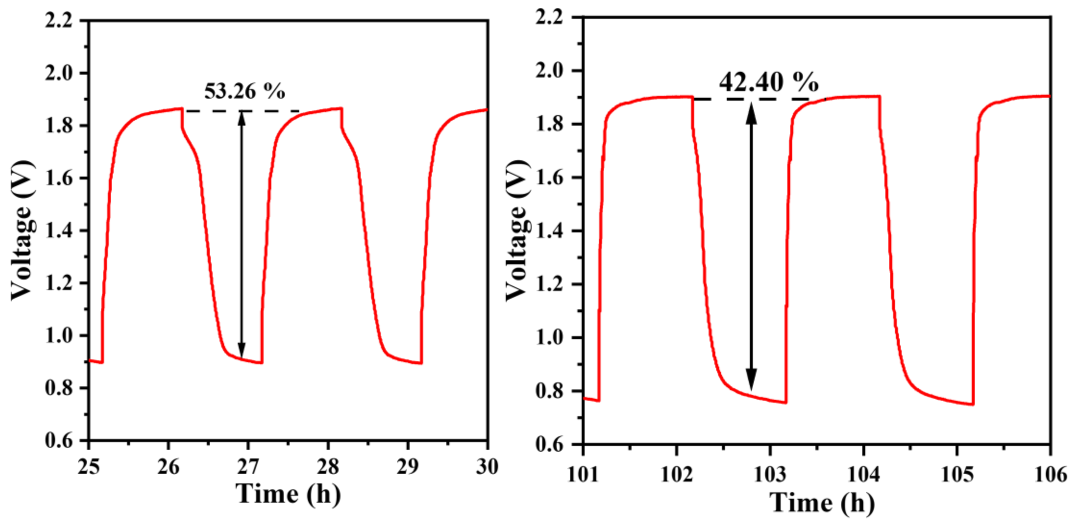

Figure 15. The cycling curves at different times in ZSO electrolyte with 0.1 M TEAB additive.

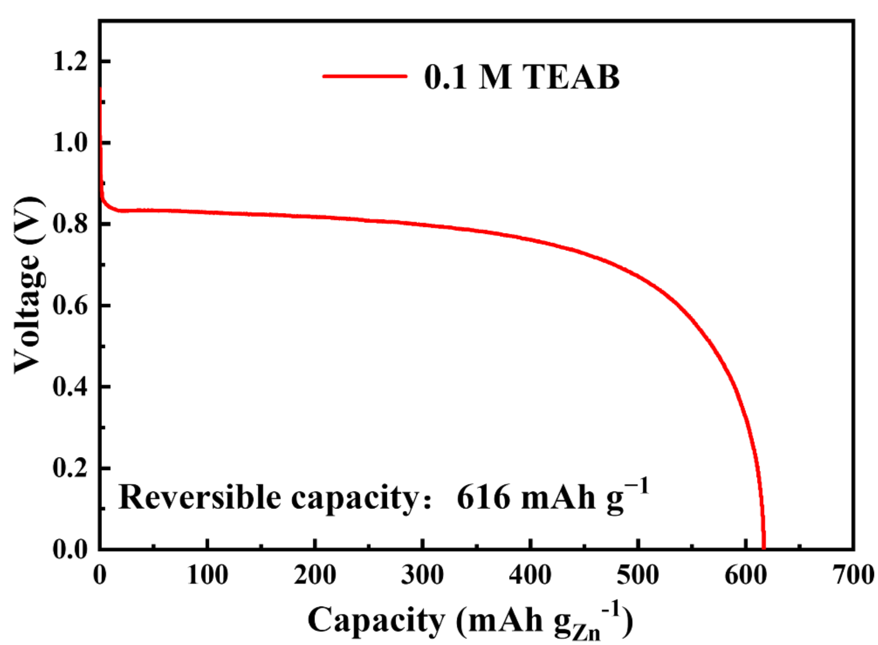

Figure 16. The Reversible capacity of Zn||air cell in ZSO electrolyte with 0.1 M TEAB additive.

