Electronic Supplementary Information

Constructing a well-wettable interface on a three-dimensional copper foam host with reinforced copper nanowires to stabilize zinc metal anodes

Yixing Fang,[a] Kun Han,[ab] Zhen Wang,[a] Jie Shi,[a] Ping Li[a]* and Xuanhui Qu[a]*

[a] *Beijing Advanced Innovation Center for Materials Genome Engineering, Institute for Advanced Materials and Technology, University of Science and Technology Beijing, Beijing 100083, PR China*

[b] *Northwest Institute for Non-ferrous Metal Research, Xi'an 710016, People's Republic of China*

* Corresponding author.

Email: ustbliping@126.com (P. Li); quxh@ustb.edu.cn (X. Qu)

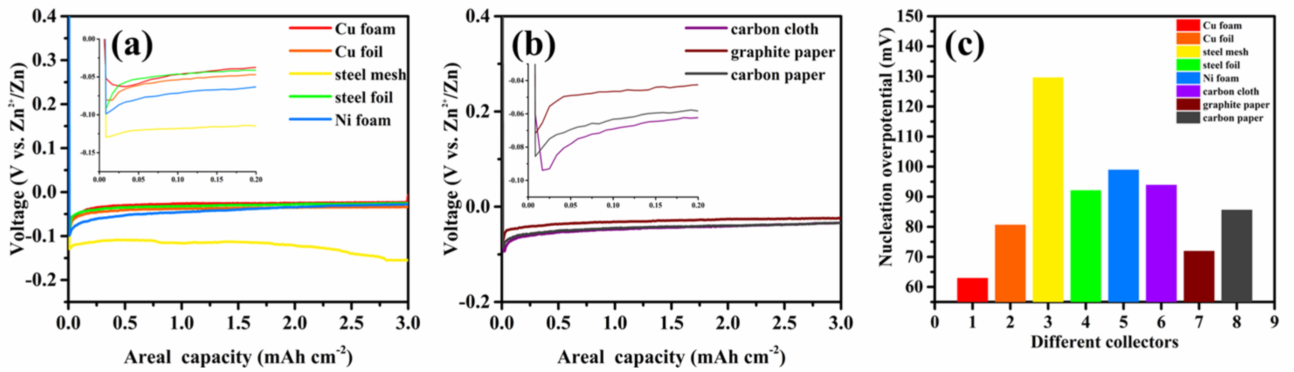

Fig. S1 Galvanostatic plating curves of (a) Cu foam, Cu foil, steel mesh, steel foil and Ni foam; (b) carbon cloth, graphite paper and carbon paper at the current of 3 mA cm^{-2} with at constant areal capacity of 3 mA h cm^{-2}. (c) Zn nucleation overpotentials of different collectors.

