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

Inorganic Salt Reinforce Zn^{2+}-conducting Solid-state Electrolyte for Ultra-stable Zn Metal Battery

Qi Han[a,b], Xiaowei Chi[a,*],Yunzhao Liu[a,b], Liang Wang[c], Yuexiu Du[a,b], Yang Ren[d], Yu Liu[a,*]

[a] Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai 200050, P.R. China

[b] University of Chinese Academy of Sciences, Beijing 100049, P.R. China

[c] School of Materials Science and Engineering, Beijing Institute of Technology, Beijing 100081, P.R. China

[d] X-ray Science Division, Argonne National Laboratory, Argonne IL 60439, USA

Corresponding Authors:

*Email: xwchi@mail.sic.ac.cn; yuliu@mail.sic.ac.cn

Table S1. Component (gelatin, salt, and water) content of GSE-x (x=0, 1.0, 1.5, 2.0, 2.5, 3.0, and 3.5)

Sample	Gelatin content [w/w%]	Salt content [w/w%]	Water content [w/w%]
GSE-0.0	9.09	12.75	78.16
GSE-1.0	5.96	14.85	79.19
GSE-1.5	9.85	20.98	69.17
GSE-2.0	15.71	30.25	54.04
GSE-2.5	18.90	35.75	45.35
GSE-3.0	20.30	34.71	44.98
GSE-3.5	20.83	34.98	44.19

Table S2. Cycling performance reported in Fig. 2e.

Data Point	Electrolyte	Zinc anode	Current density (mA cm^{-2})	Cumulative capacity plated (mAh cm^{-2})	Ref.
1	PVA	Zn foil	0.1	80	12
2	Alginate/PAAM	Electroplated zinc	0.2	16	15
3	Silica	Zn foil	0.2	300	17
4	PEO	Zinc powder	0.1	17	19
5	PEO-PPO-PEO	Zinc powder	0.1	22	19
6	Gelatin	Zn foil	0.2	160	20
7	Gelatin	Zn/SS	2	600	28
8	Liquid	C@Zn	2.5	600	29
9	Liquid	TiO_2@Zn	1	150	30
10	Liquid	PA@Zn	0.5	4000	31
This work	**GSE-2.5**	**Zn foil**	**5**	**2000**	**This work**

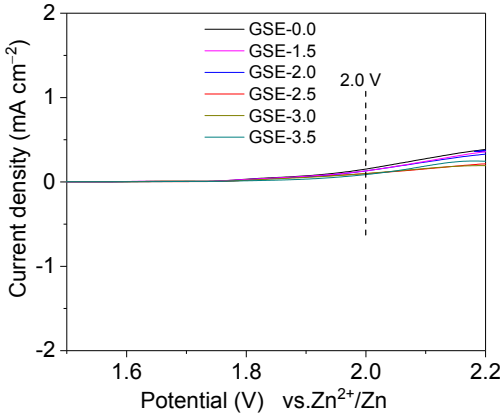

Figure S1. The LSV curves of Zn/GSE-x/SS (SS means stainless steel; x=0.0, 1.5, 2.0, 2.5, 3.0, 3.5).