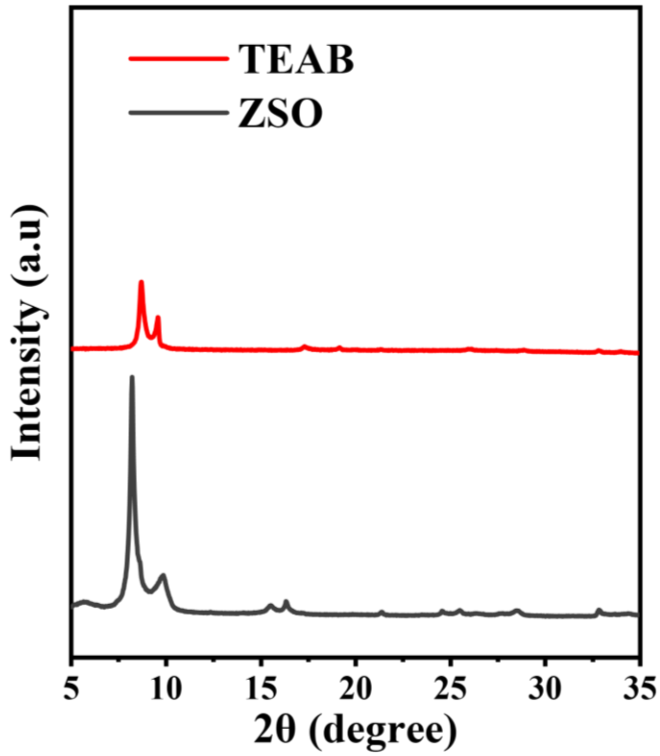

Figure 17. XRD images of anode in ZSO electrolytes with and without 0.1 M TEAB additive.

Table 1. Symmetric Zn||Zn cells cycling performance comparison between this work and other recent reports.

Strategy/Zn Salt	Current density (mA cm^{-2})	Cycling capacity (mAh cm^{-2})	Life (h)	Ref.
β-CD/$Zn(ClO_4)_2$	1 5	1 5	1000 350	Angew. Chem. Int. Ed. 2022, 61, e202210979
PC-sat/$Zn(OTf)_2$	1	1	1600	J. Am. Chem. Soc. 2022, 144, 16, 7160–7170
$Zn(H_2PO_4)_2$/Zn $(OTf)_2$	1 5	1 5	1200 200	Adv. Mater 2021, 33, 2007416
BIS-TRIS/$ZnSO_4$	1 5	1 5	1200 600	Energy Storage Mater 2021, 41, 515-521
Bet/$ZnSO_4$	2 5	2 1	800 150	Adv. Mater 2023, 35, 2208237
DMSO/$ZnCl_2$	0.5	0.5	1000	J. Am. Chem. Soc. 2020, 142, 51, 21404–21409
Na_4EDTA/$ZnSO_4$	2 5	2 2	450 2000	Adv. Energy Mater. 2021, 11, 2102010
Glucose/$ZnSO_4$	1	1	2000	Rare Metals. 2022, 41, 356-360
15-CE-5/$ZnSO_4$	2	2	720	Chem.-Eur. J. 2023, 452: 139572
PAA/$ZnSO_4$	0.5 1	0.5 1	3000 1400	eScience. 2023, 3, 100153
TC/$ZnSO_4$	1 5	0.5 2.5	2000 500	Adv. Energy Mater. 2022, 12, 2102780
TEAB/$ZnSO_4$	1 5	1 1	3950 2950	This work

Table 2. Full cells cycling performance comparison between this work and other recent reports.

Strategy/Zn Salt	**Full cell system**	**Current density A g^{-1}**	**Life (h)**	**Ref.**
$TBA_2SO_4/ZnSO_4$	Zn||MnO_2	1	300	ACS Energy Lett. 2020, 5, 9, 3012-3020
$TMA_2SO_4/ZnSO_4$	Zn||MnO_2	0.2	200	J. Colloid Interface Sci. 2022, 627, 367-374
β-CD/$Zn(ClO_4)_2$	Zn||MnO_2	1	1000	Angew. Chem. Int. Ed. 2022, 61, e202210979
PC-sat/$Zn(OTf)_2$	Zn-$ZnMn_2O_4$	0.5	300	J. Am. Chem. Soc. 2022, 144, 16, 7160–7170
BIS-TRIS/$ZnSO_4$	Zn||MnO_2	0.5	600	Energy Storage Mater 2021, 41, 515-521
$Na_4EDTA/ZnSO_4$	Zn||VO_2	4	2000	Adv. Energy Mater. 2021, 11, 2102010
SF/$ZnSO_4$	Zn||KVO	3	1000	ACS Nano 2022, 16, 7, 11392–11404
TEAB/$ZnSO_4$	Zn||MnO_2	1 3	1000 2000	This work