Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting information

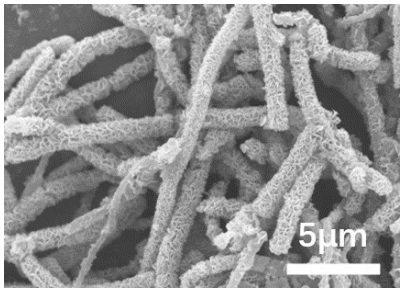

Figure S1. SEM of the V-precursor.

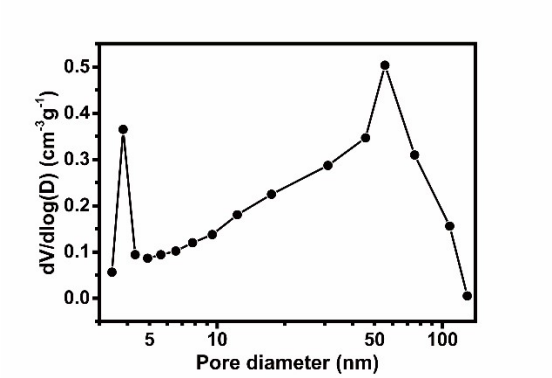

Figure S2. Pore size distribution of CNTs@VO_2.

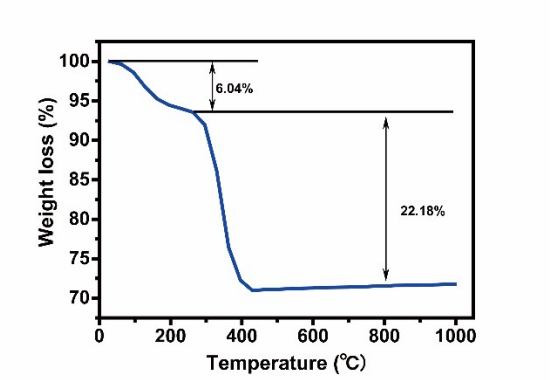

Figure S3. TGA test of CNTs@VO_2.

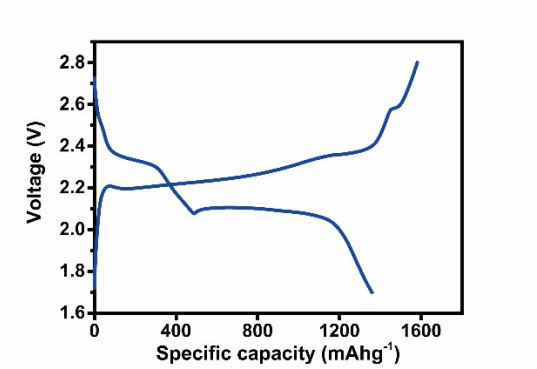

Figure S4. Charge-discharge profile of CNTs@VO_2 cathode at 0.2C.

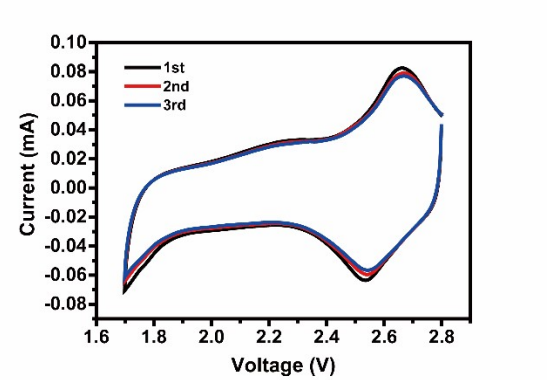

Figure S5. CV curves of the initial three cycles of bare CNTs@VO_2 cathode at 0.1 mV s^{-1}.

