Supporting Information

# Self-templated formation of hierarchically yolk-shell-structured ZnS/NC dodecahedra with superior lithium storage properties

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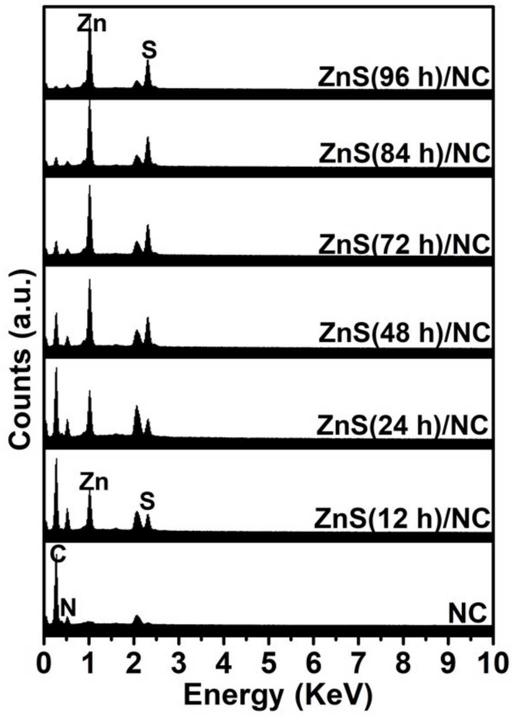