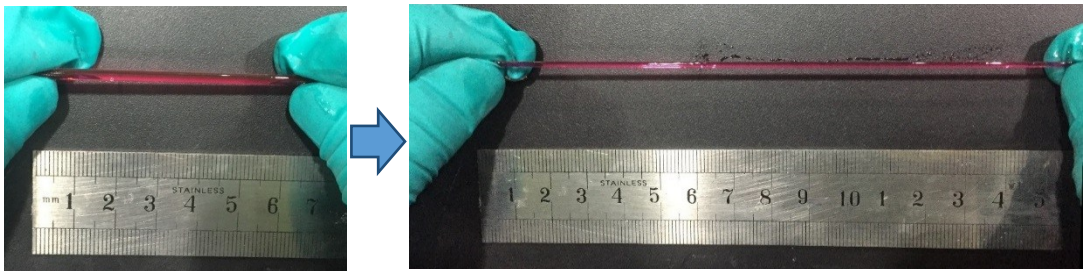

Figure S2. Relaxed (left) and elongated (right) state of the GSE-3.5

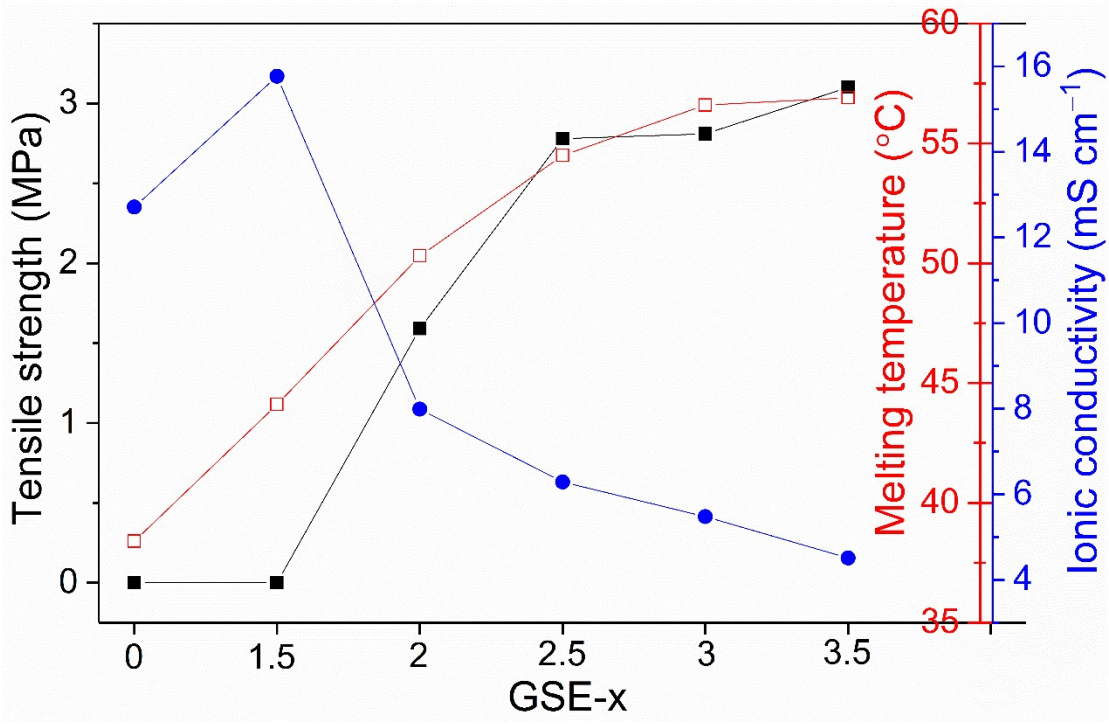

Figure S3. Comparison of properties (tensile strength, melting point, and ionic conductivity) of GSE-x (x=0, 1.0, 1.5, 2.0, 2.5, 3.0, and 3.5) .

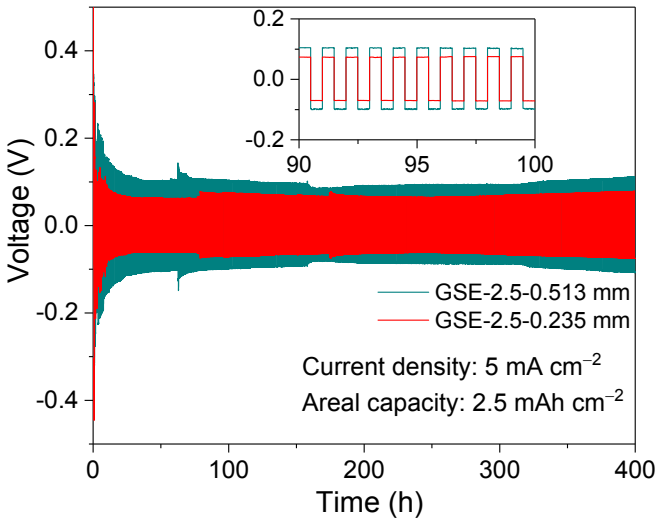

Figure S4. Galvanostatic cycling of Zn/GSE-2.5-0.235 mm/Zn, Zn/GSE-2.5-0.513 mm/Zn solid-state symmetric cells at current density of 5 mA cm^{-2}.

