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

Supporting Information

Accurate regulation of pore distribution and atomic arrangement enabling highly-efficient dual-carbon lithium ion capacitors

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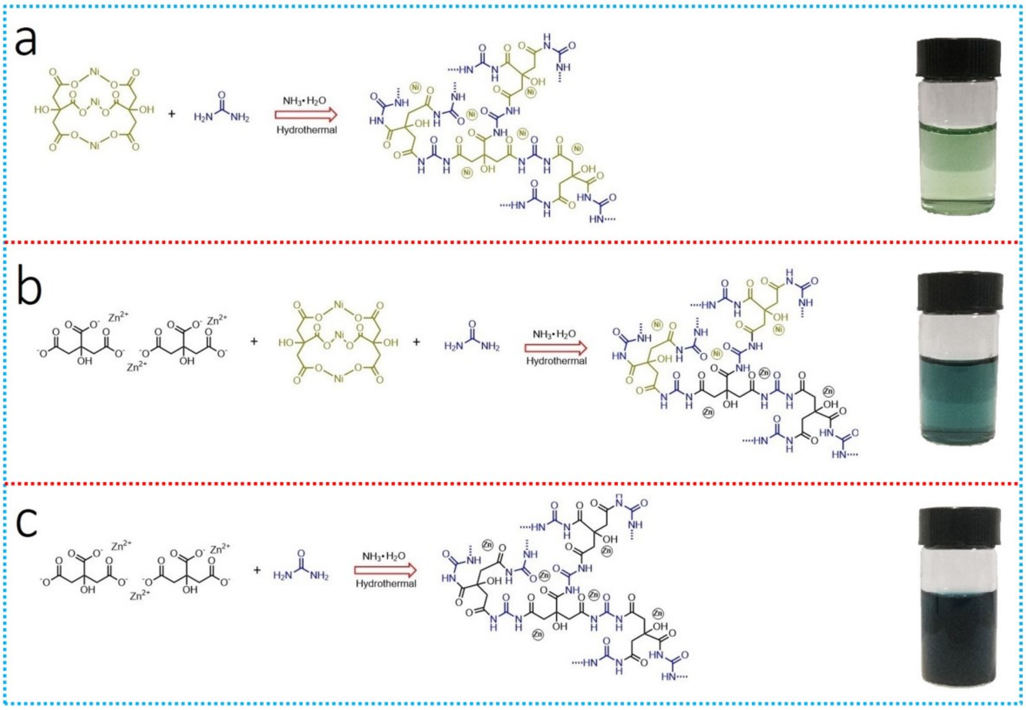

Scheme S1. Chemical synthesis route for preparing MQDs samples. The inset pictures demonstrate the aqueous solution of MQDs which the concentrations are around 10 mg ml^{-1}

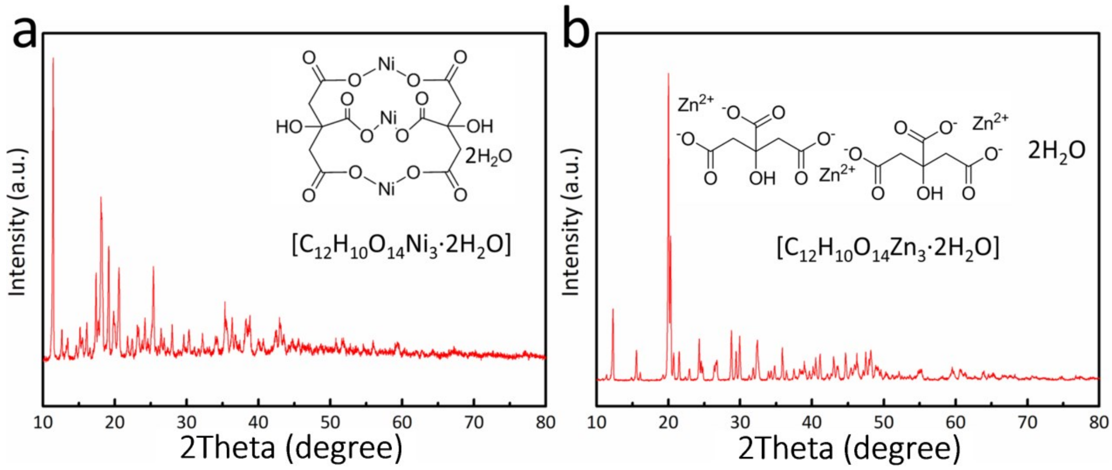

Figure S1. XRD patterns of reactants. (a) Nickel citrate hydrate, (b) Zinc citrate tribasic hydrate

