Supporting information

ZnS nanoparticles decorated on nitrogen-doped porous carbon polyhedra: a promising anode material for lithium-ion and sodium-ion batteries

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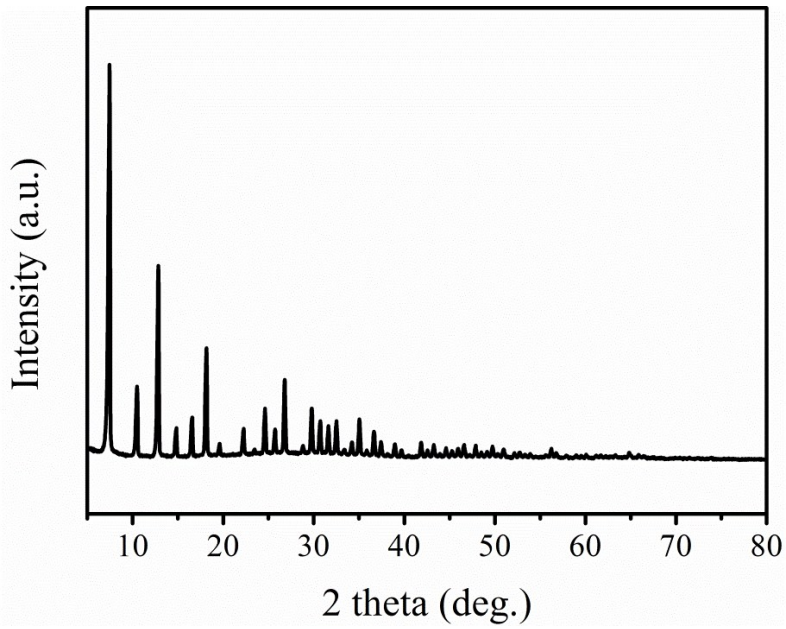

Fig. S1 XRD pattern of the as-synthesized ZIF-8.

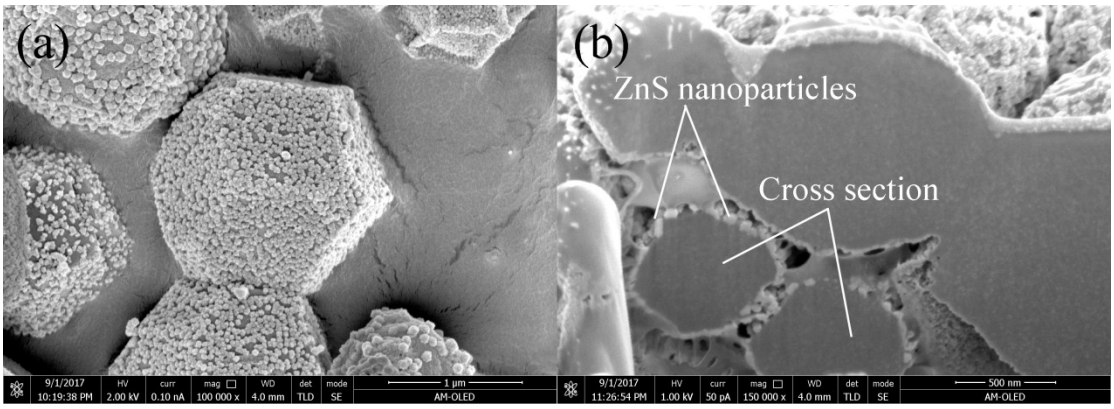

Fig. S2 FESEM images of ZnS/NPC before (a) and after (b) treatment of focused ion beam, showing the cross section of ZnS/NPC.