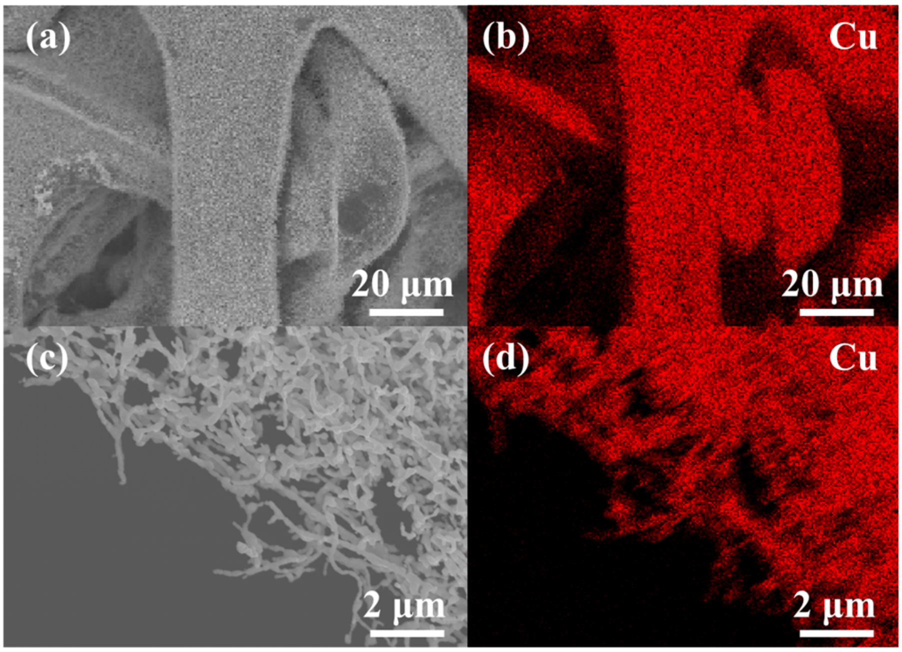

Fig. S2 the SEM-EDS images of the top view of Cu NW@Cu foam.

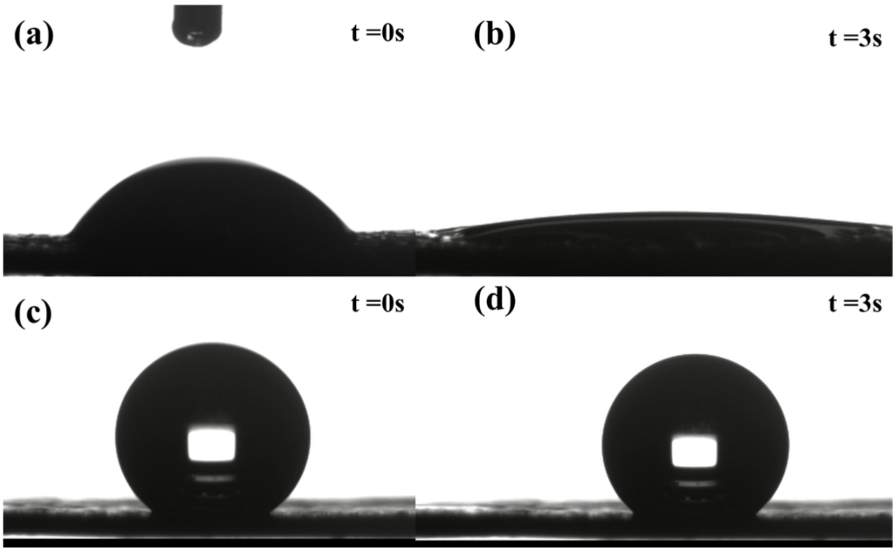

Fig. S3 Images of contact angles of the 2 M $ZnSO_4$ electrolyte droplets on (a, b) Cu NW@Cu foam and (c, d) bare Cu foam at different time intervals.

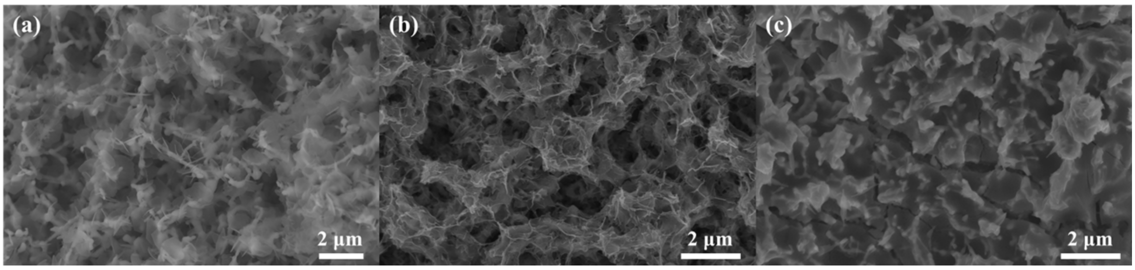

Fig. S4 SEM images of the side wall of Cu NW@Cu foam with the areal capacity of (a) 1, (b) 2 and (c) 4 mAh cm^{-2} after deposition.

