Supporting Information

Metallic 1T phase MoS_2 nanosheets decorated hollow cobalt sulfide polyhedrons for high-performance lithium storage

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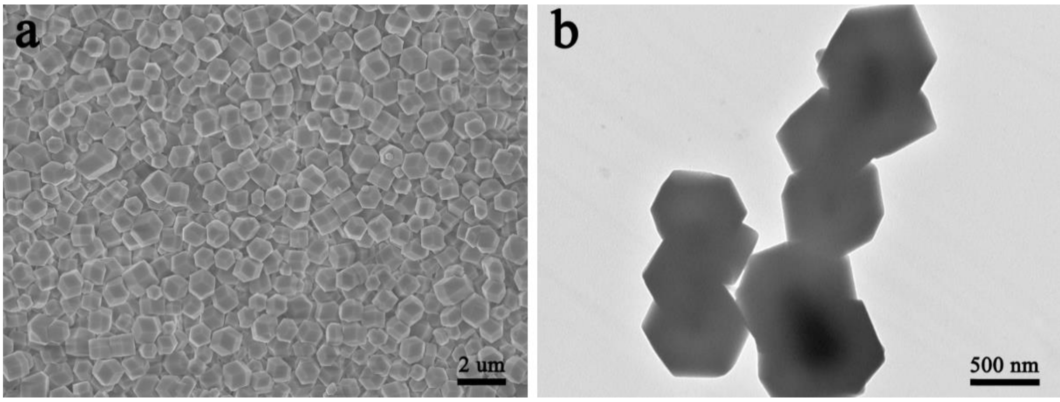

Figure S1. (a) FESEM and (b) TEM graphs of ZIF-67.

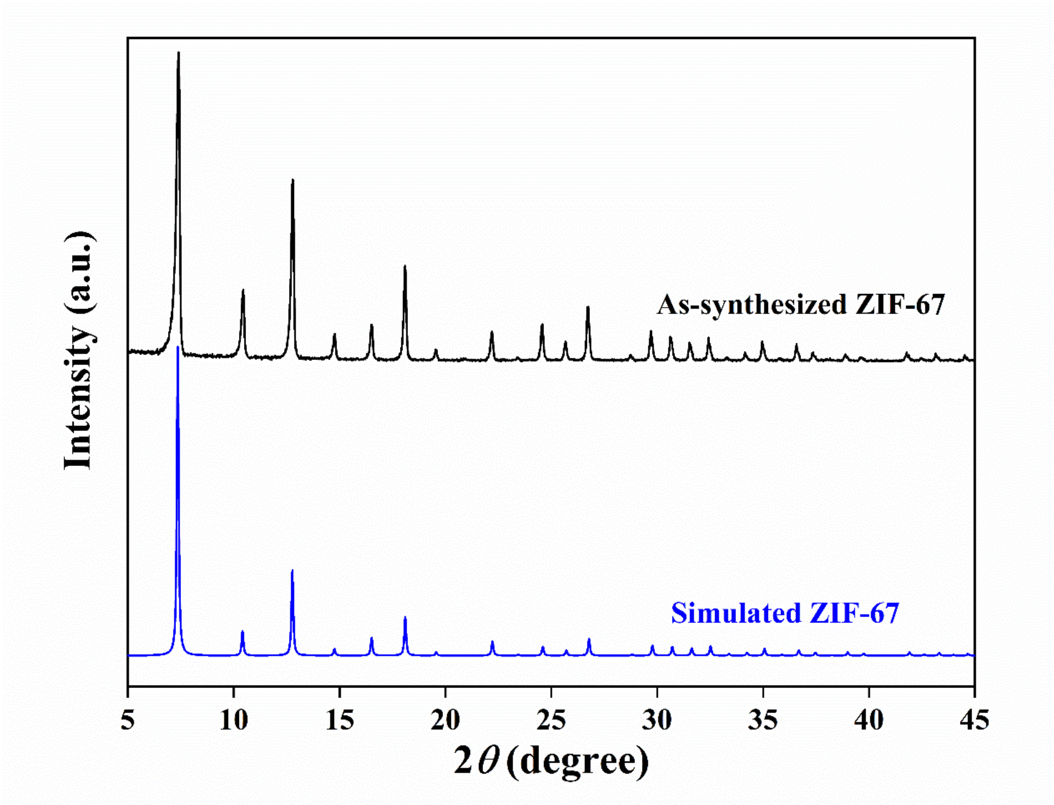

Figure S2. XRD patterns of the as-synthesized ZIF-67 and simulated ZIF-67.