**Fig. S1** EDS results of ZnS(*x* h)/NC.

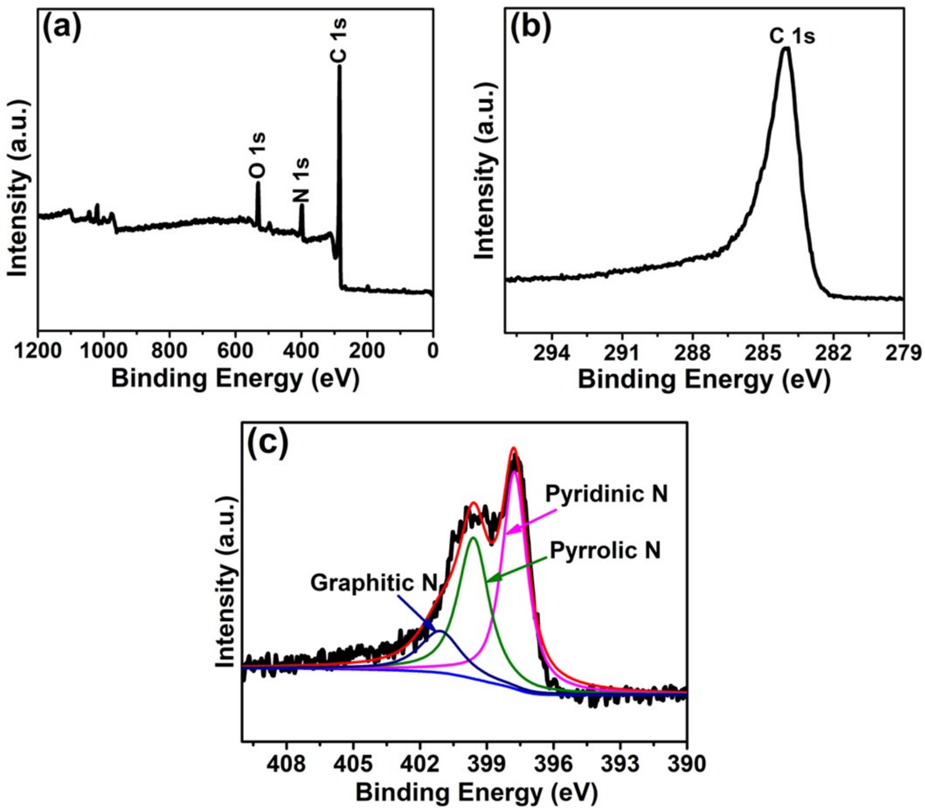


**Fig. S2** XPS spectra of NC: (a) survey, (b) C1s, and (c) N1s.

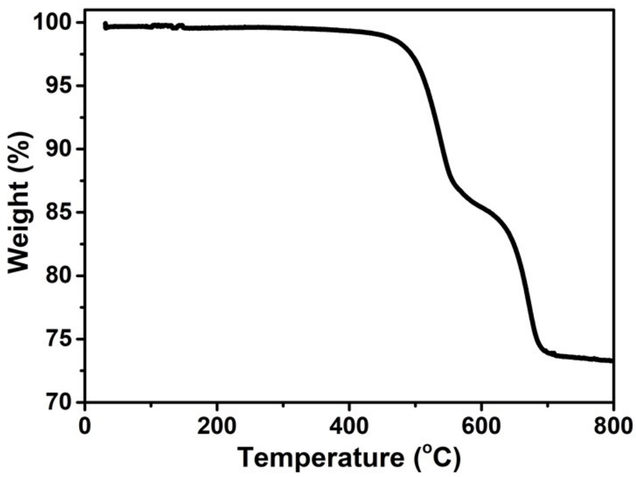


**Fig. S3** TG curve of ZnS(72 h)/NC.

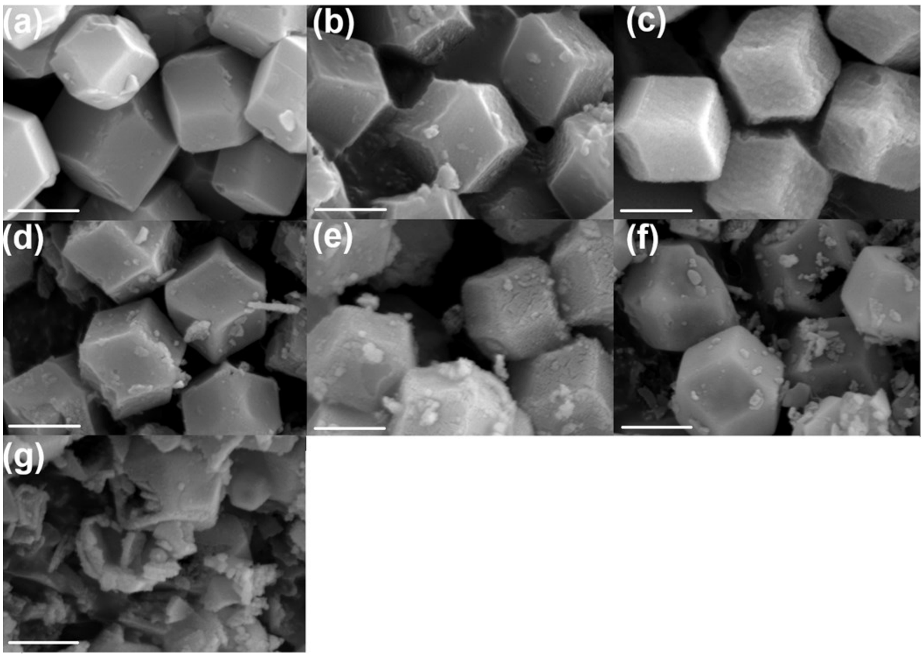


**Fig. S4** SEM images of (a) ZIF-8, (b) ZnS(12 h)@ZIF-8, (c) ZnS(24 h)@ZIF-8, (d) ZnS(48 h)@ZIF-8, (e) ZnS(72 h)@ZIF-8, (f) ZnS(84 h)@ZIF-8, and (g) ZnS(96 h)@ZIF-8. The scale bar represents 1 μm.