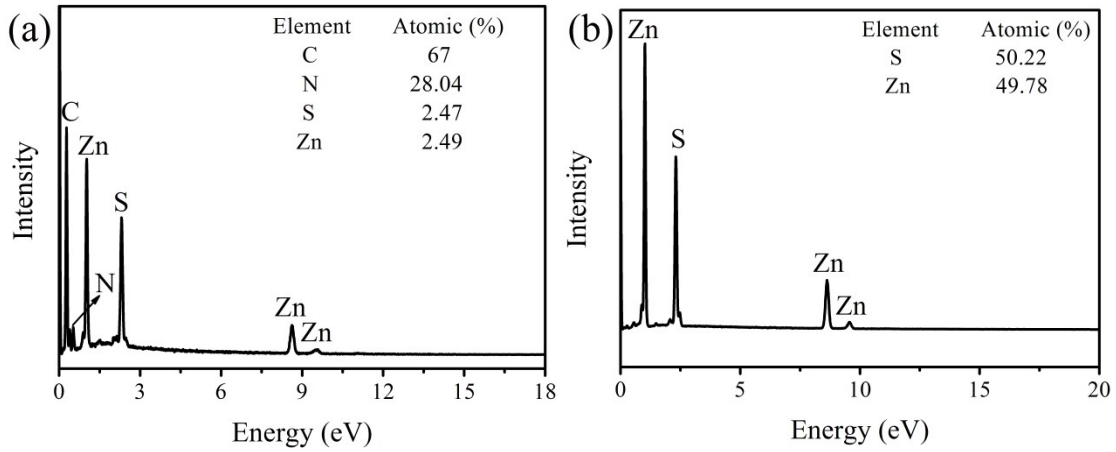

Fig. S3 EDX of ZnS/NPC (a) and ZnS (b).

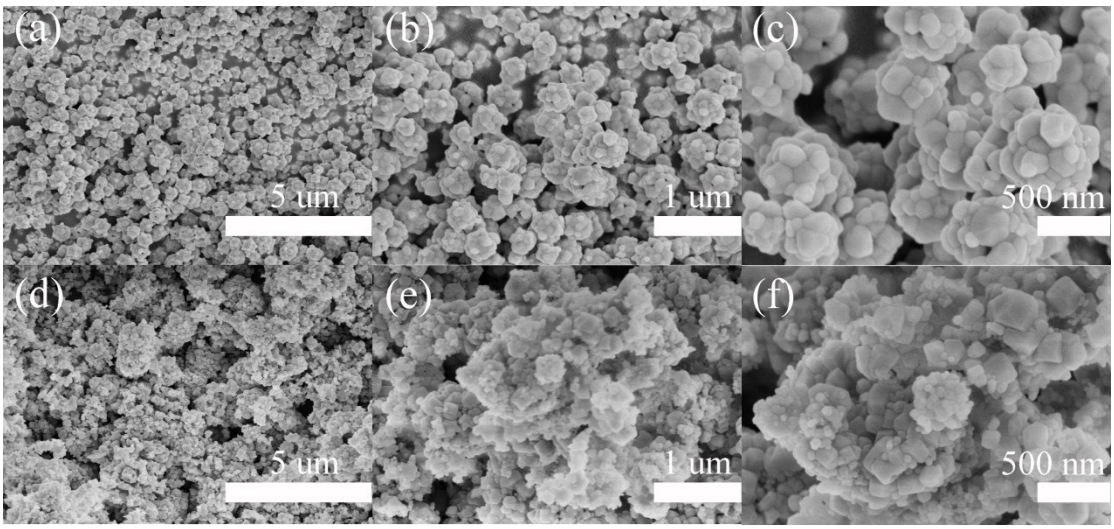

Fig. S4 FESEM images of ZIF-8 calcined in air (a, b and c) and pure ZnS (d, e and f).