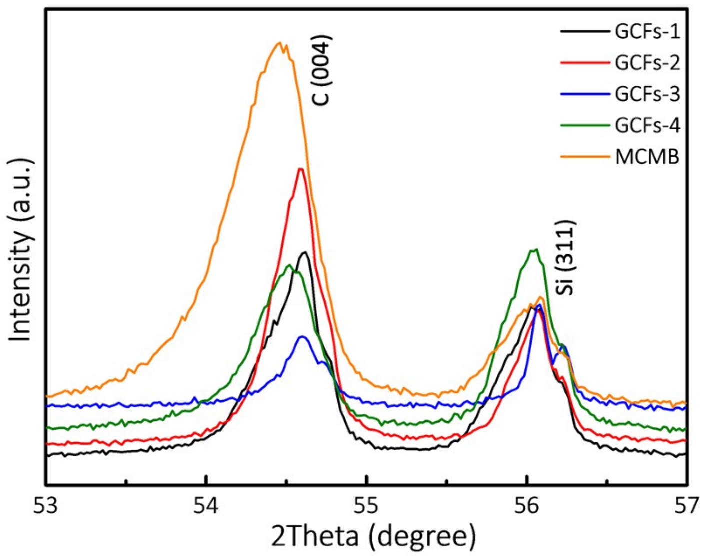

Figure S2. Graphitization degree tests of GCFs samples and commercial MCMB

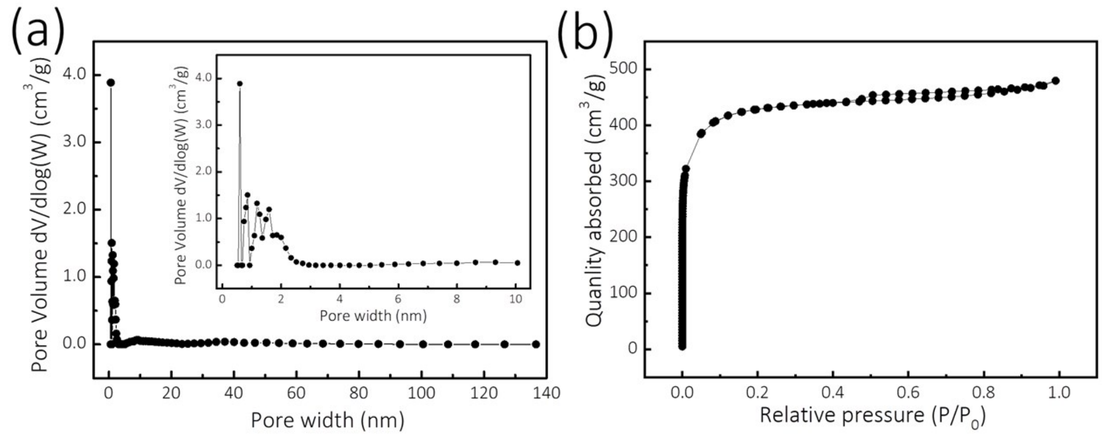

Figure S3. N_2 absorption/desorption isotherms and the pores size distribution of C-ACs, the inset image are assigned to the pores size below 10 nm