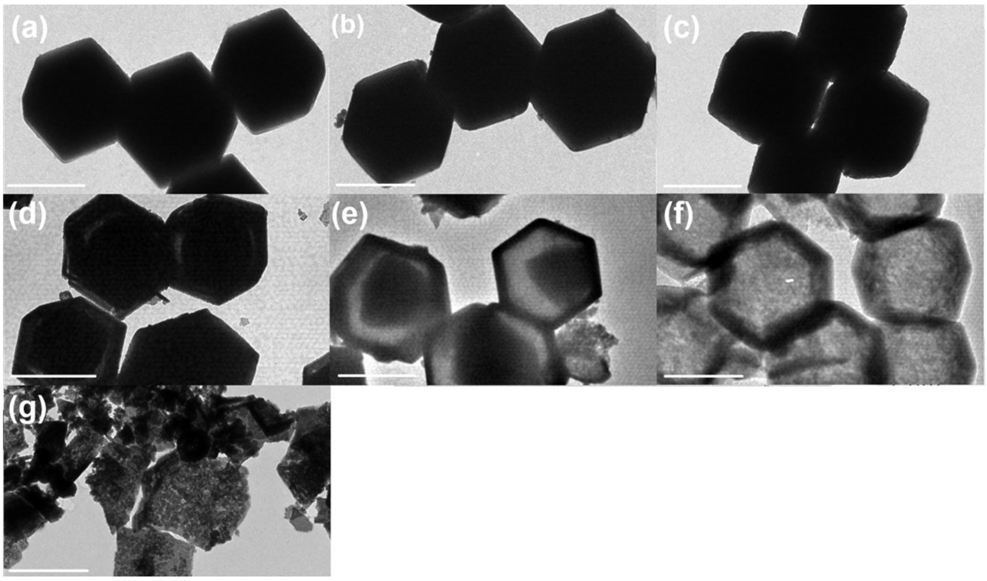


**Fig. S5** TEM images of (a) ZIF-8, (b) ZnS(12 h)@ZIF-8, (c) ZnS(24 h)@ZIF-8, (d) ZnS(48 h)@ZIF-8, (e) ZnS(72 h)@ZIF-8, (f) ZnS(84 h)@ZIF-8, and (g) ZnS(96 h)@ZIF-8. The scale bar represents 1 μm.

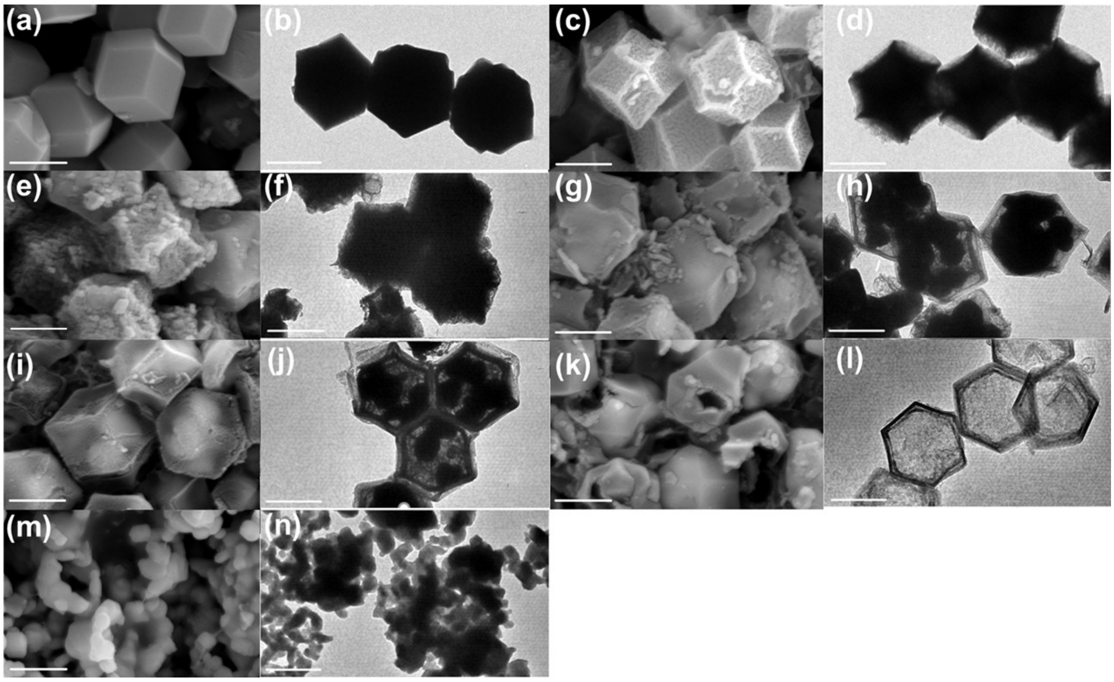


**Fig. S6** SEM and TEM images of (a, b) NC, (c, d) ZnS(12 h)/NC, (e, f) ZnS(24 h)/NC, (g, h) ZnS(48 h)/NC, (i, j) ZnS(72 h)/NC, (k, l) ZnS(84 h)/NC, and (m, n) ZnS(96 h)/NC. The scale bar represents 1 μm.