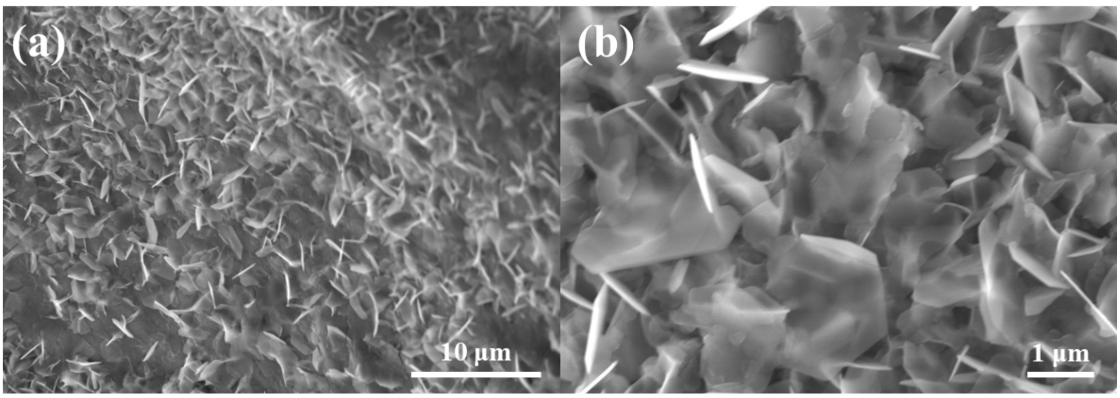

Fig. S5(a, b) Top-view SEM images of the Zn@Bare Cu foam after been plated a capacity of 4 mAh cm^{-2}.

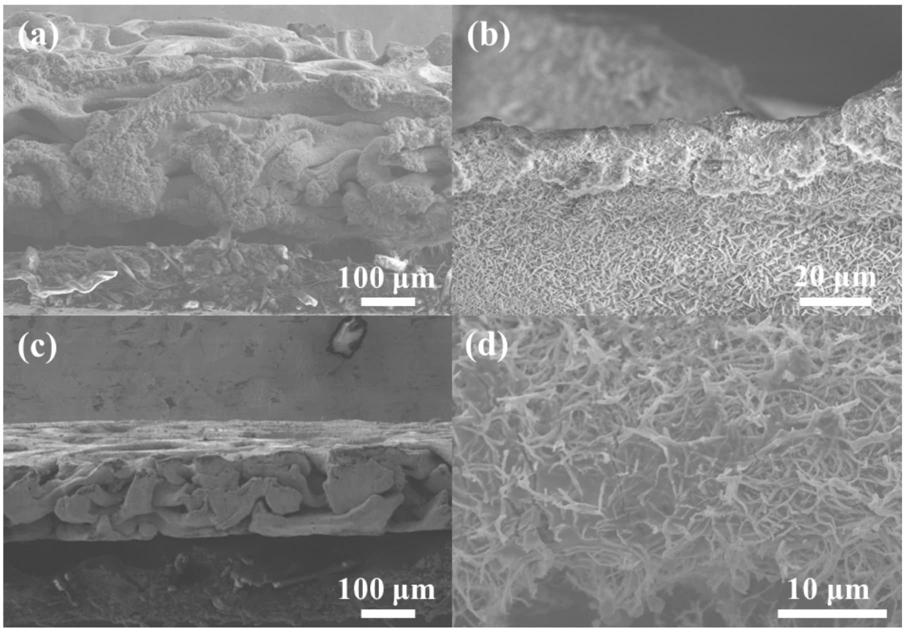

Fig. S6 SEM images of the side wall of (a, b)Bare Cu foam and (c, d)Cu NW@Cu foam with the areal capacity of 3 mAh cm^{-2} after deposition.