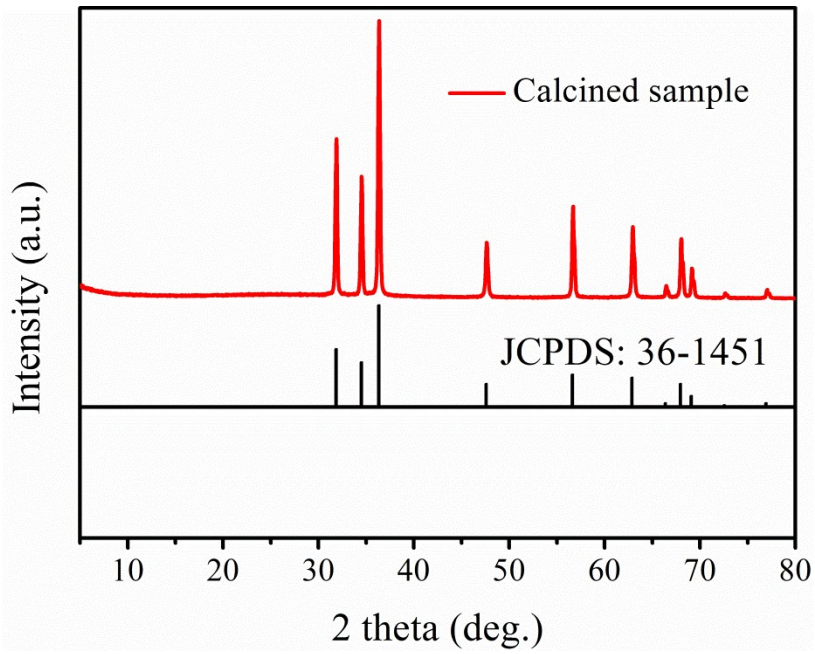

Fig. S5 XRD pattern of the calcined sample.

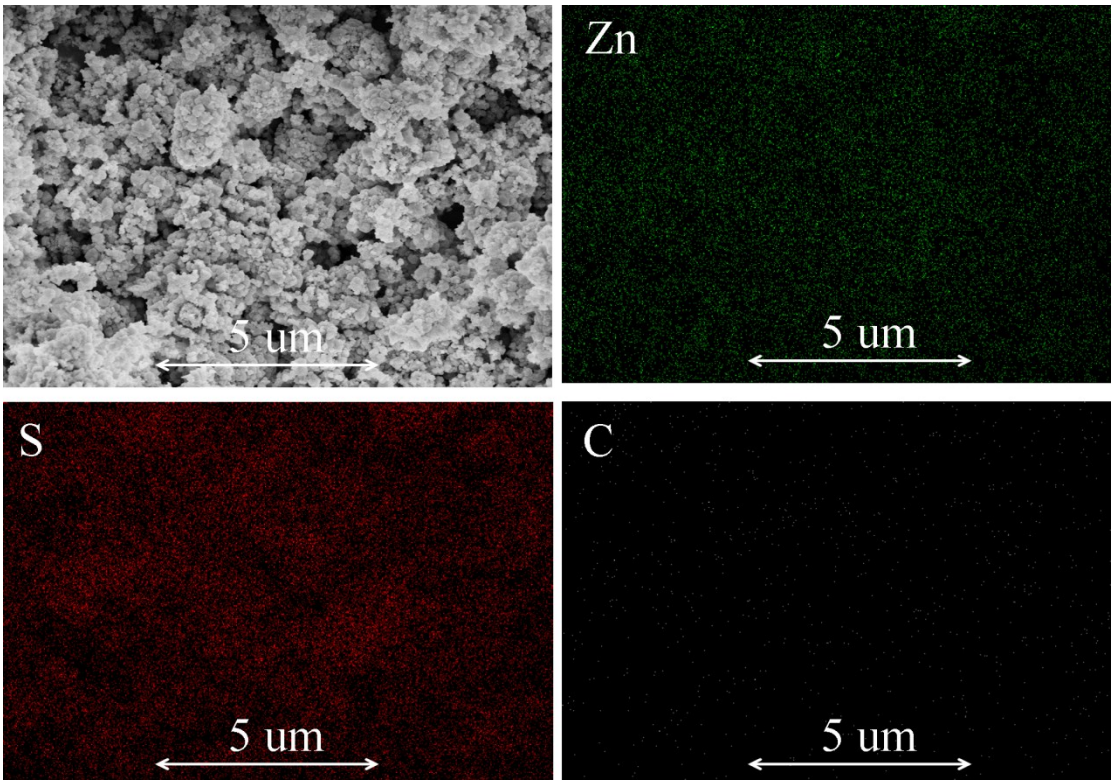

Fig. S6 Elemental mapping of pure ZnS.