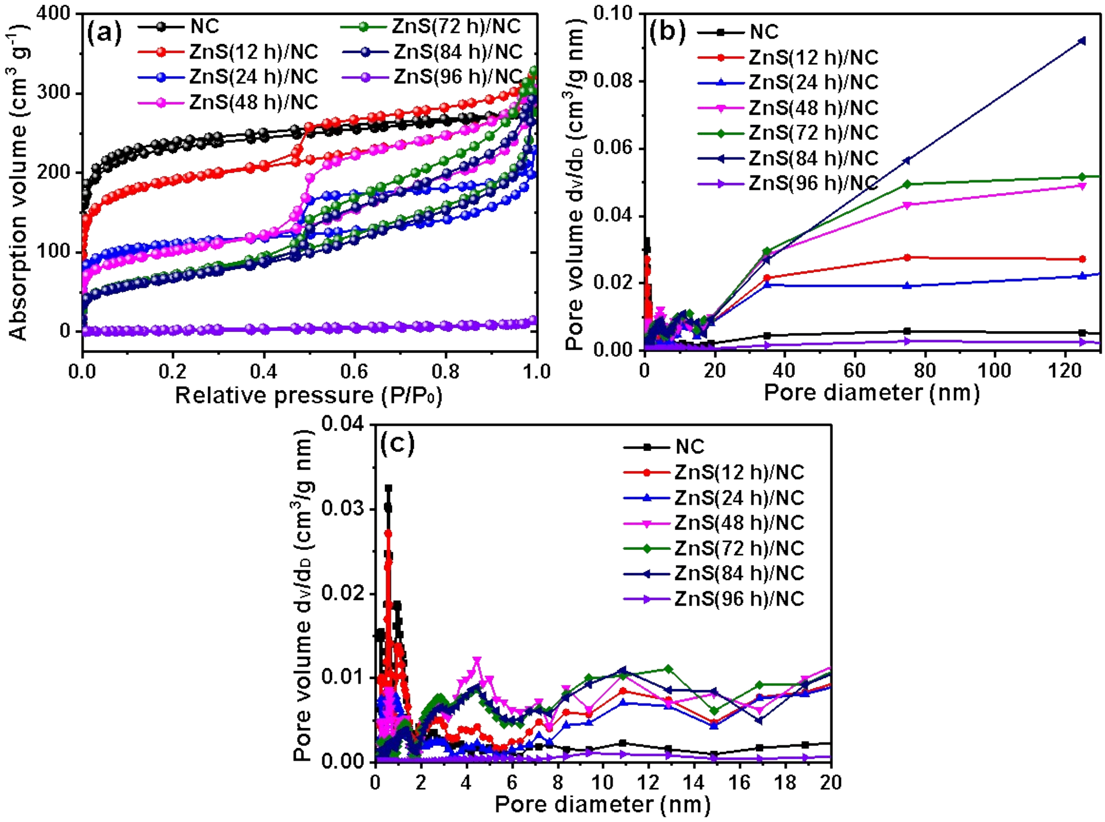


**Fig. S7** (a) $N_2$ adsorption-desorption isotherms (77 K) and (b, c) pore size distributions of NC and ZnS(*x* h)/NC (*x* = 12~96).