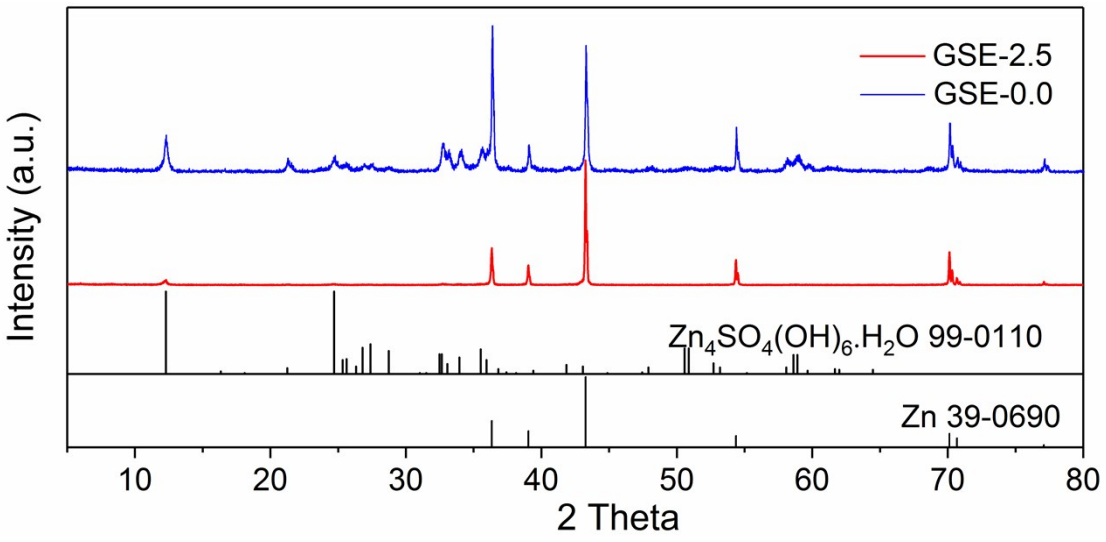

Figure S5. XRD patterns of Zn electrodes in the insets of Figure 2e and 2f.

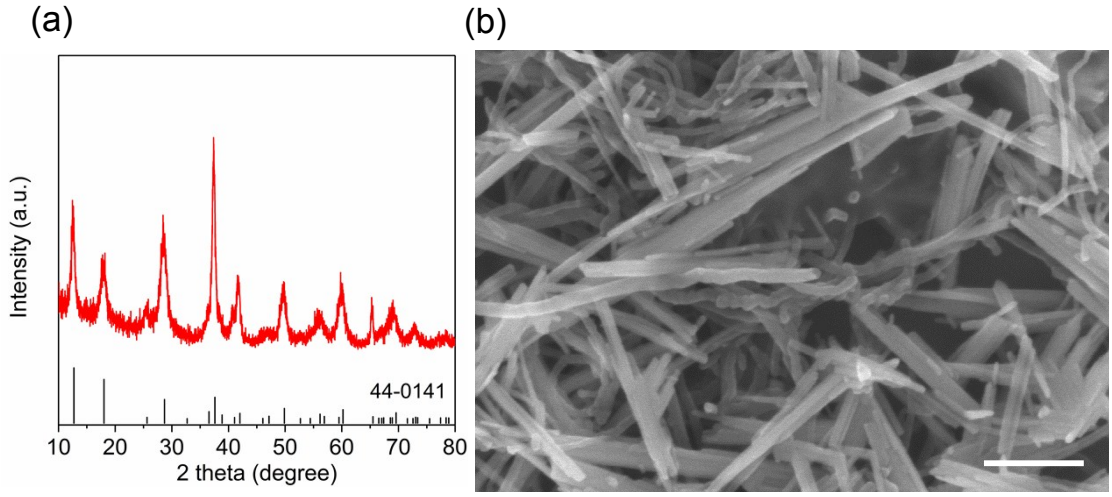

Figure S6. (a) XRD pattern; (b) SEM image of α-MnO_2/CNT composite. Scale bar: 200 nm