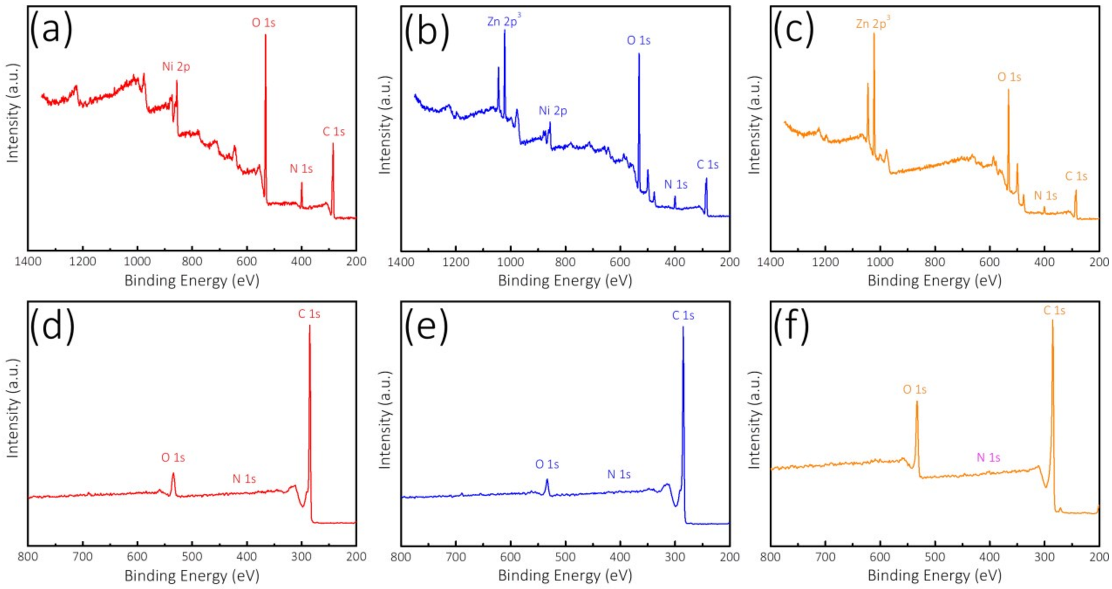

Figure S4. XPS full survey of different samples. (a) MQDs-1, (b) MQDs-3, (c) MQDs-5, (d) GCFs-1, (e) GCFs-3, (f) Z-ACs.

It can be seen from in **Figure S4** that elements of C, N, O, Ni and Zn exist in MQDs-3. However, only C, N, O, Ni and C, N, O, Zn can be found in MQDs-1 and MQDs-5, respectively. After heat treatment and acid washing, only C, N, O maintain in the final products.