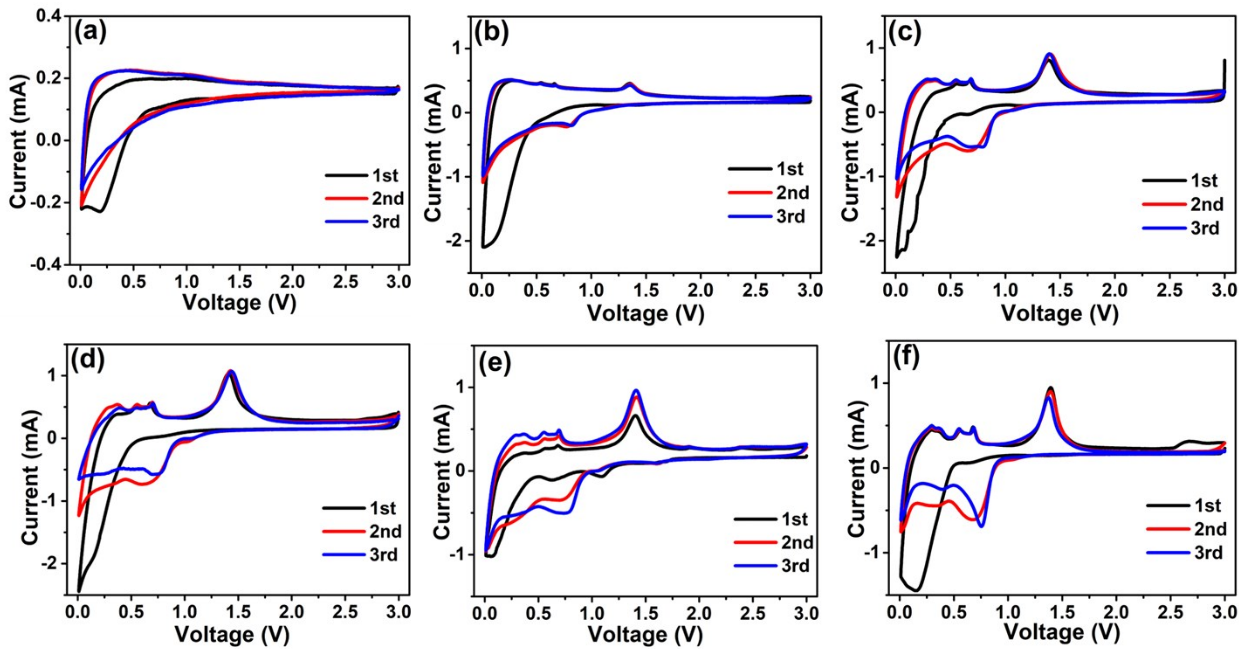


**Fig. S8** Cyclic voltammetry curves of (a) NC, (b) ZnS(12 h)/NC, (c) ZnS(24 h)/NC, (d) ZnS(48 h)/NC, (e) ZnS(84 h)/NC, and (f) ZnS(96 h)/NC.

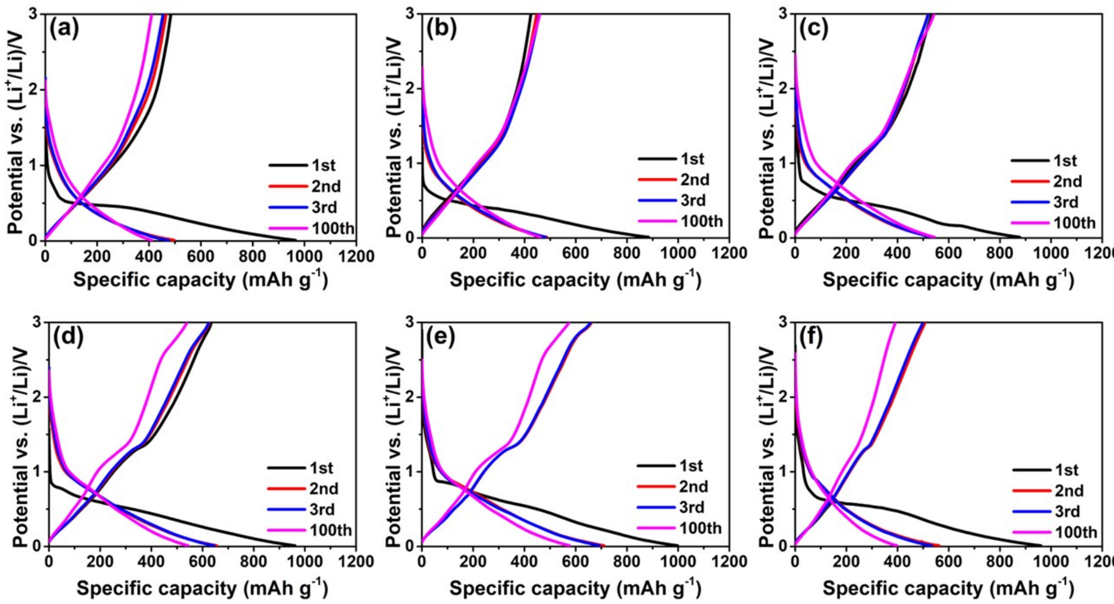


**Fig. S9** Galvanostatic discharge-charge voltage profiles at 100 mA $g^{-1}$ of (a) NC, (b) ZnS(12 h)/NC, (c) ZnS(24 h)/NC, (d) ZnS(48 h)/NC, (e) ZnS(84 h)/NC, and (f) ZnS(96 h)/NC.

