Supporting Information

Capillary-induced self-crumpled and sulfur-deficient MoS_2 nanosheets inhibit polysulfide cycling in lithium-sulfur batteries

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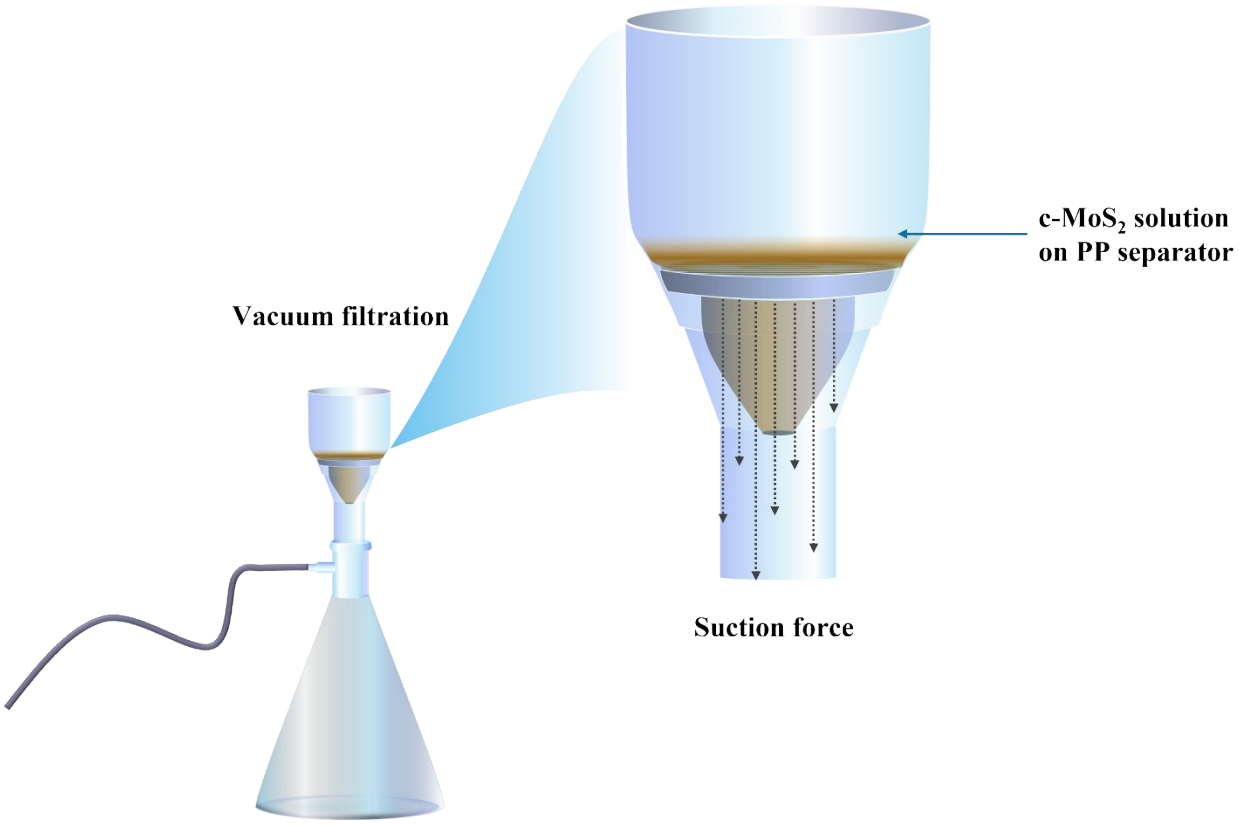

Scheme S1. Schematic representation of c-MoS_2 coating on a PP separator through simple vacuum-filtration.