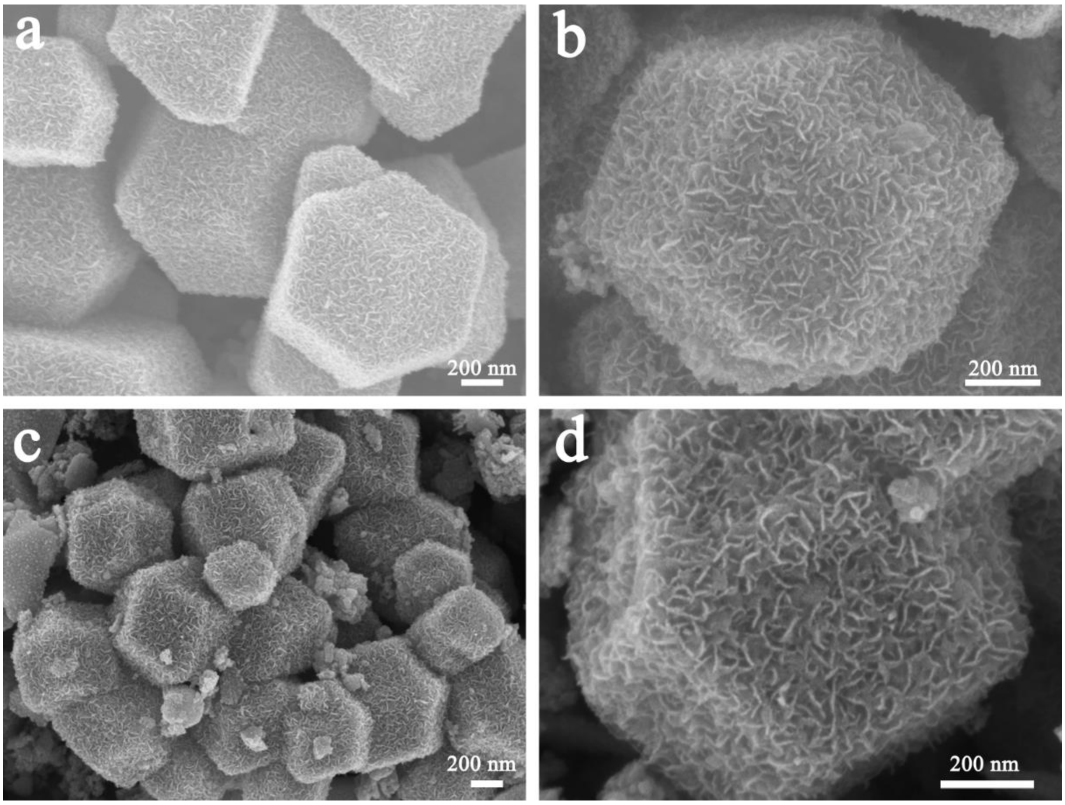

Figure S3. SEM images of (a, b) CoS@1T-MoS_2 and (c, d) Co_9S_8@2H-MoS_2.

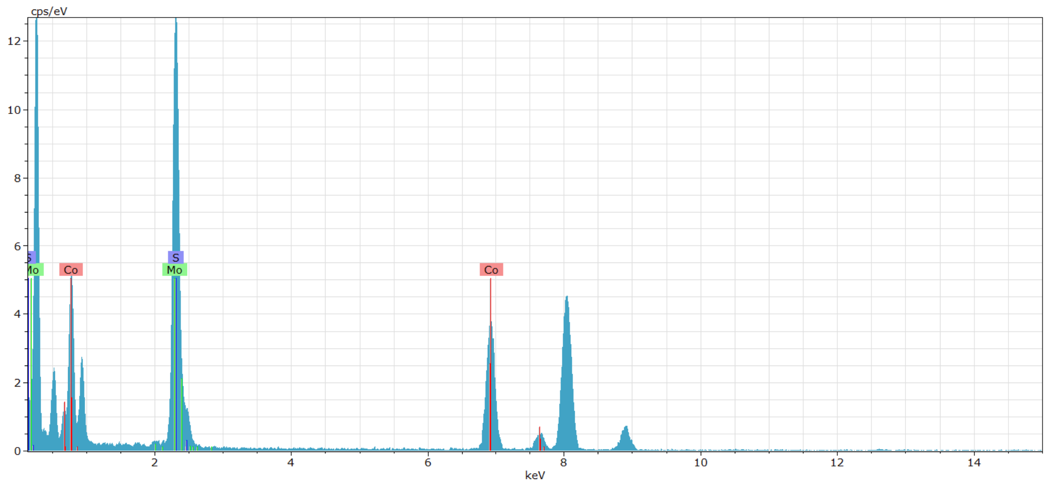

Figure S4. EDX spectrum of CoS@1T-MoS_2.