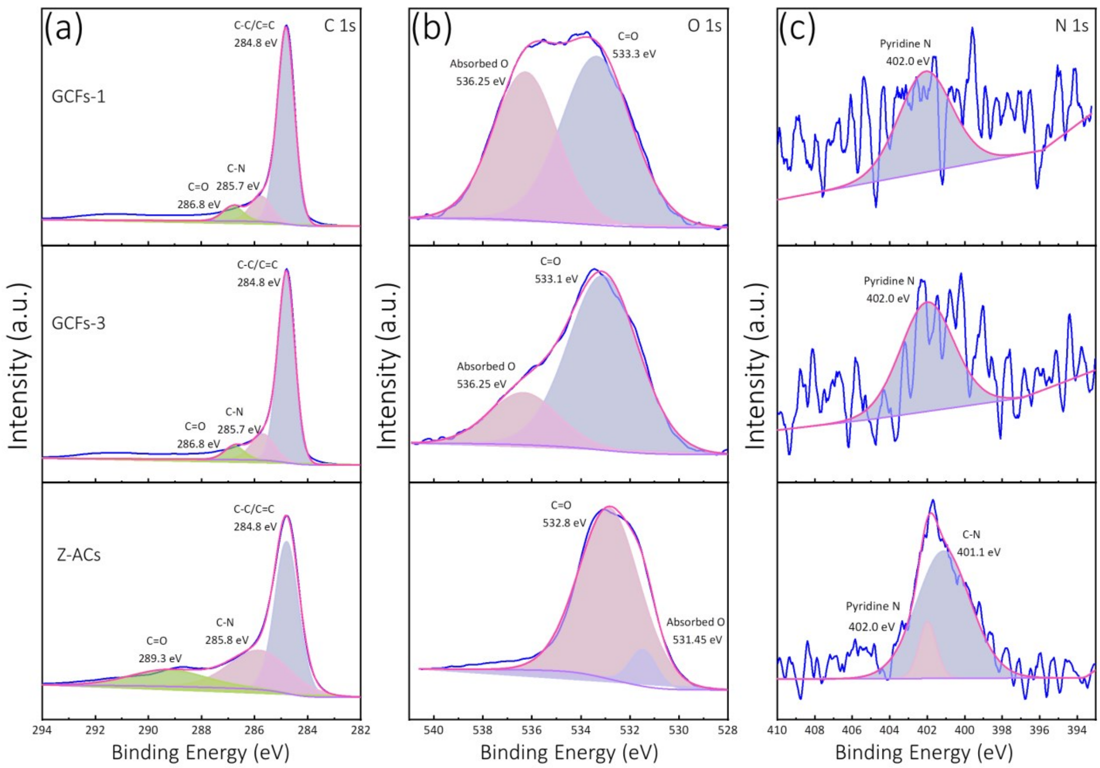

Figure S5. High resolution XPS peaks of GCFs-1, GCFs-3 and Z- ACs

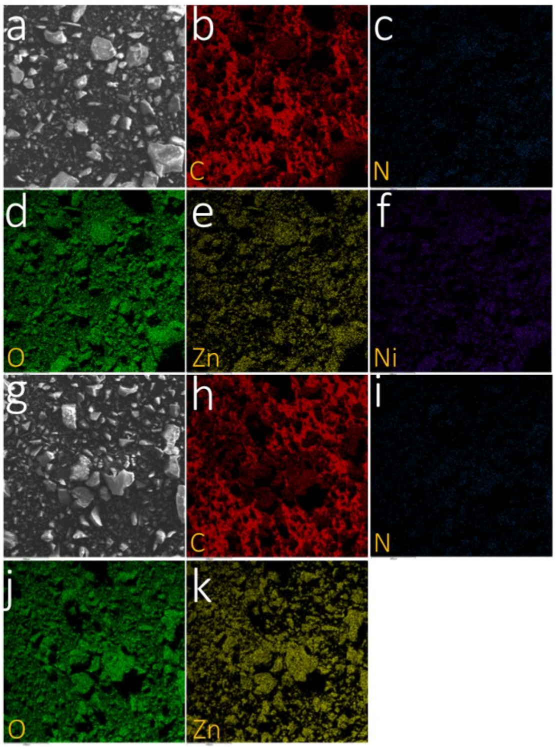

Figure S6. (a-f) SEM and the following EDS mapping of MQDs-3, (g-k) SEM and the following EDS mapping of MQDs-5

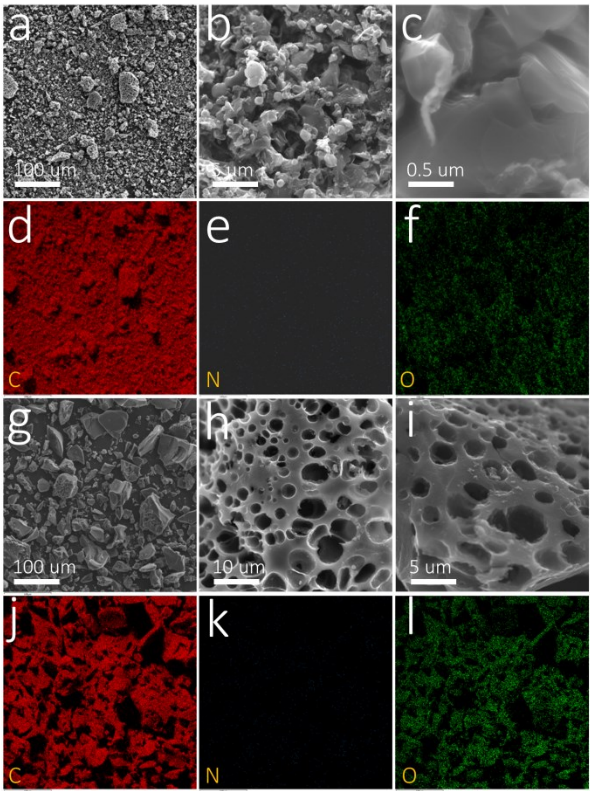

Figure S7. (a-c) SEM images and (d-f) the following EDS mapping of GCFs-3, (g-i) SEM images and (j-l) the following EDS mapping of Z-ACs

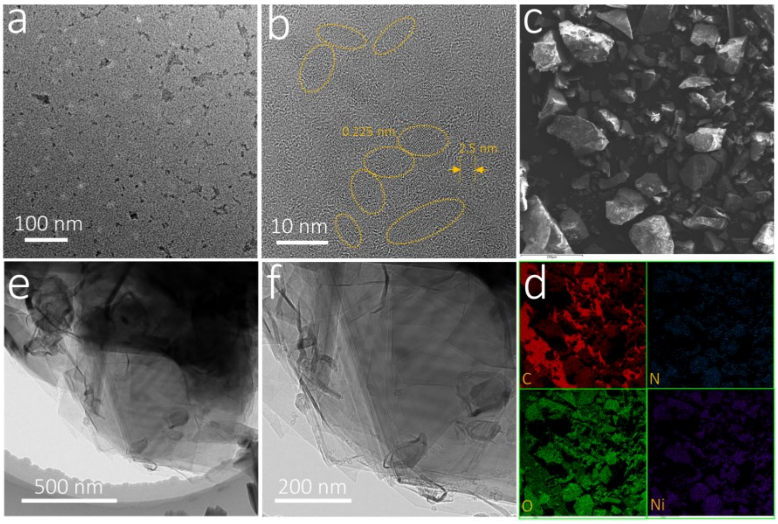

Figure S8. Morphological information of MQDs-1 and its derivatives. (a-b) TEM and HR-TEM images of MQDs-1, (c-d) SEM and the following elements distribution of MQDs-1, (e-f) TEM and HR-TEM images of GCFs-1