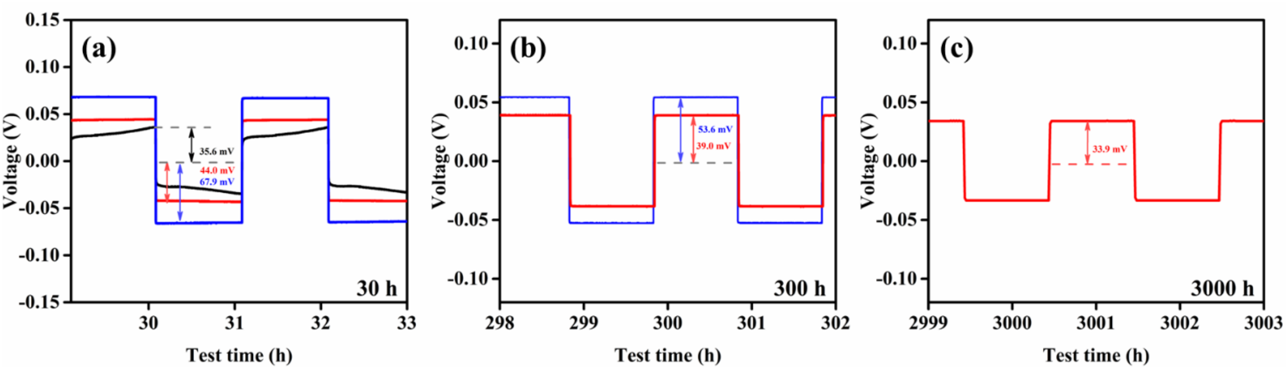

Fig. S7(a-c) Enlarged voltage-time curves of Zn@Cu NW@Cu foam at different cycles curves at 1.0 mA cm^{-2}.

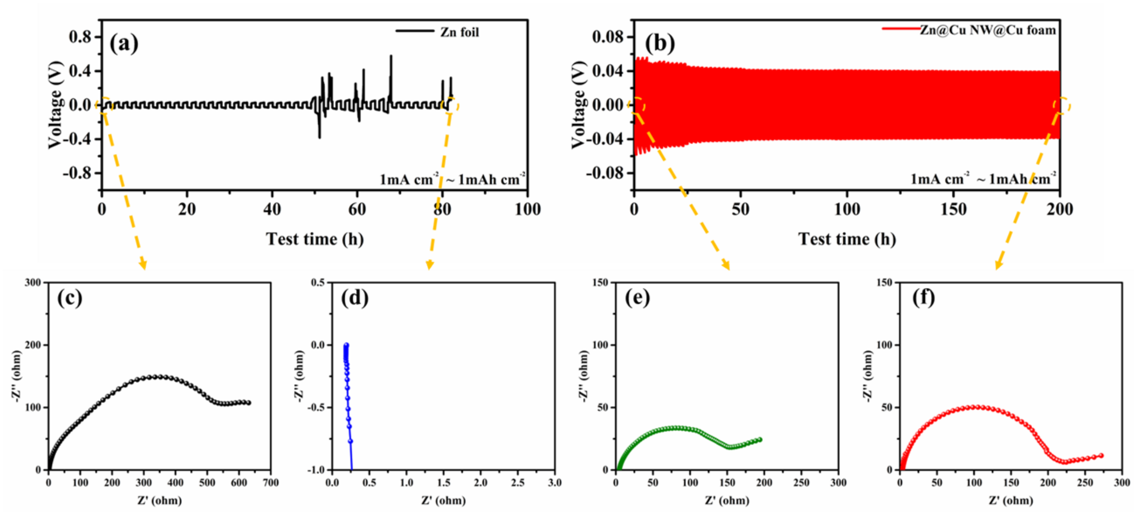

Fig. S8 Electrochemical performances of symmetric cells for (a) Zn foil and (b) Zn@Cu NW@Cu foam at 1mA cm^{-2}. The corresponding impedance spectra of the positions in (c) before test for Zn foil, (d) after 80 h before test for Zn foil, (c) before test for Zn@Cu NW@Cu foam, (d) after 200 h before test for Zn@Cu NW@Cu foam.