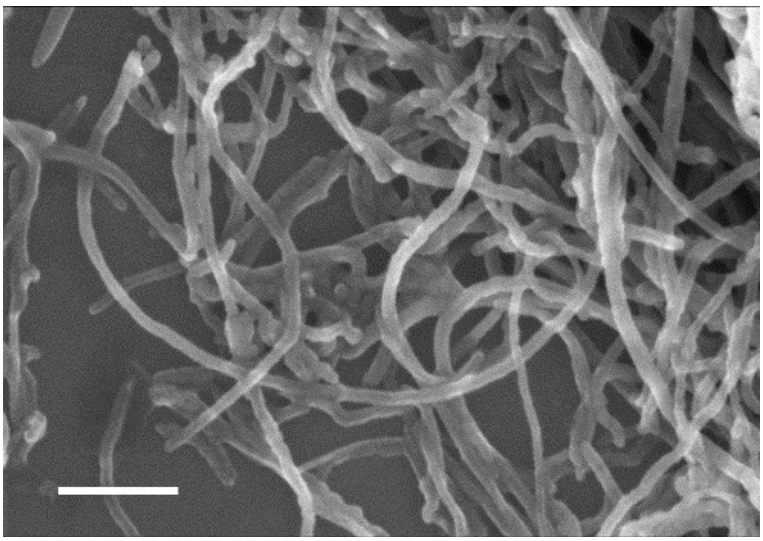

Figure S7. SEM image of acid-treated CNT. Scale bar: 200 nm

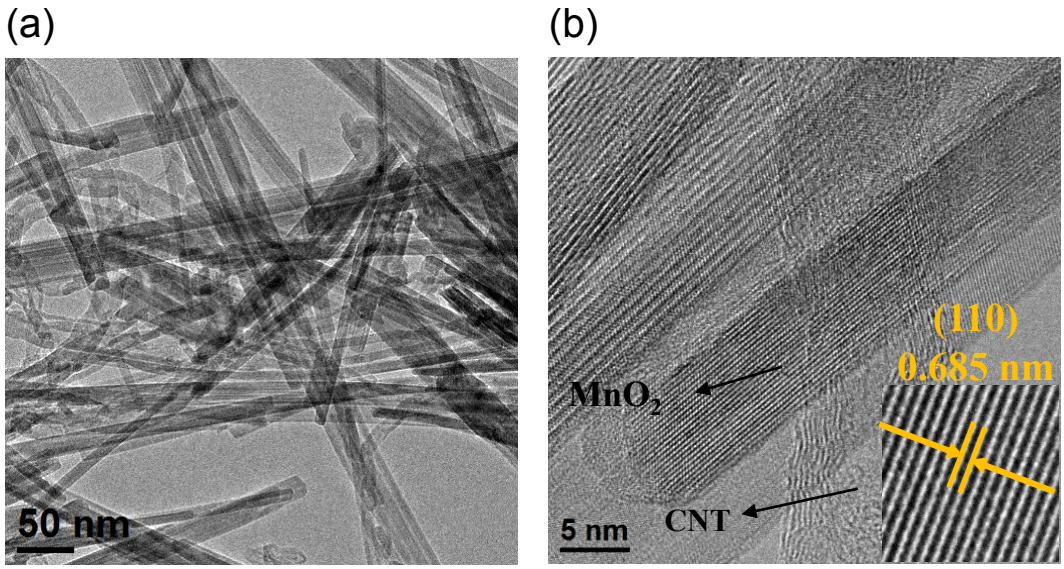

Figure S8. (a) TEM and (b) HRTEM images of α-MnO_2/CNT composite.

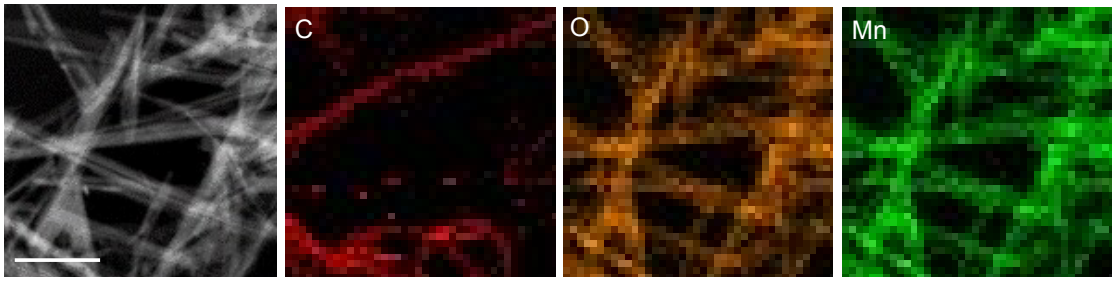

Figure S9. HAADF-STEM image and corresponding EDX mapping image of MnO_2/CNT composite. Scale bar: 200 nm