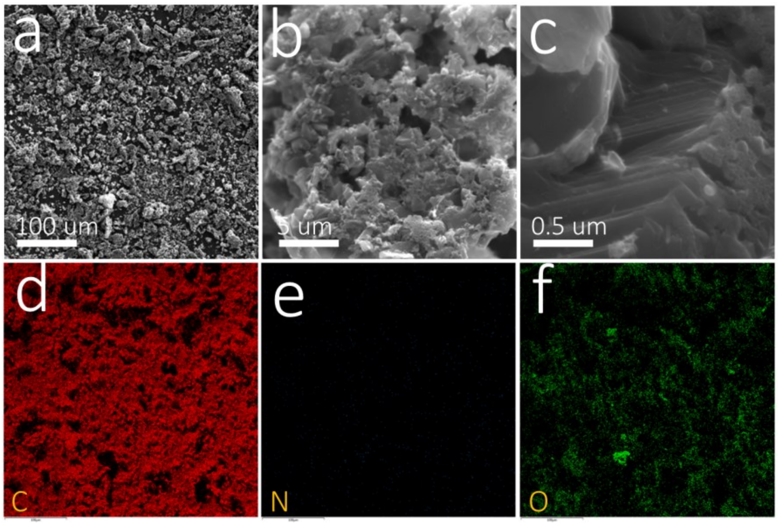

Figure S9. SEM images and the following EDS mapping results of GCFs-1

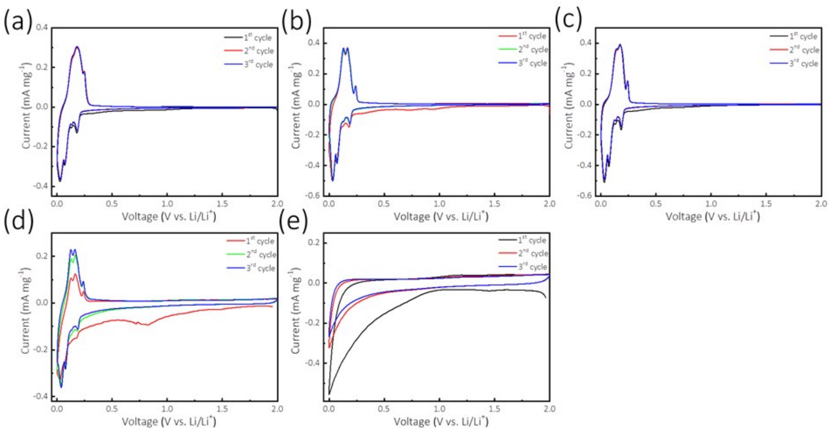

Figure S10. CV curves of GCFs-1 to GCFs-4 and Z-ACs

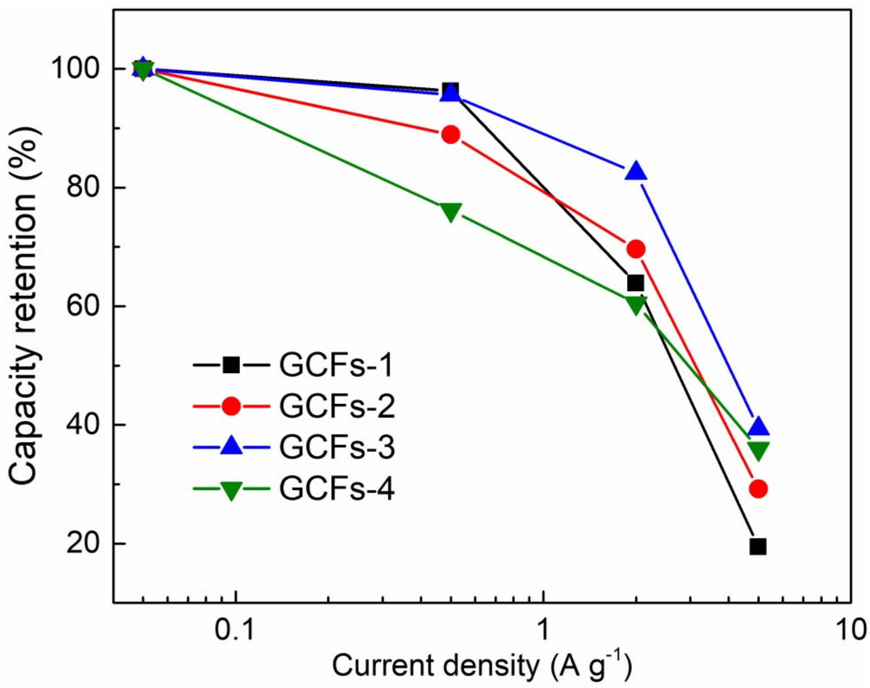

Figure S11. Rate capability of GCFs in Li-half cells.