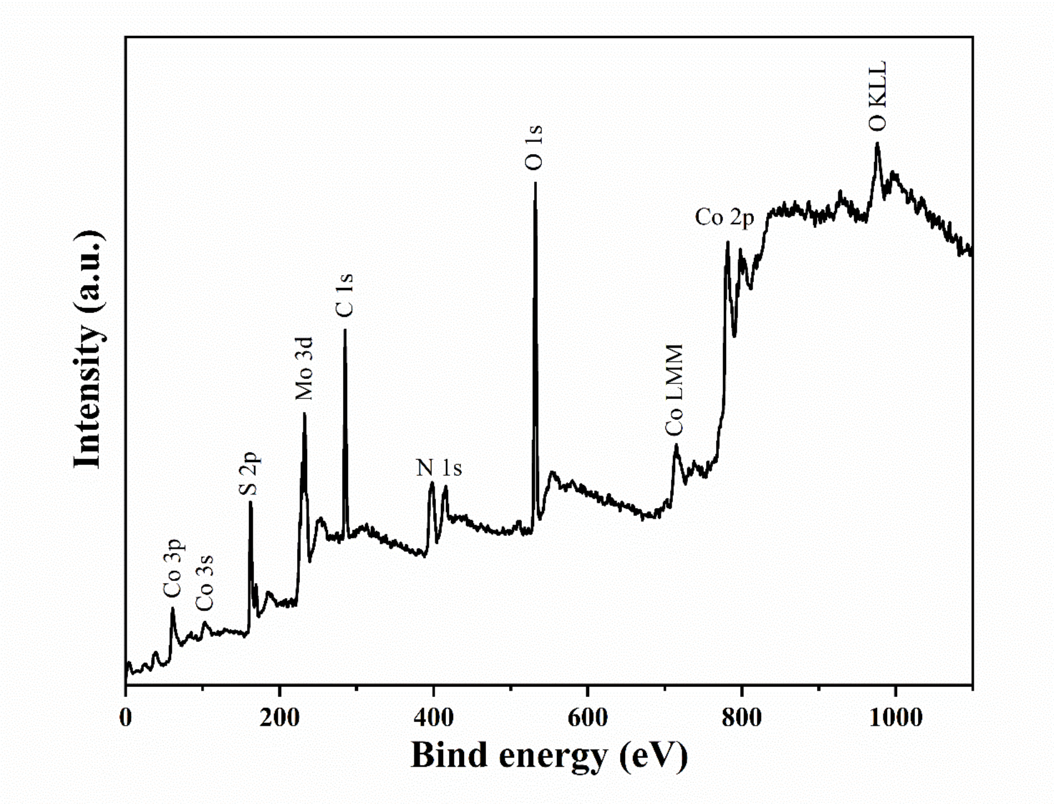

Figure S5. XPS wide scan spectral plot of CoS@1T-MoS_2.

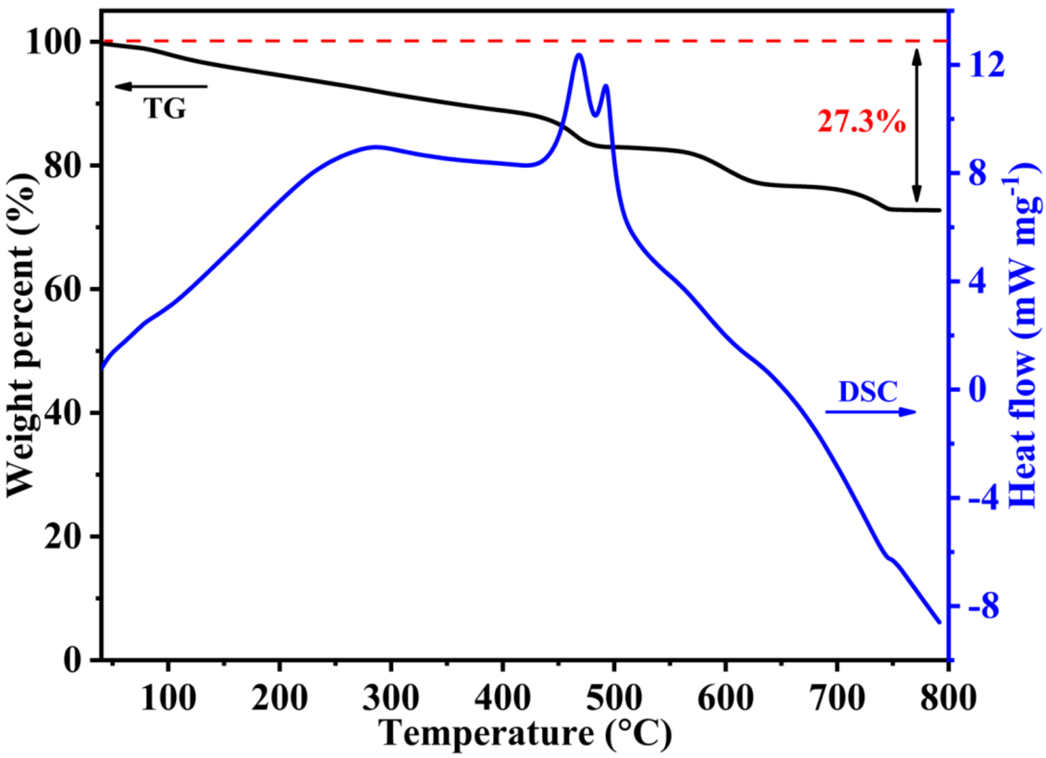

Figure S6. TGA-DSC curve of CoS@1T-MoS_2 in air.

Based on the TGA-DSC and ICP results (**Table. S1, ESI†**), the mass contents of MoS_2, CoS and amorphous carbon in the composite can be roughly calculated to be 59.0%, 34.7%, and 6.3%, respectively.

Table S1. ICP result of the CoS@1T-MoS_2 composite.