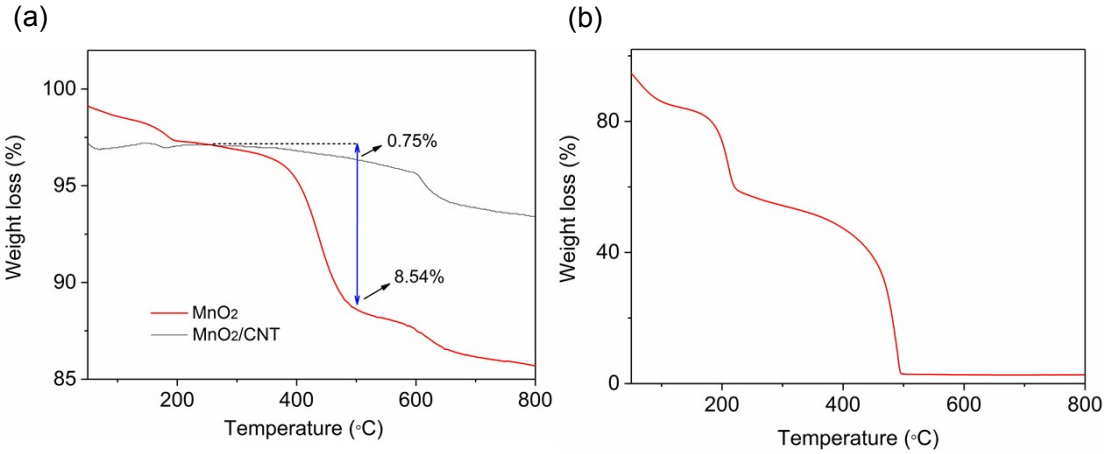

Figure S10. TG curves of (a) MnO_2, MnO_2/CNT and (b) acid-treated CNT

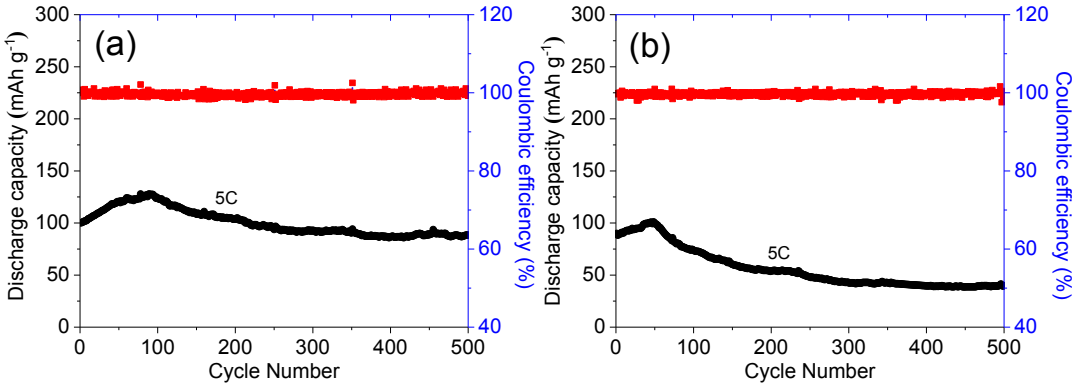

Figure 11. Cycle performance of (a) Zn/GSE-0/MnO_2, (b) Zn/GSE-3.5/MnO_2 at 5C (1C=308 mA g^{-1})