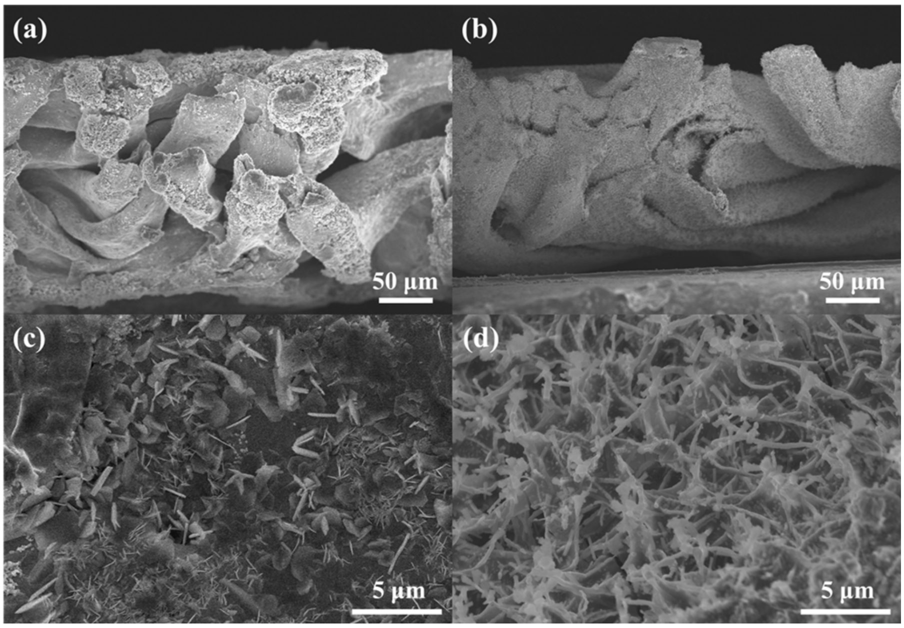

Fig. S9 Cross-sectional SEM images of (e) Zn@Bare Cu foam and (f) Zn@Cu NW@Cu foam after 50 cycles for the symmetrical cells; and the corresponding top-view SEM images of (c) Zn@ Bare Cu foam and (d) Zn@Cu NW@Cu foam.

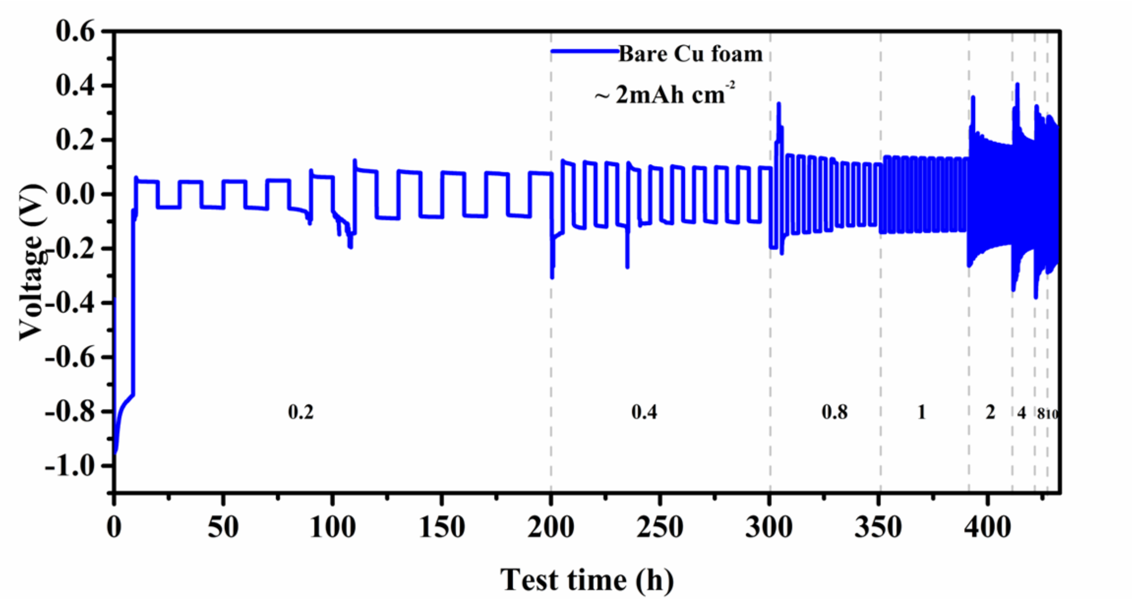

Fig. S10(a) the corresponding voltage hysteresis of Bare Cu foam is at different current densities from 0. 2 to 10 mA cm^{-2}.

