Electronic Supplementary Information for

Kinetic modulation enabling densely oriented electrodeposition of Zn anodes in aqueous batteries

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Supplementary figures and tables

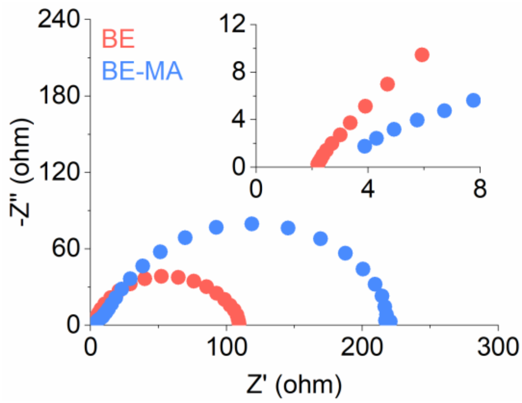

Fig. S1 Nyquist plots of Zn electrode in the BE and BE-MA electrolytes.

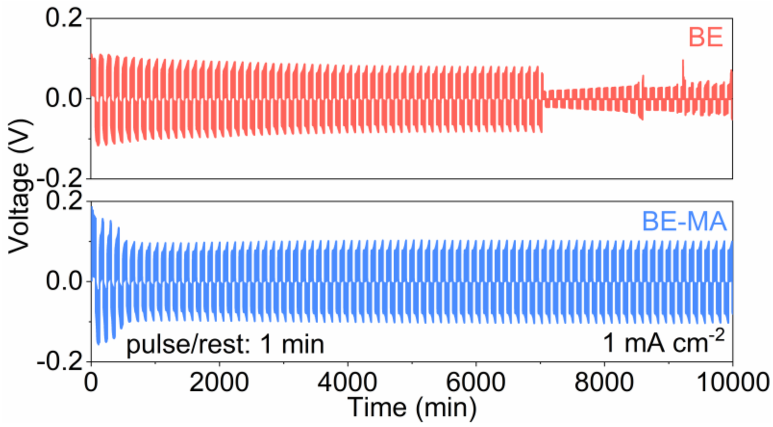

Fig. S2 GITT curves of Zn electrode in the BE and BE-MA electrolytes.

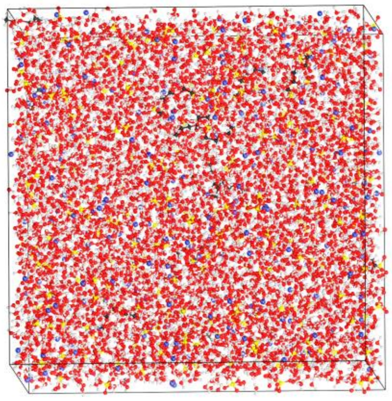

Fig. S3 Snapshots of MD simulation box of the BE-MA electrolyte.