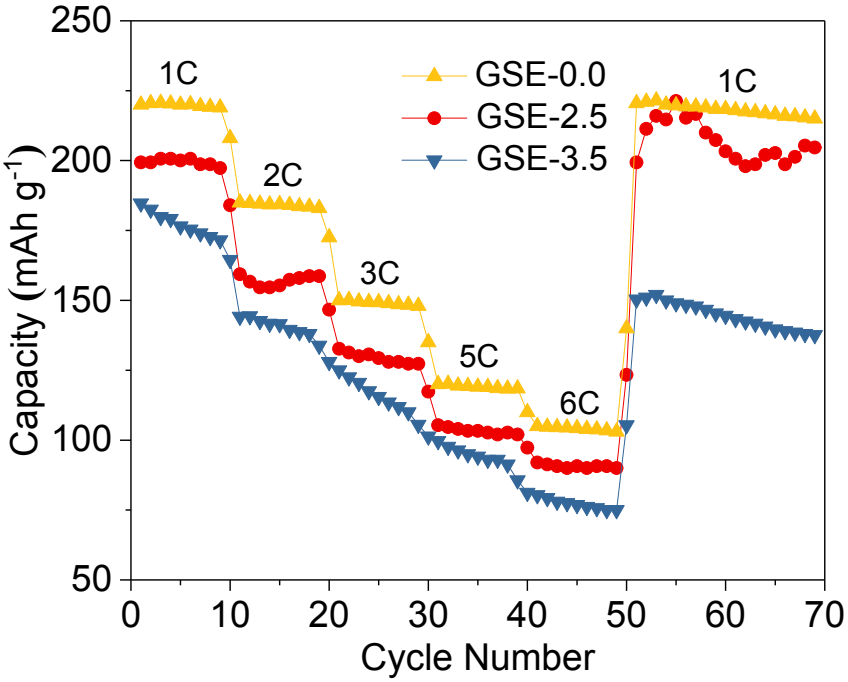

Figure S12. Rate performance of the Zn/GSE-0/MnO_2, Zn/GSE-2.5/MnO_2, and Zn/GSE-3.5/MnO_2 batteries at various rates (1C=308 mA g^{-1})

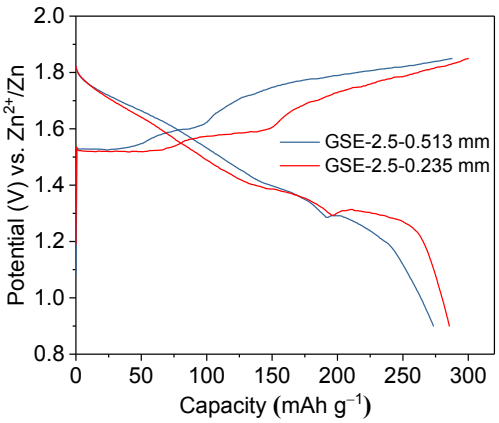

Figure S13. Charge-discharge voltage profiles of Zn/GSE-2.5-0.235 mm/MnO_2 and Zn/GSE-2.5-0.513 mm/MnO_2 batteries at the second cycle.

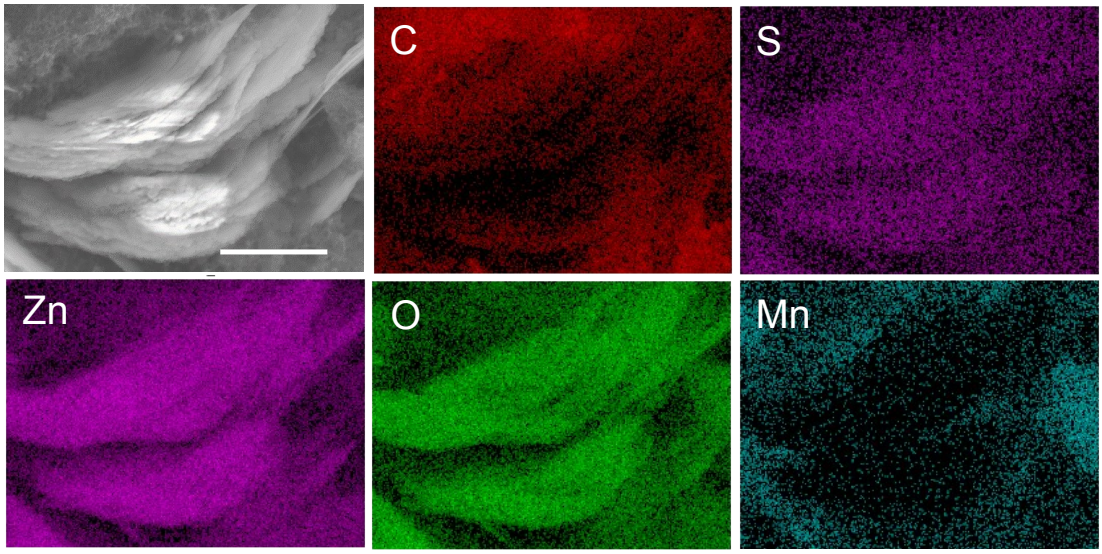

Figure S14. SEM at high magnification of the flask-like products in the fully discharged sample at state 3 in Figure 4a and the corresponding EDS mapping results. Scale bar, 5 μm