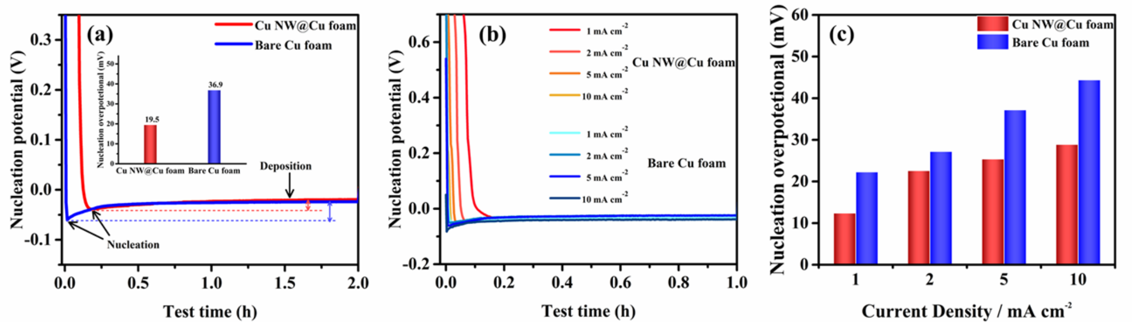

Fig. S11(a-b) Potential-time curves of Zn // Cu NW@Cu foam and Zn // Bare Cu foam at different current density, and (c) the nucleation potential values. cm^{-2}.

Table S1 Comparison of the mass loading of zinc deposited on copper substrates at different areal capacities

Sample	Deposition capacity (mAh cm^{-2})	$M_{(initial)}$ (g cm^{-2})	$M_{(final)}$ (g cm^{-2})	$\Delta M_{(Zn)}$ (g cm^{-2})
Bare Cu foam	1.0	0.0574	0.0621	0.0047
Bare Cu foam	2.0	0.0596	0.0648	0.0052
Bare Cu foam	3.0	0.0572	0.0629	0.0057
Bare Cu foam	4.0	0.0575	0.0658	0.0083
Cu NW@Cu foam	1.0	0.0568	0.0626	0.0058
Cu NW@Cu foam	2.0	0.0558	0.0648	0.0090
Cu NW@Cu foam	3.0	0.0614	0.0730	0.0116
Cu NW@Cu foam	4.0	0.0548	0.0687	0.0139

Table S2 The electrochemical performance of the recently works of Zn anodes by using different kinds of the zincophilic hosts for aqueous ZIBs

Host	Current density (mA cm^{-2})	Capacity (mAh cm^{-2})	Cycling life (h)	Voltage hysteresis (mV)	Ref.
carbon fiber-graphite felt graphene	1	1	700	50	**[S1]**
$Ti_3C_2T_x$ MXene	1	1	300	83	**[S2]**
3D porous copper skeleton	0.5	0.5	350	40	**[S3]**
Cu foam	2	1	150	40	**[S4]**
DCP-Zn	0.5	0.1	1400	60	**[S5]**
3DCu	0.2	0.033	35	60	**[S6]**
CNT foam	3	0.5	166.7	230	**[S7]**
PBI-Cu	10	1	300	35	**[S8]**
3D ZnP/CF	1	1	3000	25.1	**[S9]**
$Zn_{88}Al_{12}$	0.5	0.5	2000	~20	**[S10]**
CM@CuO	1	1	340	20	**[S11]**
ZnAl@Cu-mesh	1	0.25	180	67	**[S12]**
3D Ti-TiO_2	1	1	2000	28	**[S13]**
AgNPs@CC	2	2	800	56	**[S14]**
N-VG@CC	0.5	0.5	150	6.2	**[S15]**

MGA	10	1	1050	64	**[S16]**
MXene@Sb	0.5	0.5	1000	~80	**[S17]**
PCu	10	1	120	40	**[S18]**
Cu NBs@NCFs	2	1	450	34.6	**[S19]**
TZNC	1	1	450	~50	**[S20]**
Cu NW@Cu foam	**1**	**1**	**3000**	**33.9**	**This work**
	10	**2**	**300**	**132.1**	