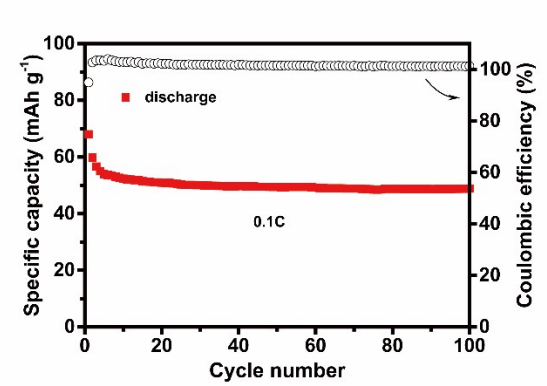

Figure S6. Cycling performance of bare CNTs@VO_2 cathode at a current density of 0.1 C for 100 cycles.

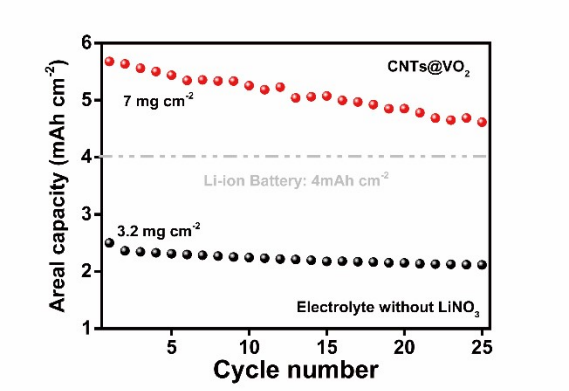

Figure S7. High loading electrodes with the electrolytes without lithium nitrate additions.

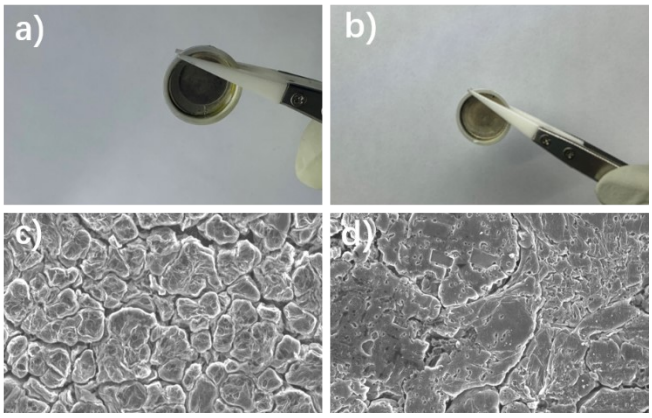

Fig S8. (a) the digital photo of the Li anode after cycling with CNTs modified separator. **(b)** the digital photo of the Li anode after cycling with CNTs@VO_2 modified separator. **(c)** SEM of the Li anode after cycling with CNTs modified separator. **(d)** SEM of the Li anode after cycling with CNTs@VO_2 modified separator.