Element	Mass concentration	Mass ratio
Co	47.66μg/mL	1
Mo	74.38μg/mL	1.56

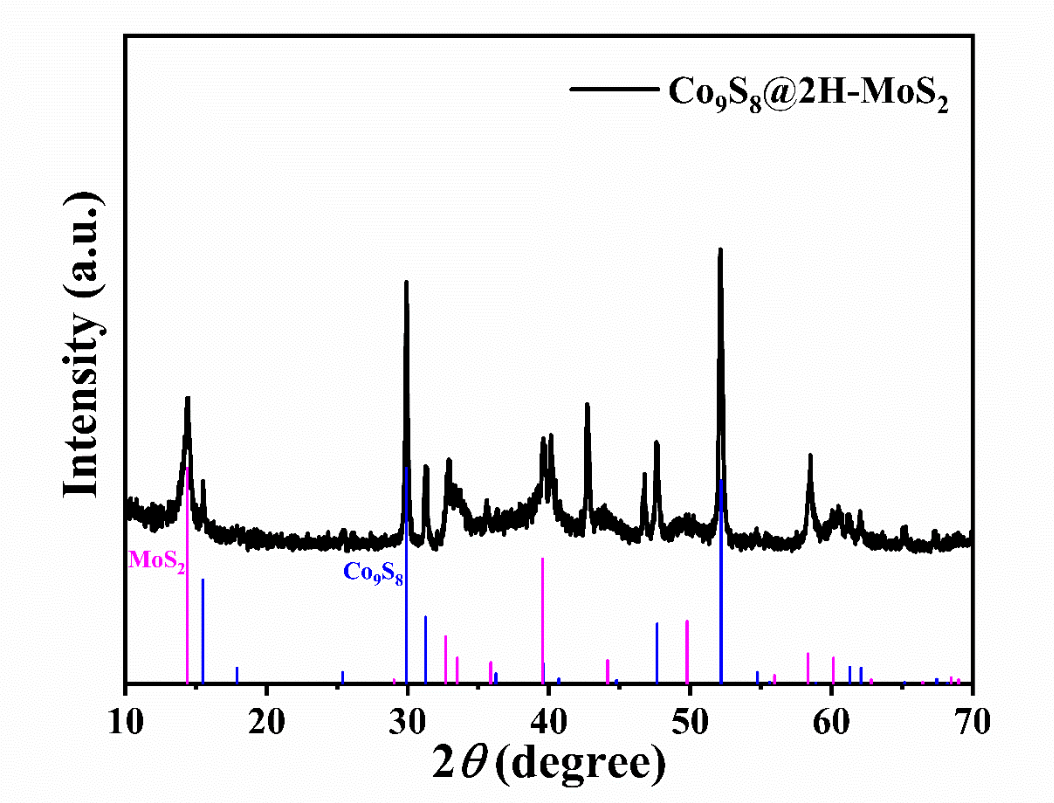

Figure S7. XRD patterns of Co_9S_8@2H-MoS_2.

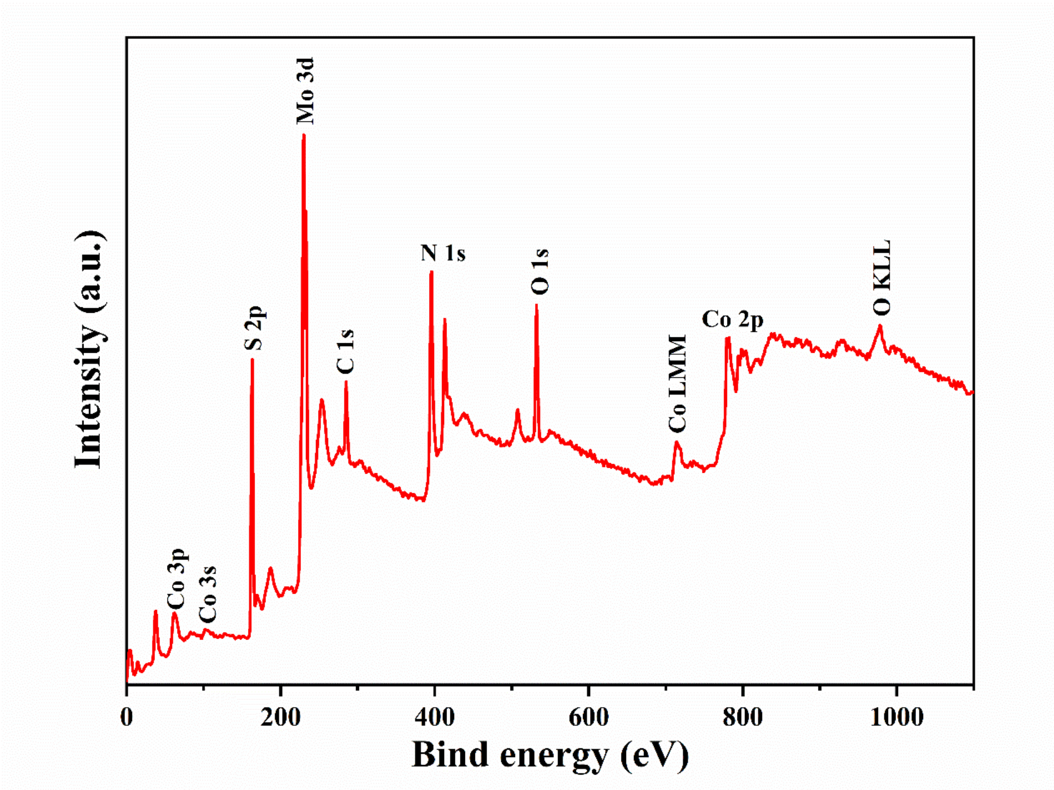

Figure S8. XPS wide scan spectral plot of Co_9S_8@2H-MoS_2.