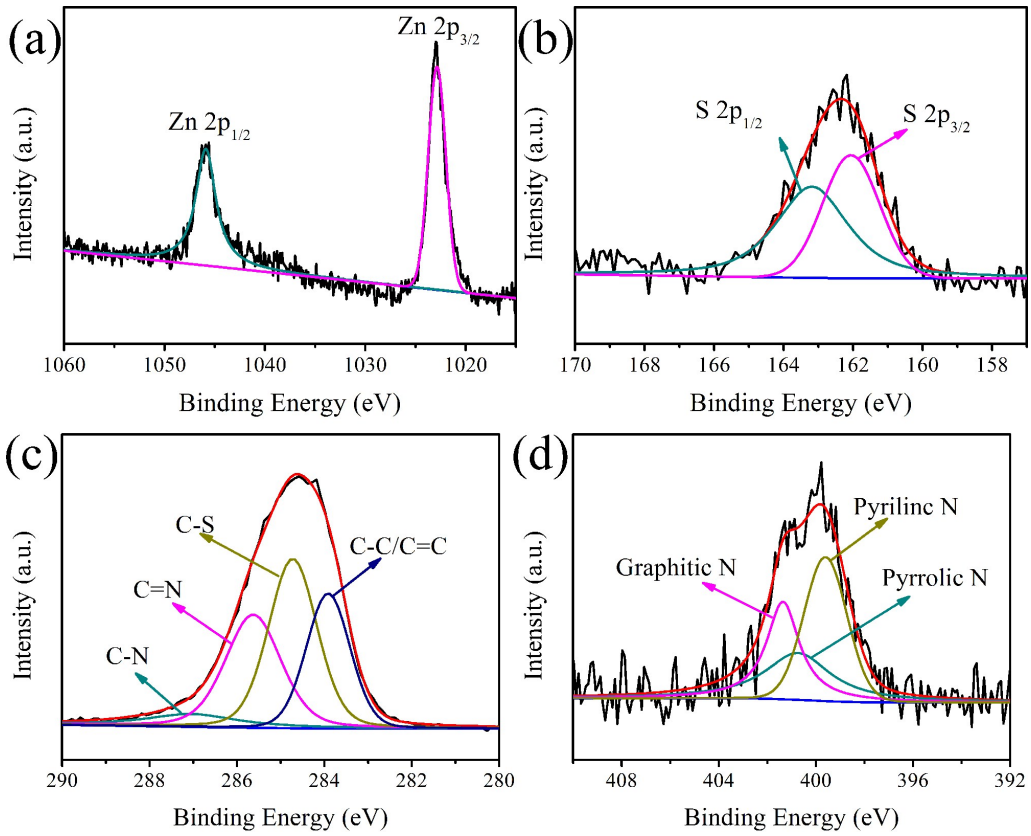

Fig. S7 XPS spectra of ZnS/NPC: (a) Zn 2p, (b) S 2p, (c) C 1S, (d) N 1s.

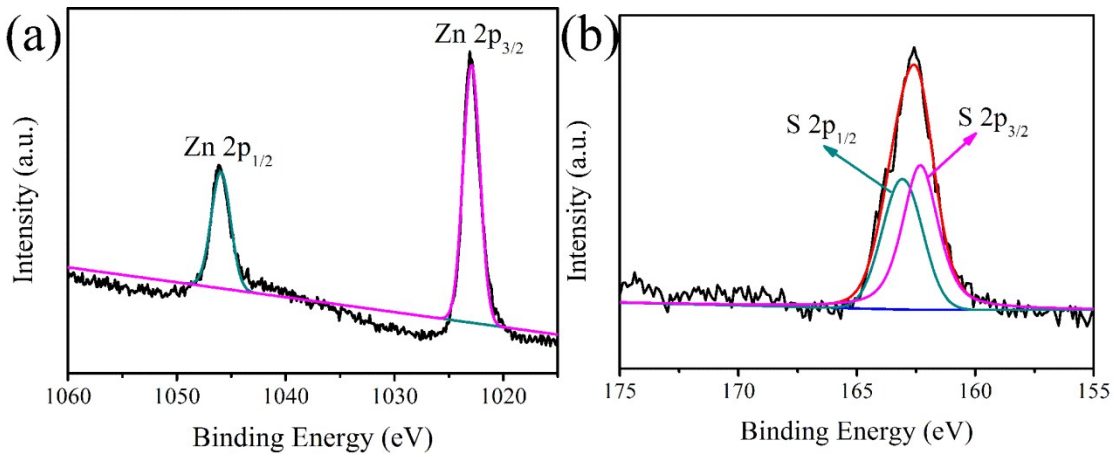

Fig. S8 XPS spectra of pure ZnS: (a) Zn 2p, (b) S 2p.