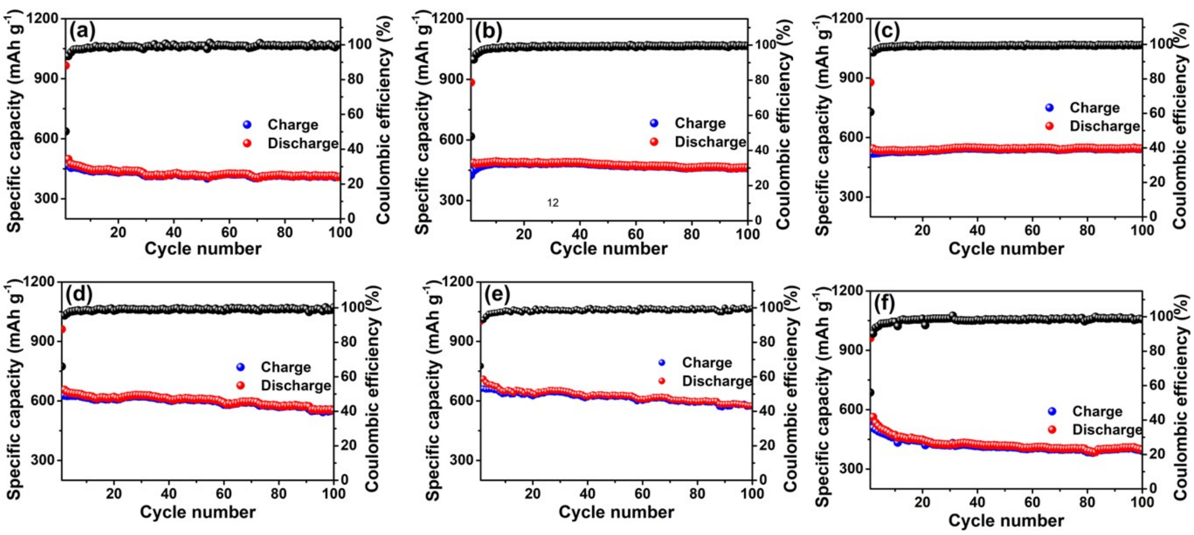


**Fig. S10** Cycling performance and coulombic efficiency in the voltage window of 0.01~3.0 V vs. $Li/Li^{+}$ at 200 mA $g^{-1}$ of (a) NC, (b) ZnS(12 h)/NC, (c) ZnS(24 h)/NC, (d) ZnS(48 h)/NC, (e) ZnS(84 h)/NC, and (f) ZnS(96 h)/NC.