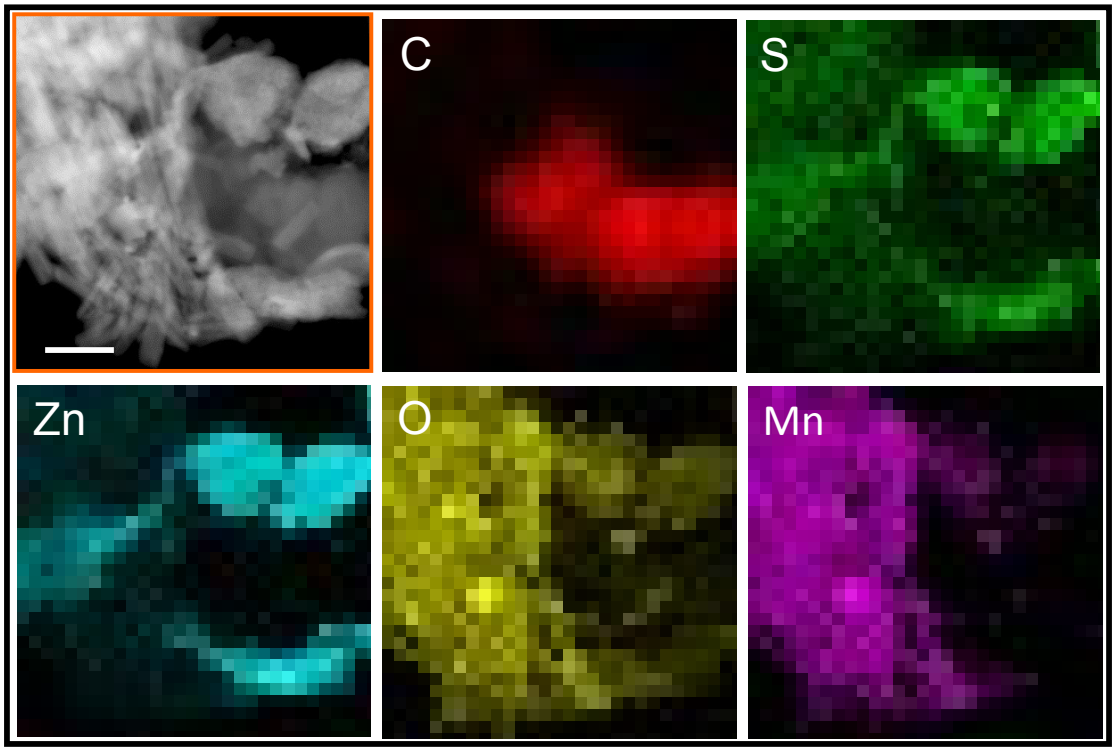

Figure S15. HAADF-STEM image and corresponding EDX mapping of the particle-shape products in the fully discharged sample at state 3 in Fig. 4a. Scale bar, 100 nm

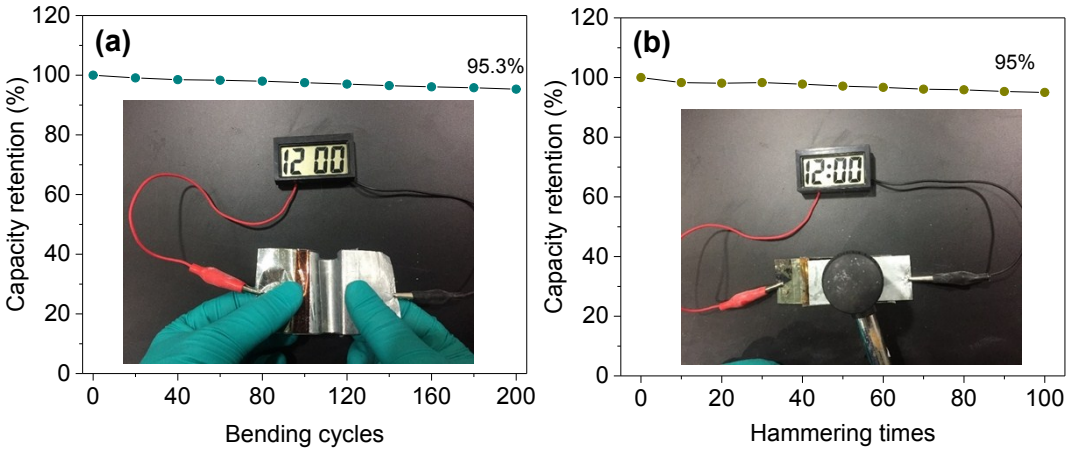

Figure S16. Electrochemical performance of the solid-state Zn/GSE-2.5/MnO_2 ZMBs under (a) being bent; (b) being hammered.