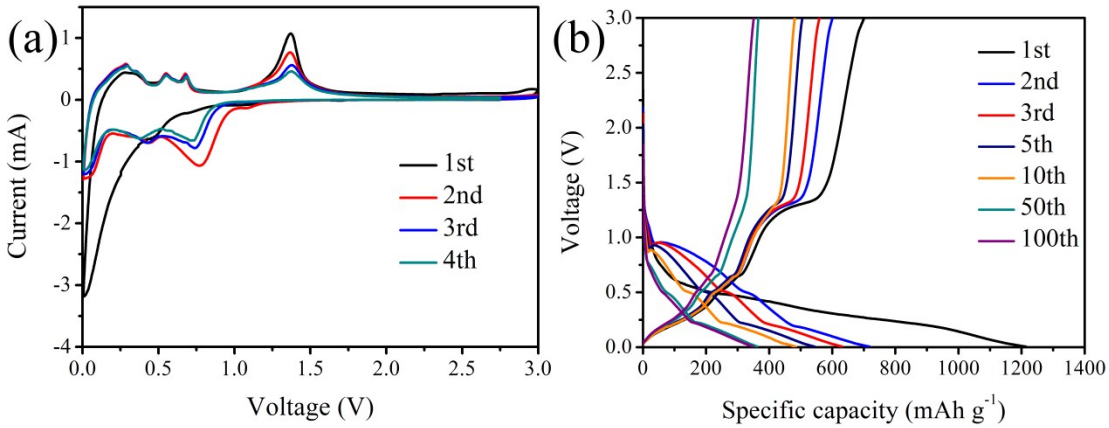

Fig. S9 CV curves of pure ZnS electrode for LIBs from 3 to 0.005 V at a scan rate of 0.2 mV s^{-1}. (b) Discharge/charge profiles of pure ZnS electrode at 100 mA g^{-1};

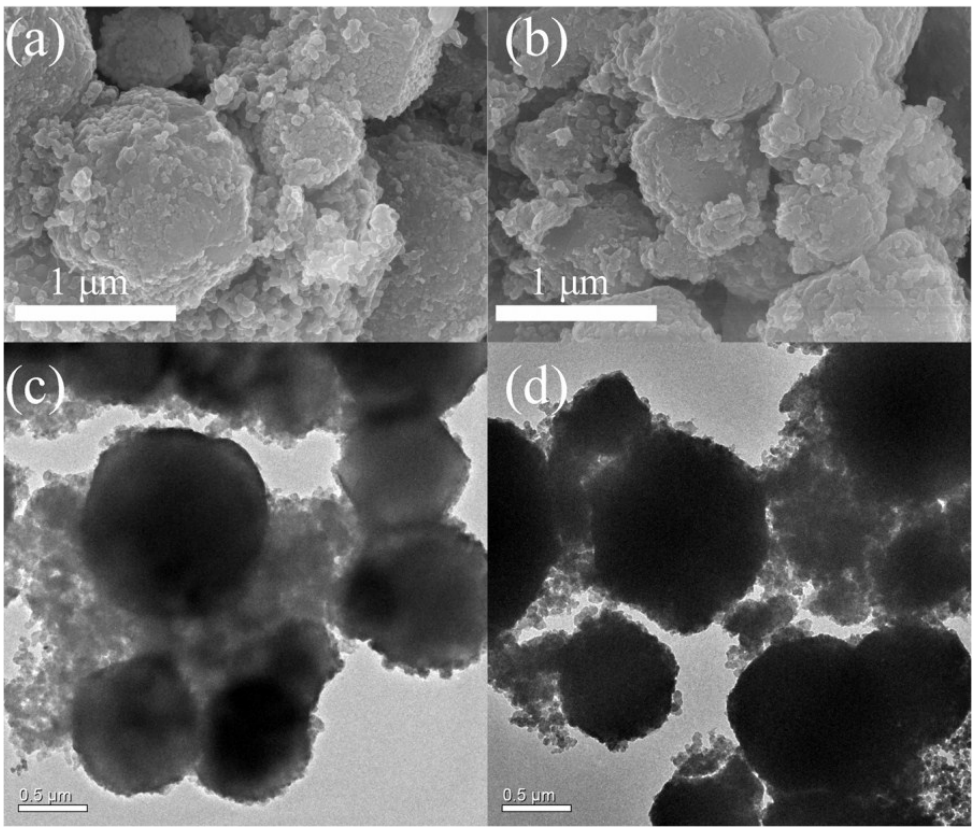

Fig. S10 FESEM images of ZnS/NPC after cycling: (a) 200 cycles for LIBs at 0.1 A g^{-1}, (b) 100 cycles for SIBs at 0.1 A g^{-1}. TEM images of ZnS/NPC after cycling: (c) 200 cycles for LIBs at 0.1 A g^{-1}, (d) 100 cycles for SIBs at 0.1 A g^{-1}.