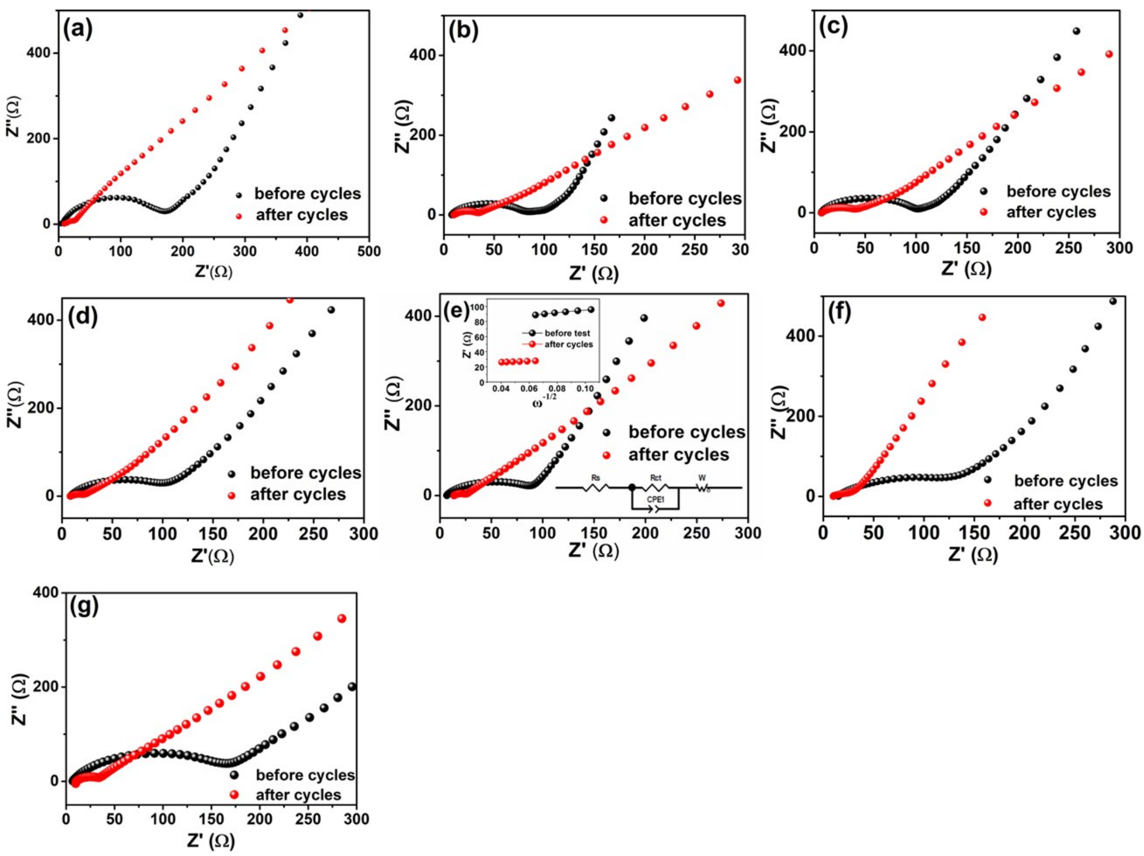

**Fig. S11** Impedance spectrum as-prepared sample. (a) NC, (b) ZnS(12 h)/NC, (c) ZnS(24 h)/NC, (d) ZnS(48 h)/NC, (e) ZnS(72 h)/NC (inset: the plot of $Z_{re}$ *vs*. the reciprocal root square of the low angular frequencies ($\omega^{-1/2}$)), (f) ZnS(84 h)/NC, (g) ZnS(96 h)/NC.