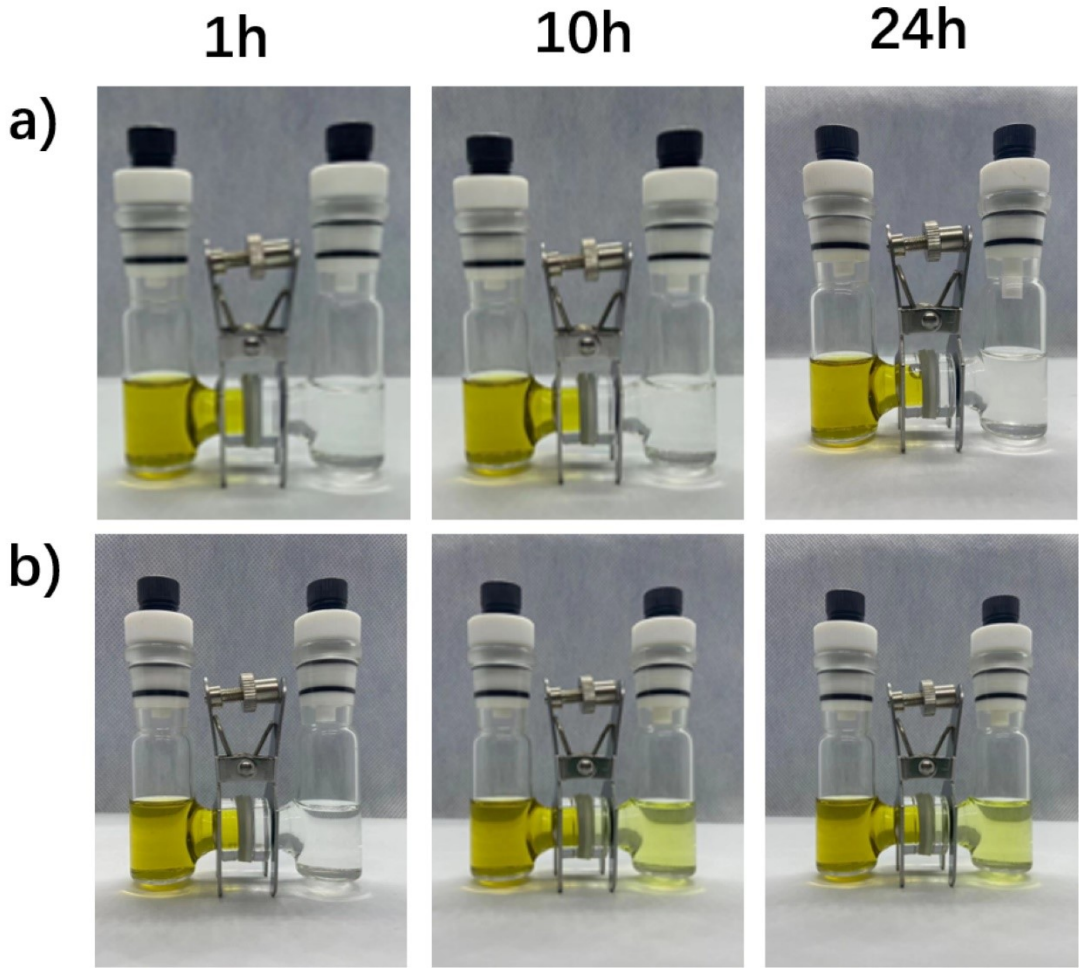

Figure S9. Photographs of proton exchanger with Li_2S_6 in DOL/DME solution and pure DOL/DME solvent in the left and right chambers, respectively. **(a)** CNTs@VO_2 modified separator. **(b)** PP separator.

Sample	Sulfur content (wt%)	Rate (C)	Initial capacity (mAh g^{-1})	Areal capacity (mAh cm^{-2})	Capacity decay (%)	Ref
VO_2/rGo	76.1	0.2	1416	3.35	0.06	1
VO_2 HSs	78	0.1	1084	1.5	0.15	2
VO_2/NCNT	75	0.2	1200	4.8	0.09	3
VO_2/rGo	70	0.2	1200	2.5	0.07	4
VO_2/rGo	76	0.2	1180	2.53	0.12	5
VO_2@NVO	80	0.2	1380	4.5	0.08	6
VO_2@CNTs	78	0.2	1397	5.4	0.08	This work

Table S1. Comparison of Li-S battery performance between CNTs@VO_2 and other works.

1. S. Li, Y. Cen, Q. Xiang, M. K. Aslam, B. Hu, W. Li, Y. Tang, Q. Yu, Y. Liu and C. Chen, *J Mater Chem A*, 2019, DOI: 10.1039/c8ta10422k.
2. L. Zhou, L. Yao, S. Li, J. Zai, S. Li, Q. He, K. He, X. Li, D. Wang and X. Qian, *J Mater Chem A*, 2019, **7**, 3618-3623.
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4. J. Xu, T. Li, W. Zhang, W. Wu, Y. Jin, X. Zhang, D. Su and G. Wang, *J Alloy Compd*, 2019, **804**, 549-553.
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6. Z. Yu, W. Lv, Q. Lin, X. Huang and Y. Yang, *Acs Nano*, 2021, **15**, 16878-16886.