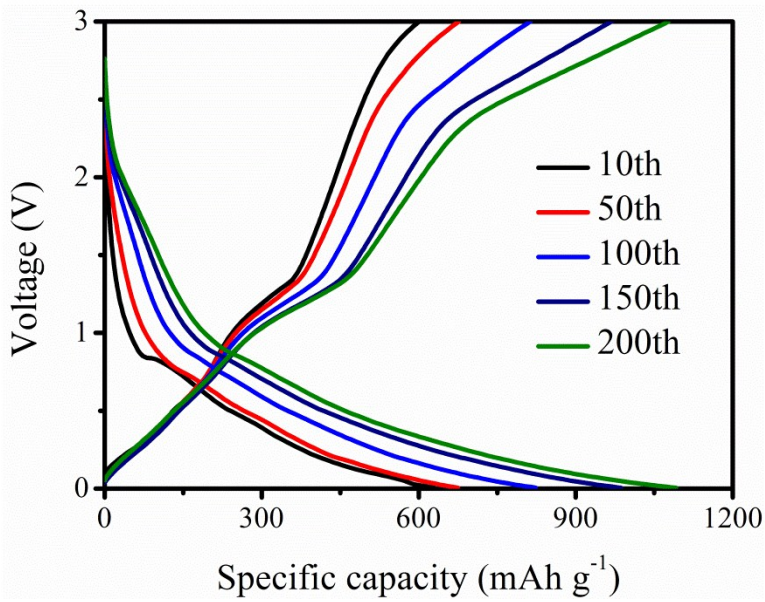

Fig. S11 Discharge/charge profiles of ZnS/NPC electrode for LIBs at 100 mA g^{-1}.