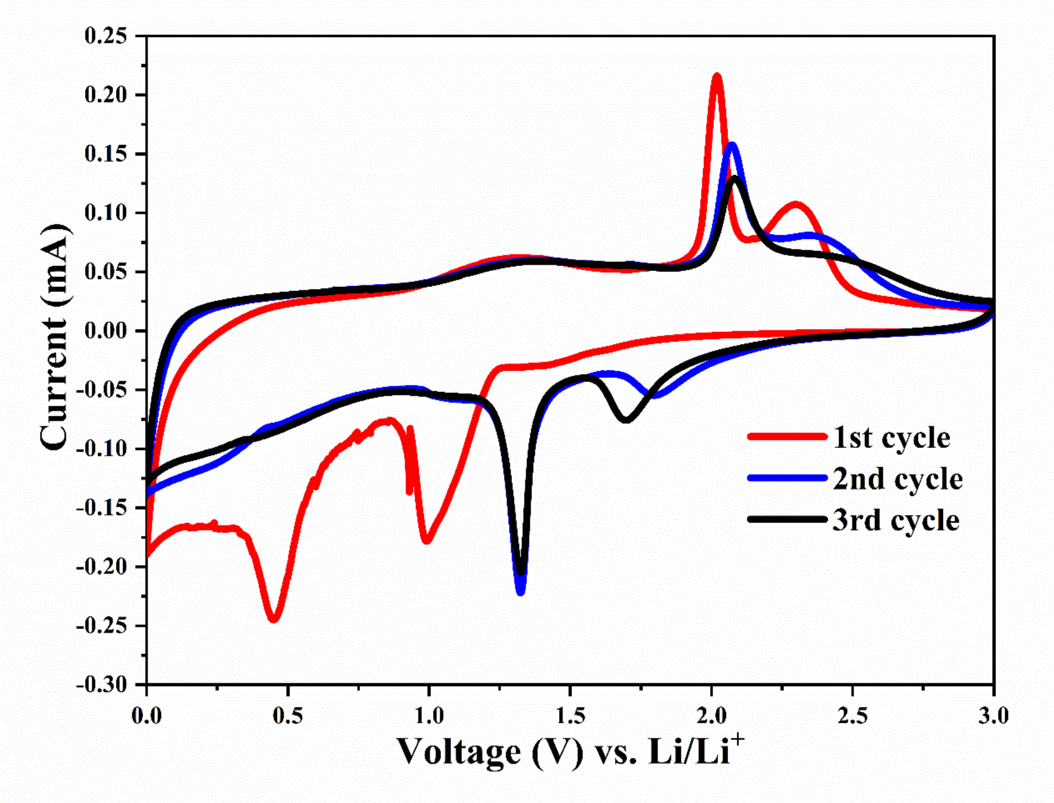

Figure S9. CV curve of the first three cycles of Co_9S_8@2H-MoS_2 in a voltage rage of 0.0-3.0 V at a scan rate of 0.1 mV s^{-1}.

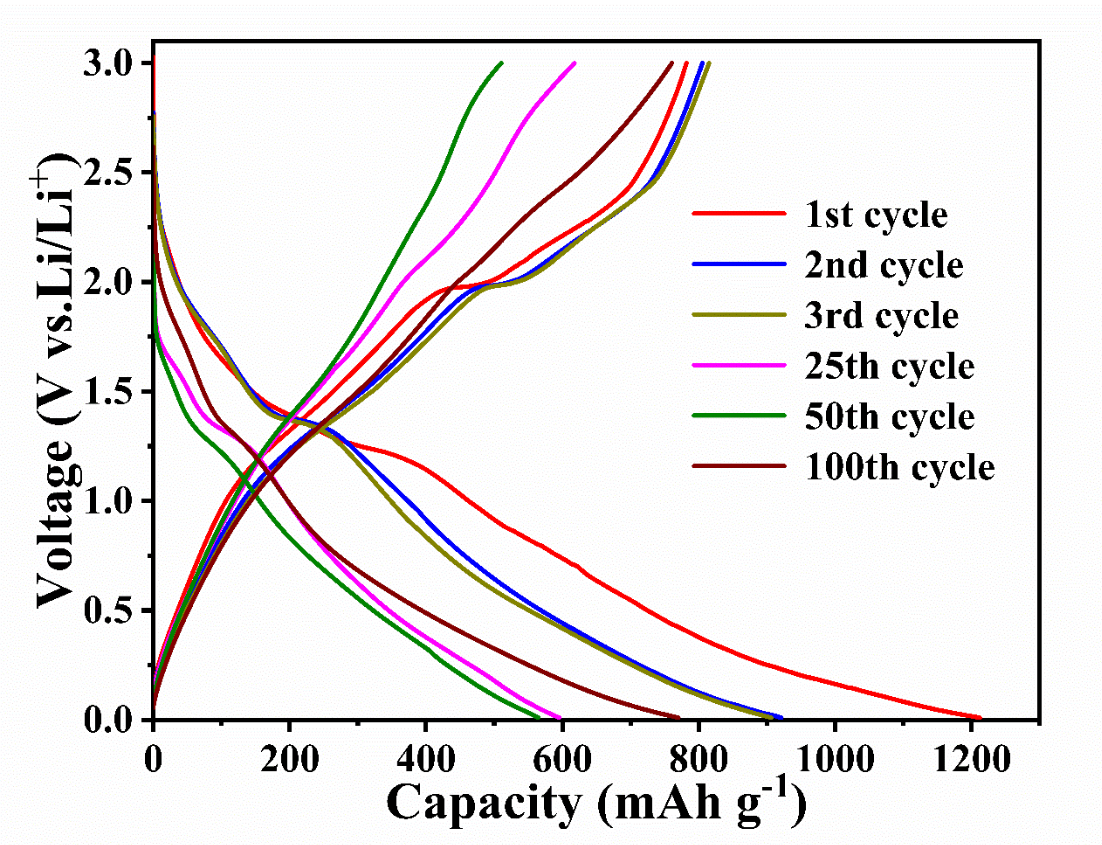

Figure S10. Charge/discharge voltage profiles of the Co_9S_8@2H-MoS_2 electrode for the 1st, 2nd, 3rd, 25th, 50th, and 100th cycles at a current density of 0.1 A g^{-1}.