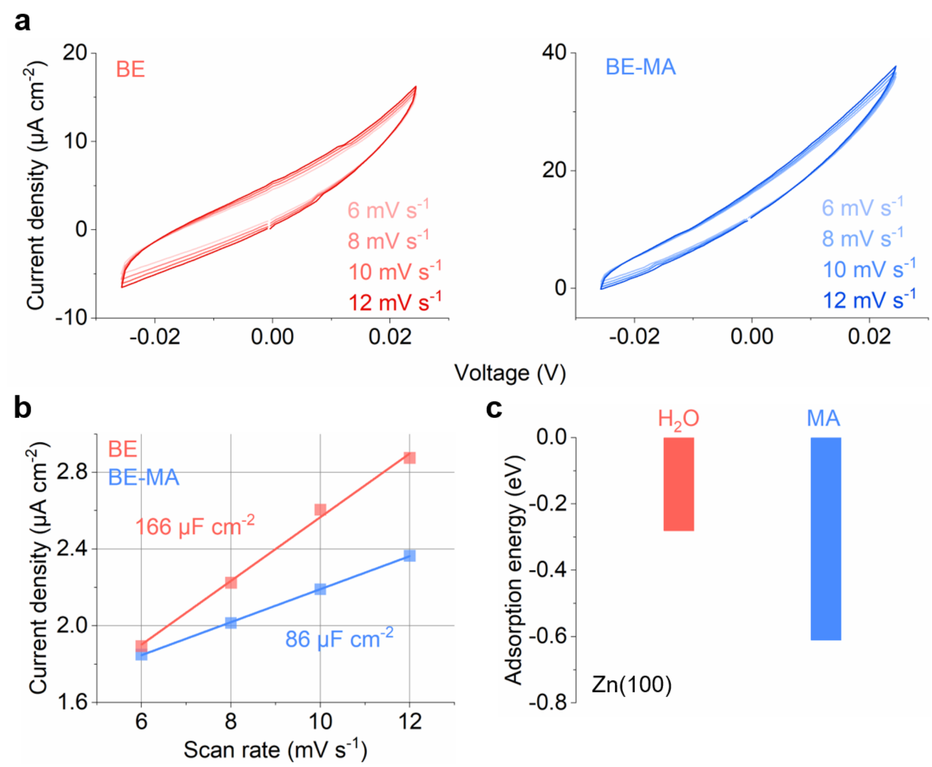

Fig. S4 a) The CV curves of Zn symmetric cells in the non-Faradic range and b) linear fits to calculate EDLC in the BE and BE-MA electrolytes. c) The adsorption energies of MA and water molecules on the surface of Zn. The lower EDLC in BE-MA and stronger adsorption energy of MA confirm the preferential accumulation of MA on Zn surface.

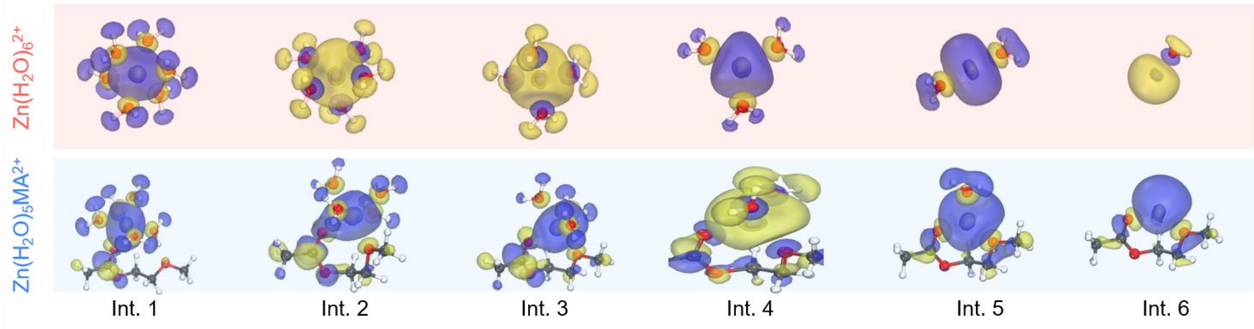

Fig. S5 The LUMOs along the desolvation processes of $Zn(H_2O)_6^{2+}$ and $Zn(H_2O)_5MA^{2+}$.

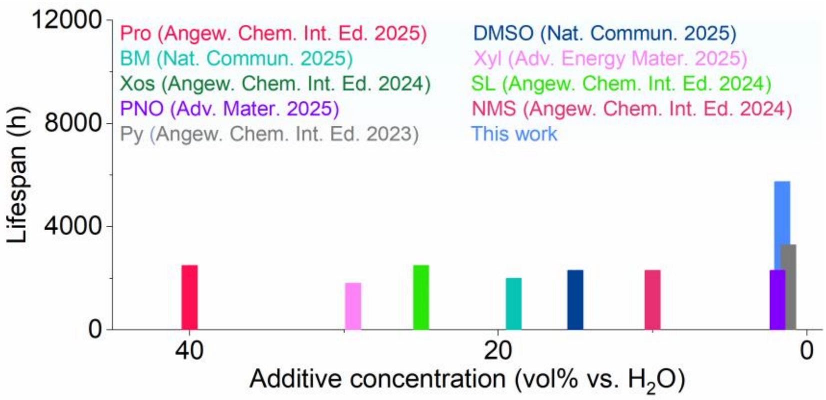

Fig. S6 Cycling performance comparison of Zn electrode in BE-MA with representative publications.