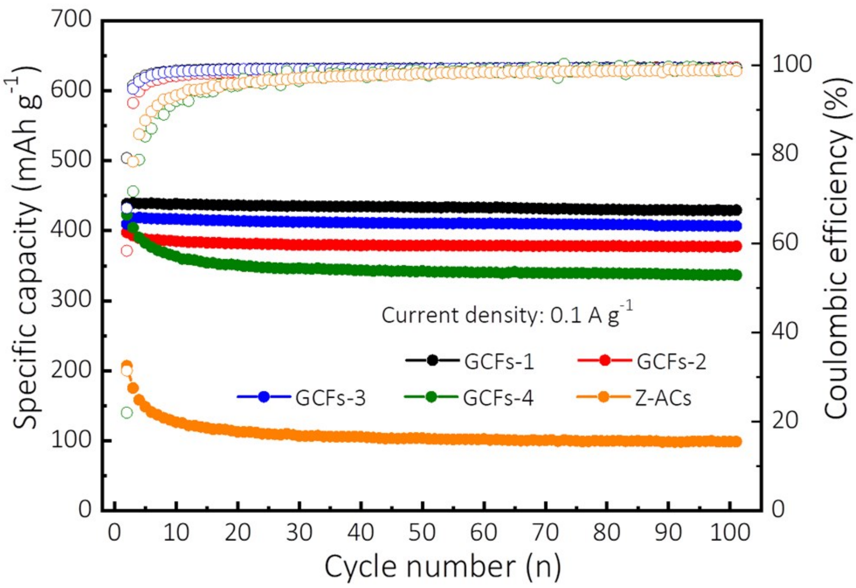

Figure S12. Cycling performance at 0.1 A g^{-1} of MQDs derivatives.

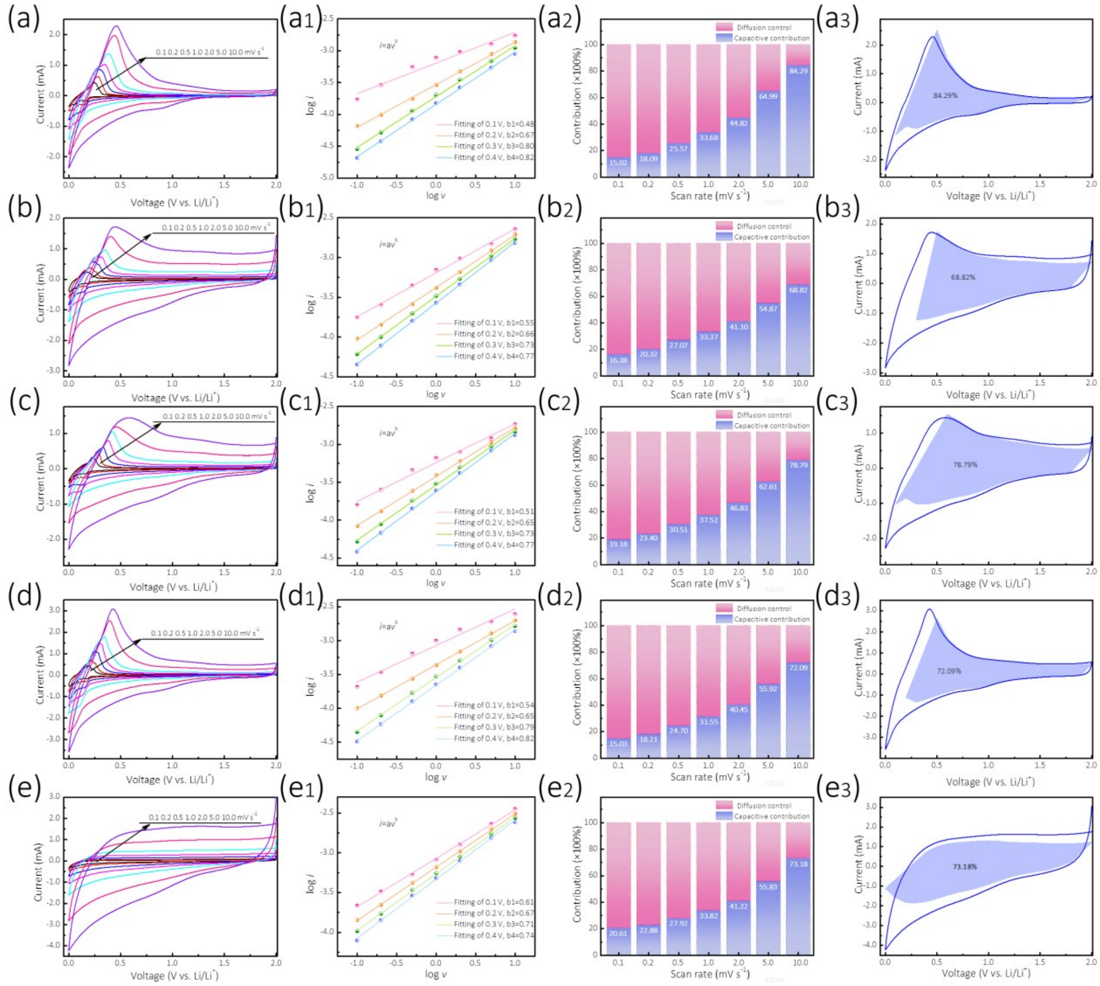

Figure S13. Capacitive contribution behavior analysis (a-a3) GCFs-1, (b-b3) GCFs-2, (c-c3) GCFs-3, (d-d3) GCFs-4, (e-e3) Z-ACs