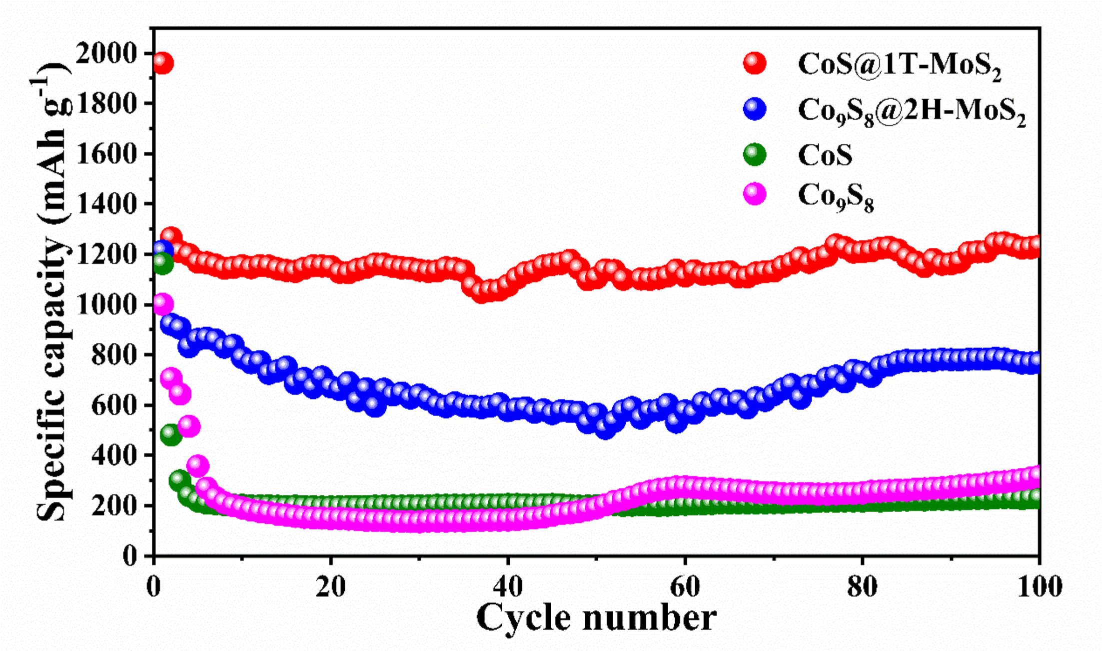

Figure S11. Cycling performance of the CoS@1T-MoS_2, Co_9S_8@2H-MoS_2, CoS and Co_9S_8 electrodes at a current density of 0.1 A g^{-1}.