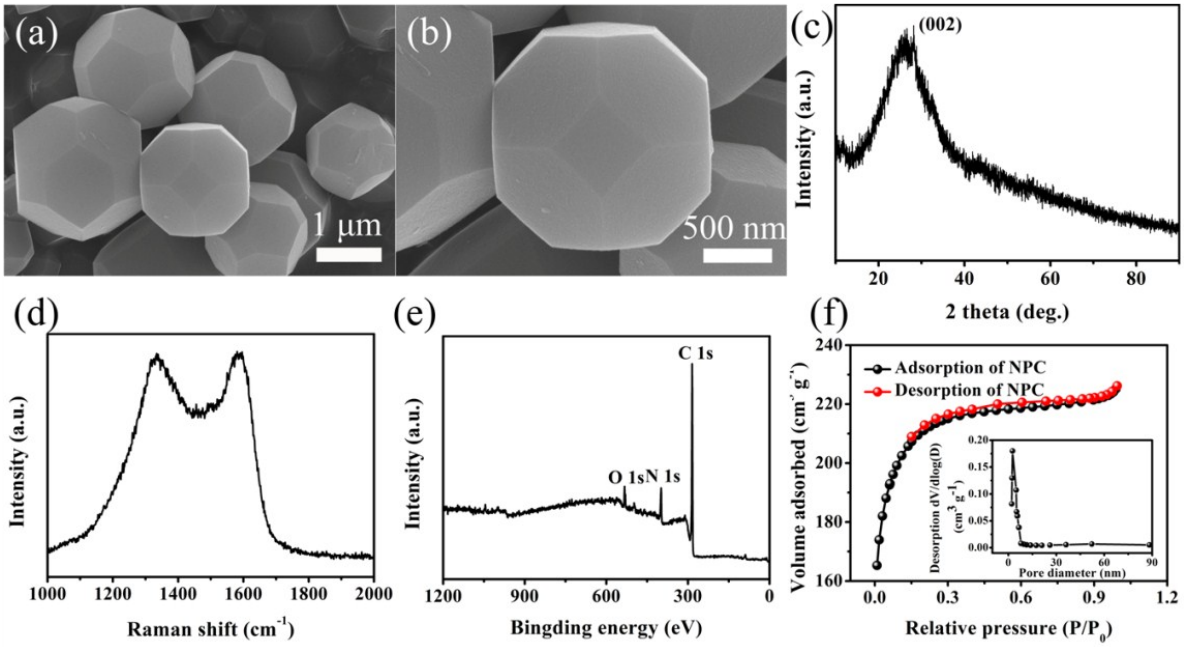

Fig. S12 FESEM images (a and b), XRD pattern (c), Raman spectrum (d), XPS spectrum (e), BET curve (f) and corresponding pore size distribution curve (inset) of pure NPC.

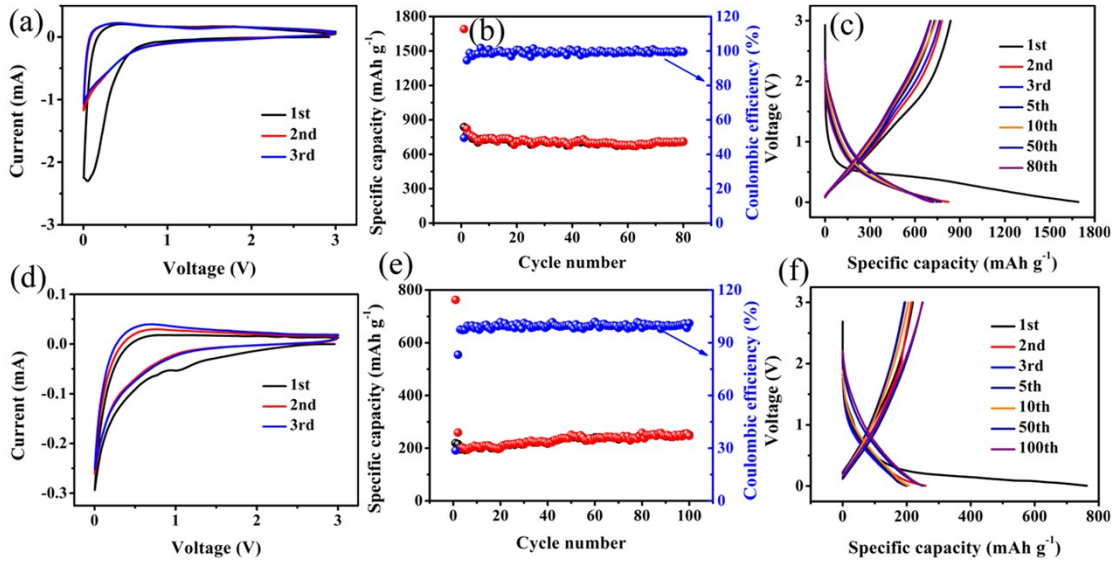

Fig. S13 Electrochemical tests of NPC for LIBs: (a) CV curves from 3 to 0.005 V at a scan rate of 0.2 mV s^{-1}. (b) Cycling performance of NPC at 0.2 A g^{-1}. (c) Discharge/charge profiles at 0.2 A g^{-1}. Electrochemical tests of NPC for SIBs: (d) CV curves from 3 to 0.005 V at a scan rate of 0.2 mV s^{-1}. (e) Cycling performance of NPC at 0.2 A g^{-1}. (f) Discharge/charge profiles at 0.2 A g^{-1}.