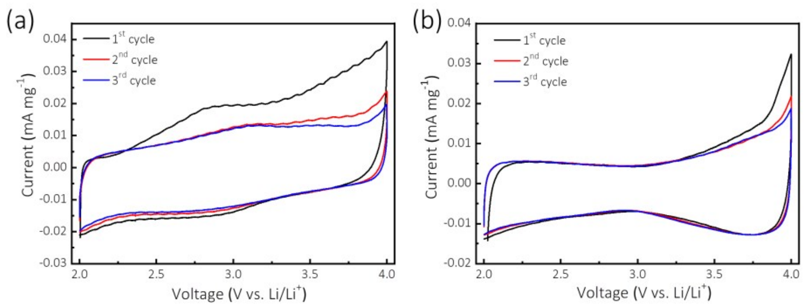

Figure S14. CV curves of Z-ACs and C-ACs

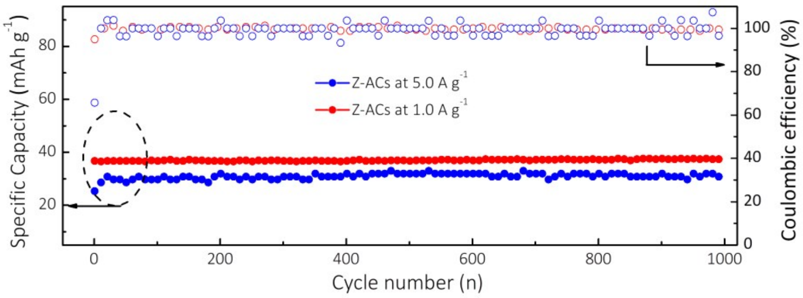

Figure S15. Cycling performance of Z-ACs at 1.0 and 5.0 A g^{-1}

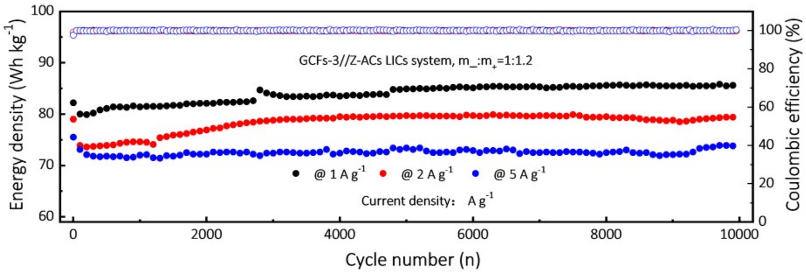

Figure S16. Cycling performance of GCFs-3//Z-ACs LICs at different current densities

Table S1. Basic parameters for preparing MQDs and final samples

Final products	Reactants (mmol)			Precursors	Metal-contained intermediates
	Nickel Citrate	Zinc Citrate	Urea		
GCFs-1	10.0	—	120	MQDs-1	MGs-1
GCFs-2	7.5	2.5	120	MQDs-2	MGs-2
GCFs-3	5.0	5.0	120	MQDs-3	MGs-3
GCFs-4	2.5	7.5	120	MQDs-4	MGs-4
Z-ACs	—	10.0	120	MQDs-5	MGs-5

Table S2. Physical parameters of MQDs derivatives and their comparisons with commercial products

	I_D/I_G	S_{BET}	V_t	Pores size	G
	—	$m^2\ g^{-1}$	$cm^3\ g^{-1}$	nm	%
GCFs-1	0.37	11.40	0.038	13.48	95.58
GCFs-2	0.66	9.38	0.042	17.70	93.02
GCFs-3	0.41	234.61	0.315	5.37	94.42
GCFs-4	0.73	496.78	0.705	5.67	89.07
Z-ACs	1.81	1522.09	1.047	2.75	—
C-ACs	—	1288.36	0.741	2.30	—
MCMB	—	—	—	—	85.12

where S_{BET} is corresponding to the specific surface area calculated by the N_2 absorption/desorption isotherms, V_t means the total pores volume, G is equal to the value of graphitization degree.