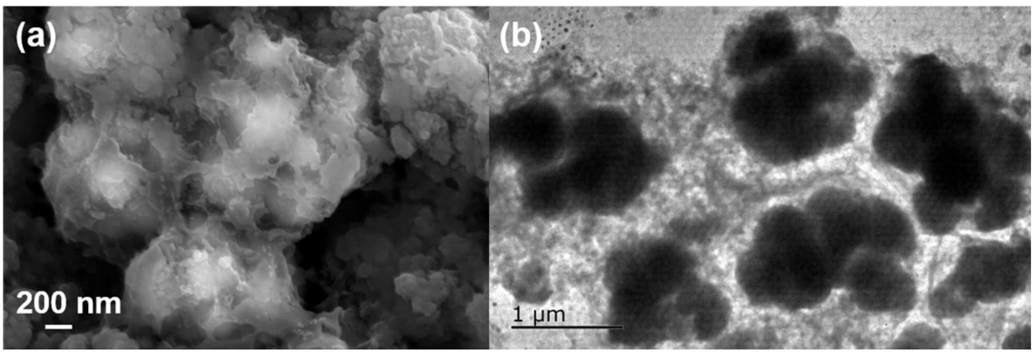


**Fig. S12** (a) SEM and (b) TEM images of the ZnS(72 h)/NC electrode after the cycles.

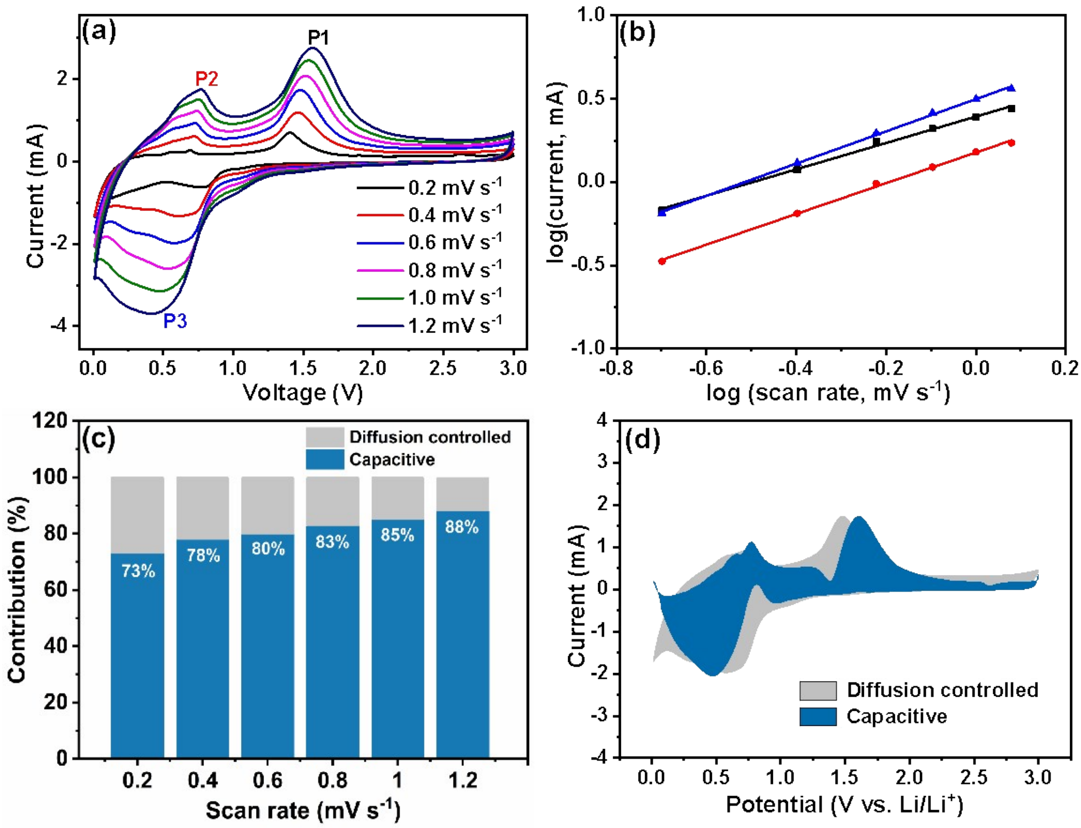


**Fig. S13** (a) CV curves of ZnS(72 h)/NC at different scan rates; (b) Determination of the *b*-value by plotting the linear relationship between log(*i*) and log(*v*); (c) Charge contribution ratios from capacitive and diffusion-controlled process at various scan rates; (d) Separation of the capacitive and diffusion-controlled currents at a scan rate of 0.6 mV $s^{-1}$.

**Table S1** Electrochemical performances of ZnS-based anode materials for LIBs.

| Materials | Specific capacity (mAh $g^{-1}$) | Cycle number | Current density (mA $g^{-1}$) | Reference |
|---|---|---|---|---|
| **ZnS(72 h)/NC** | **757**<br>**~500** | **200**<br>**1000** | **200**<br>**2000** | **this work** |
| ZnS-C/graphene | 571 | 120 | 1000 | S1 |
| ZnS/graphene | 570 | 200 | 200 | S2 |
| ZnS-rGO | 776 | 100 | 100 | S3 |
| ZnS@NC | 690 | 100 | 100 | S4 |
| ZnS/NPC | 1067 | 200 | 100 | S5 |
| ZnS NR@HCP | 840 | 300 | 600 | S6 |
| ZnS/C NPs | 506 | 600 | 500 | S7 |
| ZnS-QDS@NC | 506 | 300 | 840 | S8 |
| ZnS-C | 530 | 600 | 100 | S9 |
| ZnS/C | 570 | 150 | 100 | S10 |
| ZnS/C | 741 | 300 | 100 | S11 |
| ZnS-C | 868 | 300 | 1000 | S12 |
| ZnS/C | 482 | 300 | 400 | S13 |
| ZnS/nano-cell | 1134 | 100 | 500 | S14 |
| Zn-Co-S@N-C | 668 | 300 | 1000 | S15 |

**Table S2** Electrochemical impedance fitting parameters of ZnS(72 h)/NC.

| Cycles | $R_s$ (Ω) | $R_{ct}$ (Ω) | $\sigma$ (Ω $S^{-1/2}$) | $D_{Li^+}$ ($cm^2$ $s^{-1}$) |
|---|---|---|---|---|
| before test | 7 | 93 | 179 | $9.86 \times 10^{-13}$ |
| after cycles | 13 | 15 | 73 | $5.9 \times 10^{-12}$ |

The diffusion coefficients ($D$) of $Li^+$ ions can be calculated from the following formula of $D = R^2T^2/(2A^2n^4F^4C^2\sigma^2)$ where $A$ is the surface area of electrode, $n$ is the number of electrons per molecule attending electronic transfer reaction, $F$ is the Faraday constant, $C$ is the concentration of $Li^+$ in the electrode, $\sigma$ is the slope of the line $Z' \sim \omega^{-1/2}$, $R$ is the gas constant, and $T$ is ambient temperature. The $F$ and $R$ values are 96500 C $mol^{-1}$ and 8.314 J $K^{-1}$ $mol^{-1}$, respectively.

## References


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