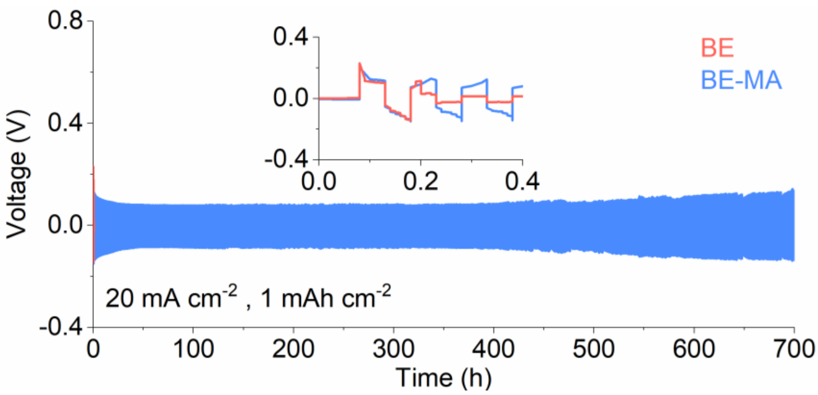

Fig. S7 Long-term Zn plating/stripping in the BE and BE-MA electrolytes at 20 mA cm^{-2}.

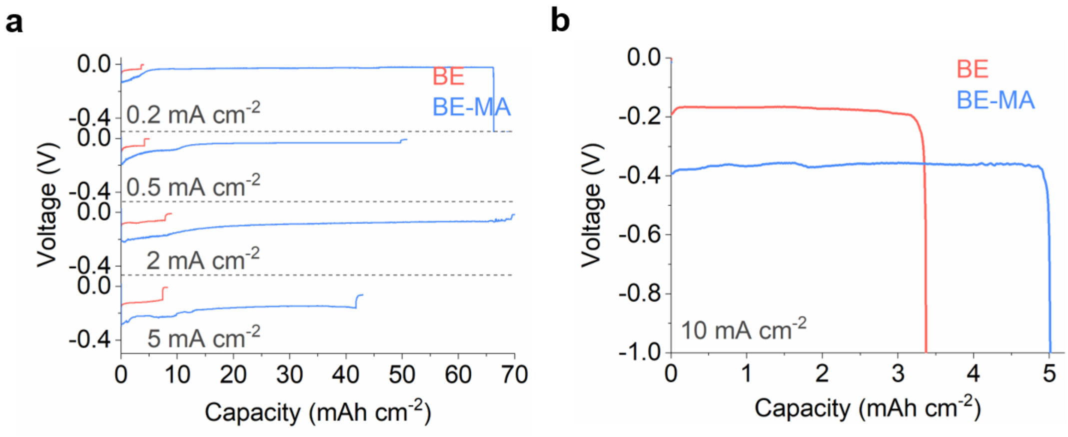

Fig. S8 Continuous single plating/stripping voltage curves of Zn in the BE and BE-MA electrolytes.

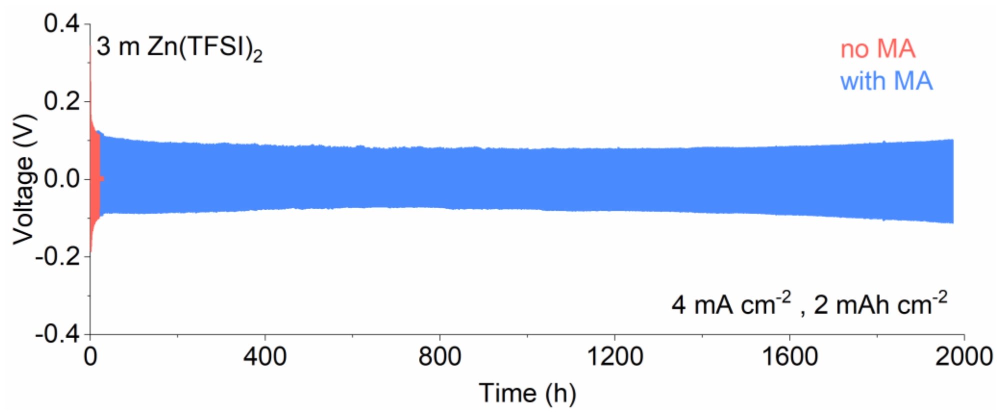

Fig. S9 Long-term Zn plating/stripping in the $Zn(TFSI)_2$-based electrolytes.