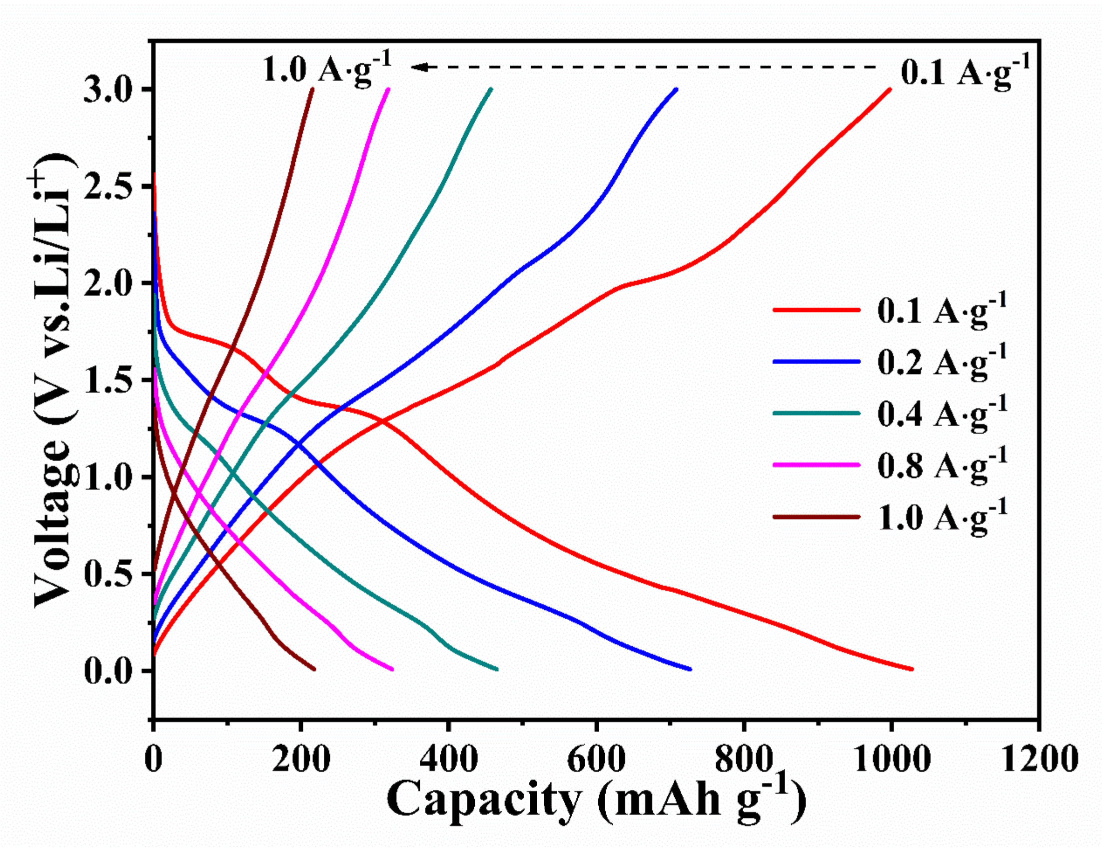

Figure S12. Charge/discharge profiles of the Co_9S_8@2H-MoS_2 electrode at different rate current densities.

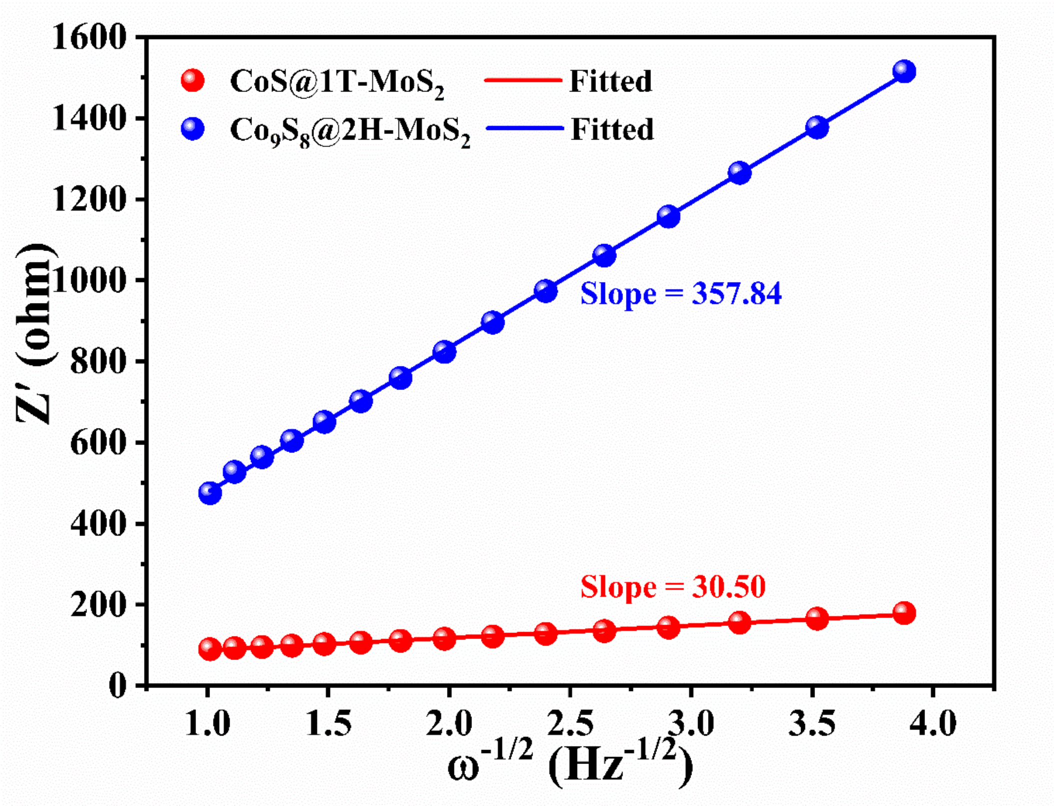

Figure S13. Fitted straight lines of Z' vs. $\omega^{-1/2}$ at low frequency of CoS@1T-MoS_2 and Co_9S_8@2H-MoS_2.

The lithium ion diffusion coefficient can be calculated using the following equation:[1]

$$D = \frac{R^2T^2}{2A^2n^4F^4C^2\sigma^2}$$

where *D* is the diffusion coefficient, *R* is the gas constant, *T* is the absolute temperature, *A* is the surface area of the electrode, n is the number of the electrons per molecule attending the electronic transfer reaction, *F* is the Faraday constant, C is the concentration of lithium ion in the electrode, σ is the Warburg factor which can be calculated from the slope of the line Z'~ $\omega^{-1/2}$ (shown in **Fig. S13, ESI†)**, respectively.

The calculated lithium diffusion coefficient of the CoS@1T-MoS_2 electrode is 2.35×10^{-11} cm^2 s^{-1}, almost 138 times higher than that of the Co_9S_8@2H-MoS_2 electrode (1.70×10^{-13} cm^2 s^{-1}) .