Table S3. Elements content analysis calculated by XPS

	C	N	O	Ni	Zn
	Atomic ratio (%)				
MQDs-1	50.04	8.07	35.85	6.04	—
MQDs-3	44.34	6.24	39.19	4.23	6.01
MQDs-5	46.03	4.68	38.19	—	11.10
GCFs-1	91.91	—	8.09	—	—
GCFs-3	94.71	0.22	5.07	—	—
Z-ACs	85.03	0.65	14.31	—	—

Table S4. Electrochemical performance comparisons of GCFs-3//Z-ACs LICs with recent published articles

Anode	Cathode	Voltage/ V	Electrochemical performance	References
GCFs-3	Z-ACs	2.0-4.0	60.3 Wh kg^{-1} at 19.8 kW kg^{-1}, 98.1% after 20000 cycles at 5.0 A g^{-1}	This work
PGCs	AC	2.0-4.0	44.2 Wh kg^{-1} at 6.527 kW kg^{-1}, 97.3% after 10000 cycles at 5.0 A g^{-1}	1
LTO/Graphene	AC	1.5-3.0	12.8 Wh kg^{-1} at 57.6 kW kg^{-1}, 97% after 2000 cycles at 25.0 A g^{-1}	2
GNS	AC	2.0-4.0	10.9 Wh kg^{-1} at 19.62 kW kg^{-1}, 96.5% after 5000 cycles at 5.0 A g^{-1}	3
MnNCN	AC	0.1-4.0	~10 Wh kg^{-1} at 8.5 kW kg^{-1}, no degradation after 5000 cycles at 5.0 A g^{-1}	4
GC1000	SFAC-2	2.0-4.0	32 Wh kg^{-1} at 6.63 kW kg^{-1}, 96.5% after 3000 cycles at 1.0 A g^{-1}	5
PGCNs	AC	2.0-4.0	24.5 Wh kg^{-1} at 14.09 kW kg^{-1}, 89.5% after 40000 cycles at 5.0 A g^{-1}	6
$cNiCo_2O_4$	VACNF	1.0-4.2	26.44 Wh kg^{-1} at 40 kW kg^{-1}, 90% after 9000 cycles at 4.0 A g^{-1}	7
FeS_2/C	AC	0.0-3.2	5 Wh kg^{-1} at 4 kW kg^{-1}, keep stable after 2500 cycles at 3.24 kW kg^{-1}	8
CAC	NMNC	0.0-3.0	63 Wh kg^{-1} at 6.6 kW kg^{-1}, 98% after 10000 cycles	9
CO-CS	AC	2.0-4.3	~32 Wh kg^{-1} at ~7.9 kW kg^{-1}, ~81% after 10000 cycles at 1.5 A g^{-1}	10
Nb_2O_5	AC	1.0-3.5	65.39 Wh kg^{-1} at 5.35 kW kg^{-1}, without cycling data	11
MnO/C	CNS	1.0-4.0	30 Wh kg^{-1} at 20 kW kg^{-1}, 70% after 5000 cycles	12
VO-CF	AC	2.0-4.3	~32 Wh kg^{-1} at 7.9 kW kg^{-1}, 67% after 10000 cycles at 1.5 A g^{-1}	13
MoO_2−CNT	YP80	0.0-3.0	34 Wh kg^{-1} at 4 kW kg^{-1}, 75% after 1000 cycles at 1.5 A g^{-1}	14
TiO2@PCNFs	AC	0.0-3.0	27.5 Wh kg^{-1} at 5.0 kW kg^{-1}, 80.5% after 10000 cycles at 10 A g^{-1}	15
$Ti_3C_2T_x$/CNT	AC	1.0-4.0	19 Wh kg^{-1} at 5.8 kW kg^{-1}, 81.3% after 5000 cycles at 2.0 A g^{-1}	16
Graphite	BNC	1.0-4.0	53.6 Wh kg^{-1} at 10 kW kg^{-1}, 76.3% after 2000 cycles at 1.25 kW kg^{-1}	17

CNF@$CoNi_2S_4$	AC	1.0-4.0	35 Wh kg^{-1} at 15 kW kg^{-1}, 96% after 5000 cycles at 2.0 A g^{-1}	18
$BiVO_4$	PRGO	0.0-4.0	42 Wh kg^{-1} at 3.86 kW kg^{-1}, 81% after 6000 cycles at 0.9 A g^{-1}	19
Fe_2O_3@C	N-HPC	1.0-4.0	31 Wh kg^{-1} at 9.2 kW kg^{-1}, 84.1% after 1000 cycles at 1.0 A g^{-1}	20

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