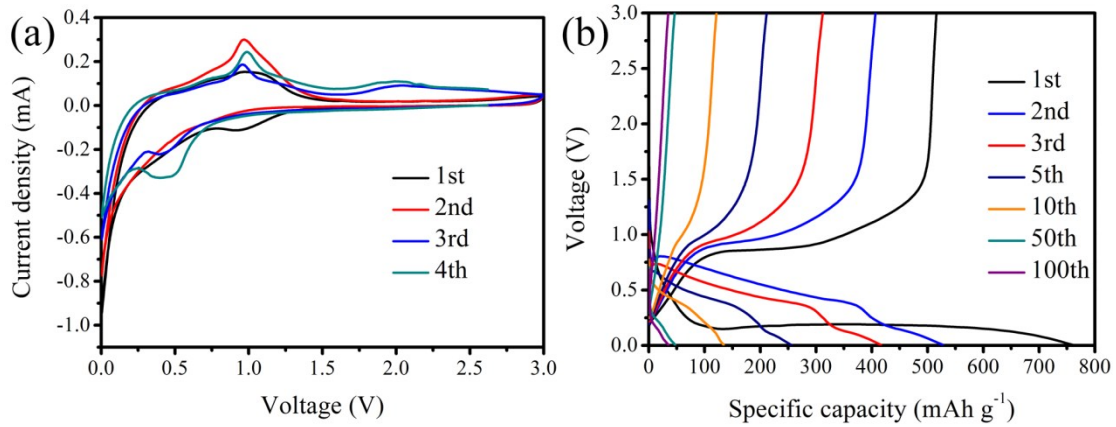

Fig. S14 CV curves of pure ZnS electrode for SIBs from 3 to 0.005 V at a scan rate of 0.2 mV s^{-1}. (b) Discharge/charge profiles of ZnS electrode at 100 mA g^{-1}.

Table S1 Pore parameters of ZnS/NPC, ZnS and NPC.

Sample	Pore parameters		
	Specific surface area ($cm^2\ g^{-1}$)	Average pore size (nm)	Pore volume ($cm^3\ g^{-1}$)
ZnS/NPC	395.1	4.0	0.29
ZnS	23.86	32	0.11
NPC	805.3	3.0	0.34

Table S2 Summary of the ZnS based anode materials for LIBs applications.

Sample	Morphology	Voltage (V)	Cycling performance	Long-term cycling performance at high current density	Ref.
ZnS/C	Core/shell	0.01-2.5	741 mAh g^{-1} at 0.1 A g^{-1} after 300 cycles	750 mAh g^{-1} at 0.5 A g^{-1} after 300 cycles	1
ZnS/C nanoparticles	Core-shell	0.01-2.5	530 mAh g^{-1} at 0.1 A g^{-1} after 600 cycles	506 mAh g-1 at 0.5 A g-1 after 600 cycles	2
ZnS/graphene	Composites	0.01-3	633 mAh g^{-1} at 0.1 A g^{-1} after 200 cycles	/	3
ZnS/RGO	Composites	0.01-3	776 mAh g^{-1} at 0.1 A g^{-1} after 100 cycles	/	4
ZnS/C	Composites	0.02-2	360.4 mAh g^{-1} at 0.4 A g^{-1} after 100 cycles	/	5
ZnS/C	Sphere	0.01-3	868 mAh g^{-1} at 1 A g^{-1} after 300 cycles	/	6
ZnS/porous carbon matrix	Composites	0.01-2.5	438 mAh g^{-1} at 0.1 A g^{-1} after 300 cycles	/	7
ZnS/nitrogen doped carbon	Urchin	0.05-3	690 mAh g^{-1} at 0.1 A g^{-1} after 100 cycles 520 mAh g^{-1} at 1 A g^{-1} after 200 cycles	/	8
ZnS decorated on porous carbon polyhedra	polyhedra	0.005-3	1067.4 mAh g^{-1} at 0.1 A g^{-1} after 200 cycle	856.8 mAh g^{-1} at 1 A g^{-1} after 1000 cycles	This work

Table 3 Summary of the ZnS based anode materials for SIBs applications.

sample	Morphology	Voltage (V)	Cycling performacne	Long-term cycling performance at high current density	Ref.
ZnS	Microspheres	0.01-3	465 mAh g^{-1} at 0.32 A g^{-1} after 100 cycles	/	9
ZnS/nitrogen doped carbon	Urchin	0.05-3	460 mAh g^{-1} at 0.2 A g^{-1} after 80 cycles 380 mAh g^{-1} at 1 A g^{-1} after 100 cycles	/	8
ZnS/RGO	Composites	0.005-3	481 mAh g^{-1} at 0.1 A g^{-1} after 50 cycles	/	10
ZnS decorated on porous carbon polyhedra	polyhedea	0.005-3	370.6 mAh g^{-1} at 0.1 A g^{-1} after 100 cycels	289.2 mAh g^{-1} at 1 A g^{-1} after 1000 cycles	This work

References

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