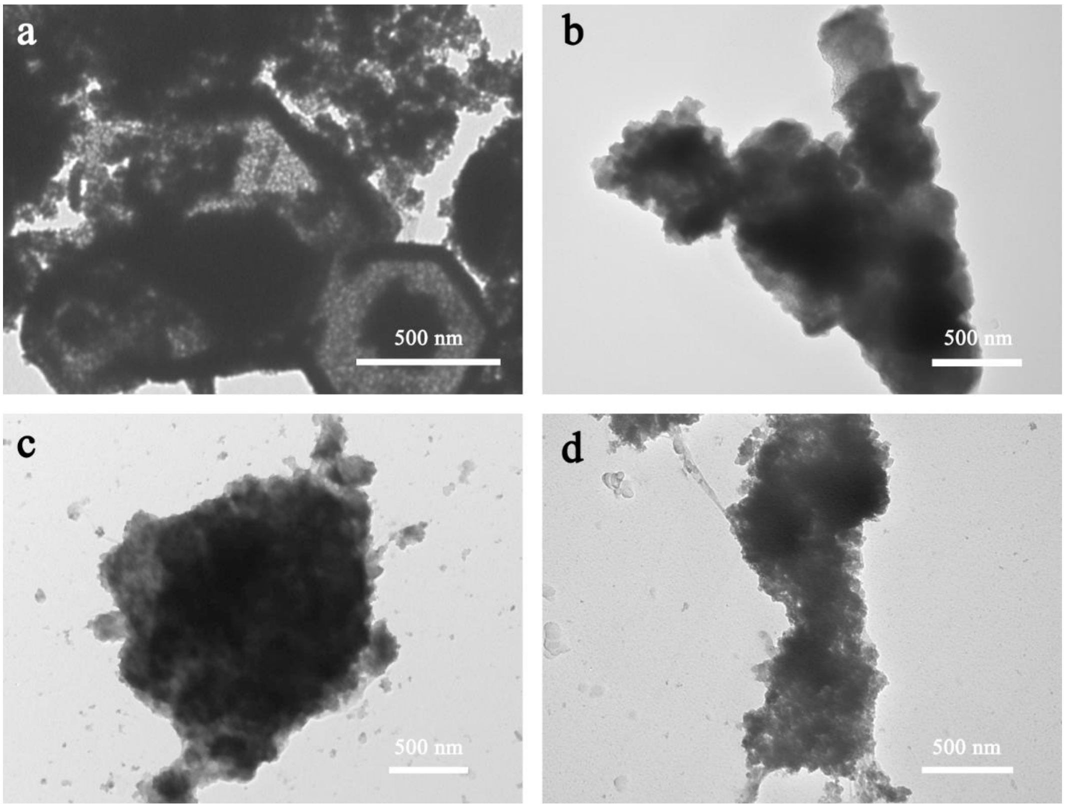

Figure S14. TEM image of the CoS@1T-MoS_2 composite after 100 cycles at a current density of 0.1 A g^{-1} (a) and 220 cycles at a current density of 1 A g^{-1} (b-d).

Table S2. The comparison of Li-storage performance between CoS@1T-MoS_2 and other CoS_x-based anodes.

Samples	Current density (mA g^{-1})	Charge capacity (mA h g^{-1})	Cycle number	Ref.
Co_9S_8/N-C	544	784	400	2
rGO/CoS_x	100	613	100	3
NiS_2@CoS_2	1000	670	100	4
CoS_2/rGO	50	644	30	5
CoS_2	100	720	10	6
CoS	100	589	10	6
M-CoS@C	1000	790	500	7
CoS/graphene	58.9	898	80	8
CoS@PCP/CNTs	200	1668	100	9
Co_9S_8/MoS_2	1000	732	200	10
Co_3S_4/Graphene	140.56	720	100	11
NC/CoS_2-650	100	560	50	12
CoS_x hollow spheres	500	1012	100	13
Co_9S_8 hollow spheres	100	254.9	100	14
Flower-like $Co_{1-x}S$	100	485	150	15
Yolk shell Co_9S_8	1000	634	100	16

Rose-like Co_9S_8	50	123	30	17
Graphene/Co_9S_8	545	573	500	18
MWCNT@a-C@Co_9S_8	1000	662	120	19
CoS@1T-MoS_2	**100** **1000**	**1269** **936**	**100** **220**	**This work**

Table S3. The comparison of Li-storage performance between CoS@1T-MoS_2 and other MoS_2-based anodes.

Samples	**Current density (mA g^{-1})**	**Charge capacity (mA h g^{-1})**	**Cycle number**	**Ref.**
Hollow MoS_2 nanotubes	100	727	100	20
MoS_2/C	100	888.1	50	21
Hollow MoS_2 nanoparticles	100	902	80	22
MoS_2-SWNT	100	992	100	23
Single-layer MoS_2–graphene nanosheet	100	808	100	24
Quasi-hollow C@MoS_2	100	652	100	25
FL-MoS_2@PCNNs	2000	676	520	26
MoS_2/mesoporous carbon	400	1023	500	27
Co_9S_8/MoS_2	1000	732	200	10
MoS_2–C microspheres	1000	800	170	28
C@MoS_2 nanoboxes	100	900	50	29
MoS_2/Polyaniline nanowires	100	952.6	50	30
MoS_2/N-doped graphene nanosheets	100	1021.2	50	31
CNT/MoS_2 tubular nanohybrids	5000	800	1000	32
MoS_2@Carbon microspheres	1000	650	300	33
MoS_2 entrapped carbon sheath	1000	823	200	34
MoS_2/Nanotube Composite	2000	950	500	35
MoS_2/rGO nanoflowers	100	1150	60	36
Yolk/shell MoS_2@C	1000	993	200	37
HC-MoS_2@GF	200	820	50	38
Single-layered MoS_2/carbon nanowire	1000	1007	100	39
1T-MoS_2/CFC	1000	853	140	40
CoS@1T-MoS_2	**100** **1000**	**1269** **936**	**100** **220**	**This work**

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