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Table S3 compare the Zn||Cu asymmetric cell performance regarding to the CE, life time, and areal capacity

Host	electrolyte	current density (mA cm^{-2})	Areal capacity (mAh cm^{-2})	Lifespan (h)	Coulombic efficiency (CE)	Ref.
3DP-FeNi	3 M $ZnSO_4$	1	1	200	98.8%	**[R1]**
Cu NBs@NCFs	2 M $ZnSO_4$	5	1	1000	98.8%	**[R2]**
CuZIF-L@TM	2 M $ZnSO_4$	1	1	300	97.6%	**[R3]**
TZNC	2 M $ZnSO_4$	5	1	1000	98.6%	**[R4]**
CnC HS	3 M $Zn(CF_3SO_3)_2$	4	1	200	95%	**[R5]**
MXene@Sb-300	3 M $Zn(CF_3SO_3)_2$	1	0.1	1500	97.2%	**[R6]**
N-VG@CC	2 M $ZnSO_4$	5	2	10	95%	**[R7]**
3D Ti-TiO_2	3 M $ZnSO_4$	5	2	120	95.01%	**[R8]**
PBI-Cu	1 M $ZnSO_4$	2	1	200		**[R9]**
DCP	2 M $Zn(CF_3SO_3)_2$	2	1	50	97%	**[R10]**
ED Zn	1 M $ZnSO_4$	1	1	100	98%	**[R11]**
CNT	2 M $ZnSO_4$	2	2	30	95%-97%	**[R12]**
3D Porous Copper Skeleton	2 M $ZnSO_4$	1	2	66	99.53%	**[R13]**
GF	0.5 M Na_2SO_4 and 0.05 M $ZnSO_4$	1	1	150	96.5%	**[R14]**
PCu		5	1	450	97.55%	**[R15]**
Cu NW@Cu foam	**2 M $ZnSO_4$**	**1**	**2**	**150**	**98%**	**This work**

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R2. Y. Zeng, P. X. Sun, Z. Pei, Q. Jin, X. Zhang, L. Yu and X. W. David Lou, *Advanced materials*, 2022, **34**, 2200342.

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R4. P. X. Sun, Z. Cao, Y. X. Zeng, W. W. Xie, N. W. Li, D. Luan, S. Yang, L. Yu and X. W. D. Lou, *Angewandte Chemie*, 2022, **61**, e202115649.

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R8. Y. An, Y. Tian, S. Xiong, J. Feng and Y. Qian, *ACS Nano* 2021 **15**, 11828.
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Table S4 the electrochemical performance of the recently works of Zn anodes regarding to the areal capacity

Cathode	Anode	Areal capacity (mAh cm^{-2})	Cycling capacity (mAh g^{-1})	Ref.
α-MnO_2	3D Zn@CFs	7.85	239.4 (140 cycles /1C=308 mAh g^{-1})	**[M1]**
α-MnO_2	Zn@CP	8.33	150 (150 cycles /0.75 A g^{-1})	**[M2]**
$LiMn_2O_4$ (LMO)	MGA@Zn	5.0	60 (480 cycles /2C=296 mAh g^{-1})	**[M3]**
NVO	Zn@Cu-Sn@SSM	5.0	162 (1000 cycles /2.0 A g^{-1})	**[M4]**
MnO_2	C_{flower}/Zn	1.0	(275 mA h g^{-1} at 0.1 Ag^{-1} 75 mA h g−1 at 5 A g−1)	**[M5]**
α-MnO_2	**Zn@Cu NW@Cu foam**	**4.0**	**181.8 (3000 cycles /2.0 A g^{-1})**	**This work**

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Table S5 Impedance parameters calculated from an equivalent circuit model

Sample	R_s	R_f	R_{ct}
Zn@Cu NW@Cu foam // MnO_2-fresh	2.1	22.1	38.5
Zn@Cu NW@Cu foam // MnO_2 -after 20 cycles	5.7	33.3	99.2
Zn foil // MnO_2-fresh	2.9	66.6	68.2
Zn foil // MnO_2-after 20 cycles	4.0	115.7	125.7