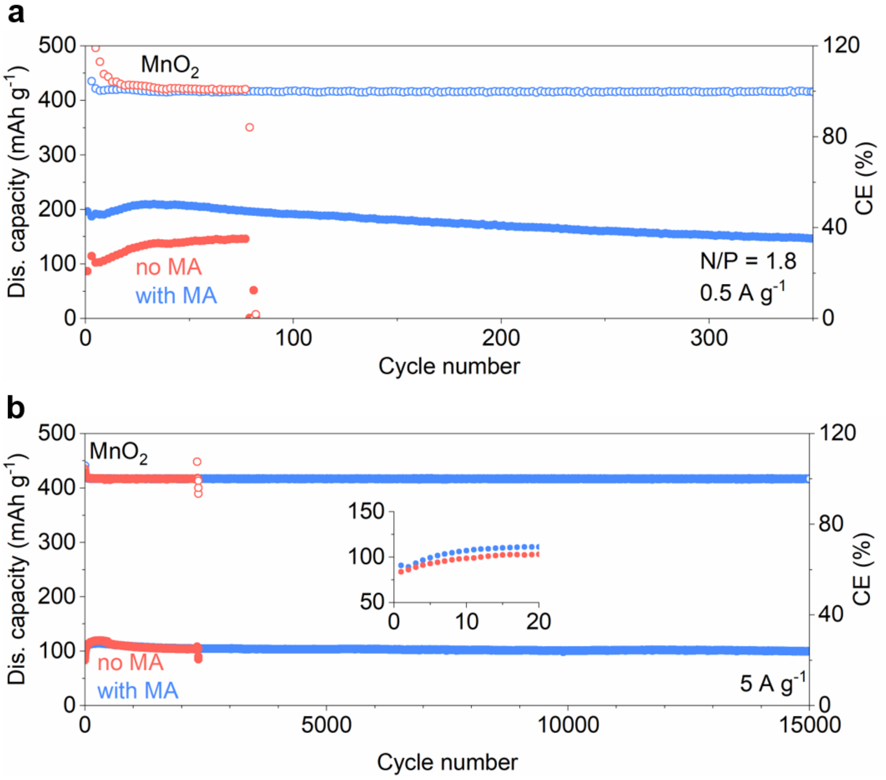

Fig. S10 Cycling performance of Zn//MnO_2 full cells in the electrolytes without and with MA additive at a) 0.5 A g^{-1} and N/P = 1.8, b) 5 A g^{-1} and excess Zn anode (inset showing the initial activation cycles).

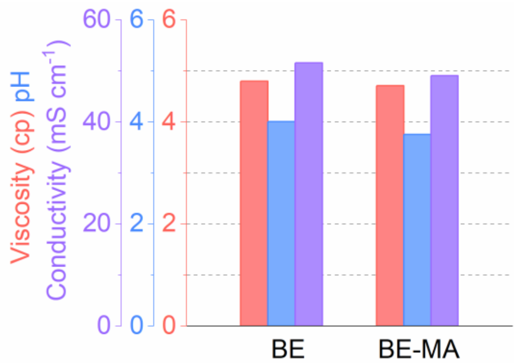

Fig. S11 The basic properties of the two electrolytes.

Table S1 Cycling performance comparison of Zn electrode in BE-MA with representative publications.

Electrolyte additive	Additive vol% vs. H_2O	Lifespan (h)	Ref.
Pro	40	2500	1
DMSO	15	2300	2
BM	19	2000	3
Xyl	29.4	1800	4
Xos	10	960	5
SL	25	2500	6
PNO	1.9	2300	7
NMS	10	2300	8
Py	1.2	3300	9
MA	1.6	5740	This work

Table S2 The cycling performance at high DOD using the BE-MA electrolyte in comparison to representative studies.

Electrolyte additive or anode regulation	DOD (%)	CPC (Ah cm^{-2})	Ref.
ZnSn alloy	35.2	0.6	10
TZNC@Zn	25	0.4	11
	50	0.4	
AQS additive	20	0.235	12
LRZCF@ZCC-Zn	40	0.19	13
Glusose additive	8	0.675	14
Zn-N_3P_{y+1}Pr-C@Zn	10	0.375	15
	50	0.25	
PC additive	25	0.185	16
ILHCE additive	20	0.702	17
DES-Zn	10	0.525	18
	40	0.615	
(002)-Zn	45.5	1.05	19
C_8TAB additive	20	0.15	20
MA additive	50	1.58	This work

Table S3 The cycling performance of Zn//$V_6O_{13}·H_2O$ full cell using the BE-MA electrolyte in comparison to representative studies.

Electrolyte additive or anode regulation	N/P ratio	Cycle number	Capacity retained (mAh g^{-1})	Ref.
GFZP-Zn-NVO	2.4	130	206	21
At-Sn@HCN-Zn-V_2O_5	3.4	500	75	22
ZPO@Zn-MnO_2	2.4	110	113	23
CMFs-Zn-MnO_2	4.2	200	117	24
MA additive-$V_6O_{13}·H_2O$	1.8	600	302	This work

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