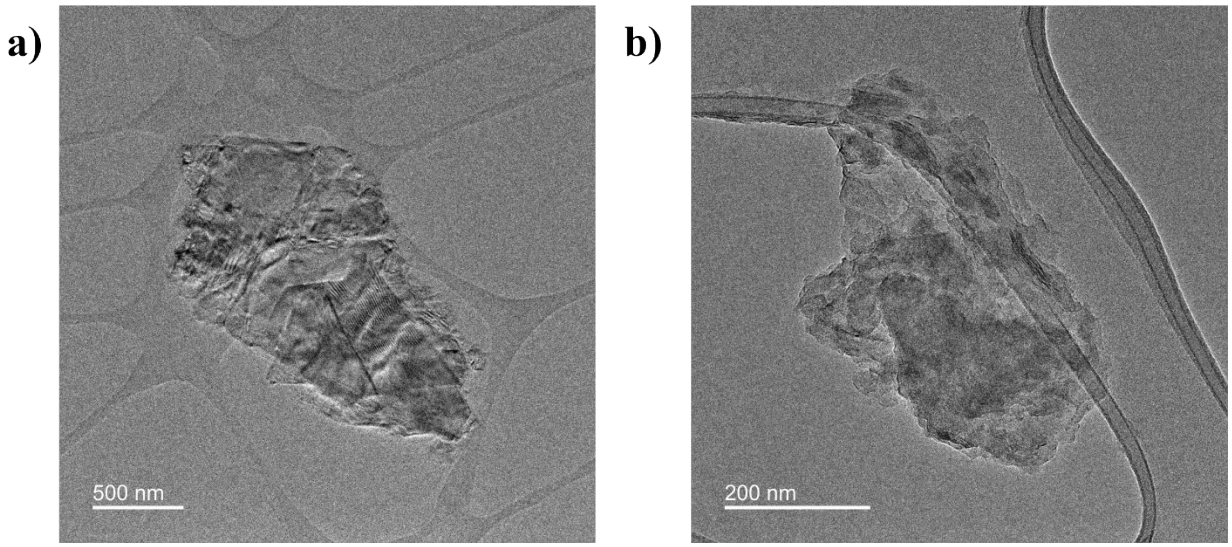

Figure S1. TEM images of **a)** commercial MoS_2 and **b)** ce-MoS_2.

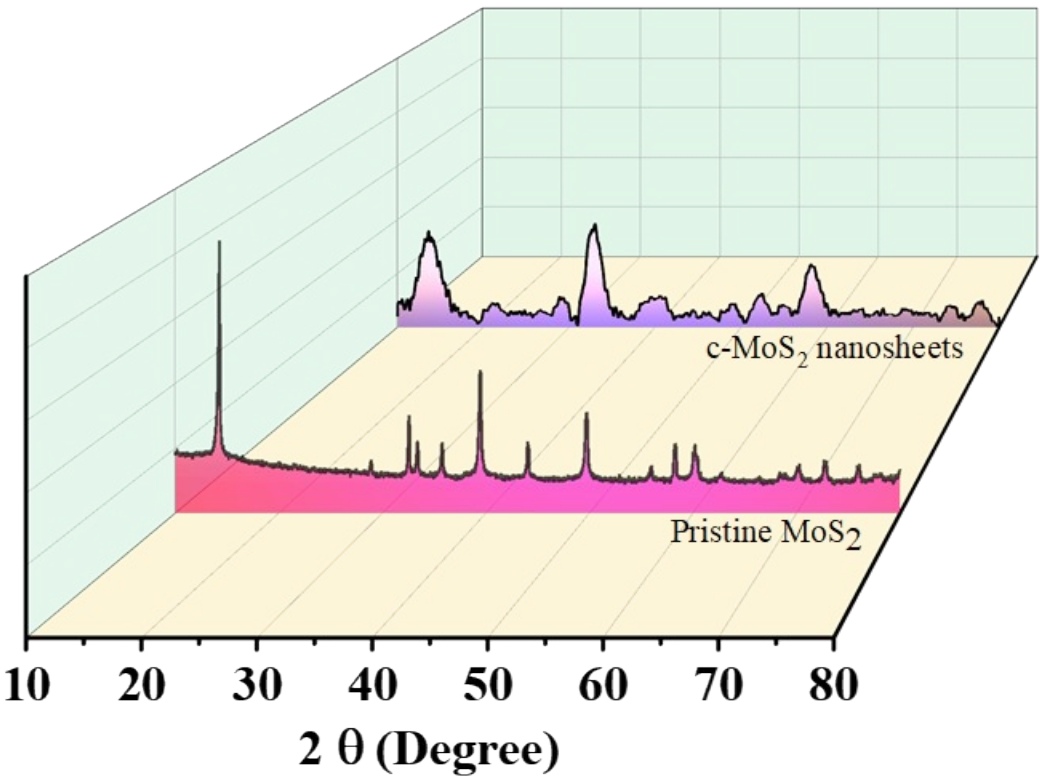

Figure S2. XRD patterns of pristine commercial MoS_2 and c-MoS_2 nanosheets.

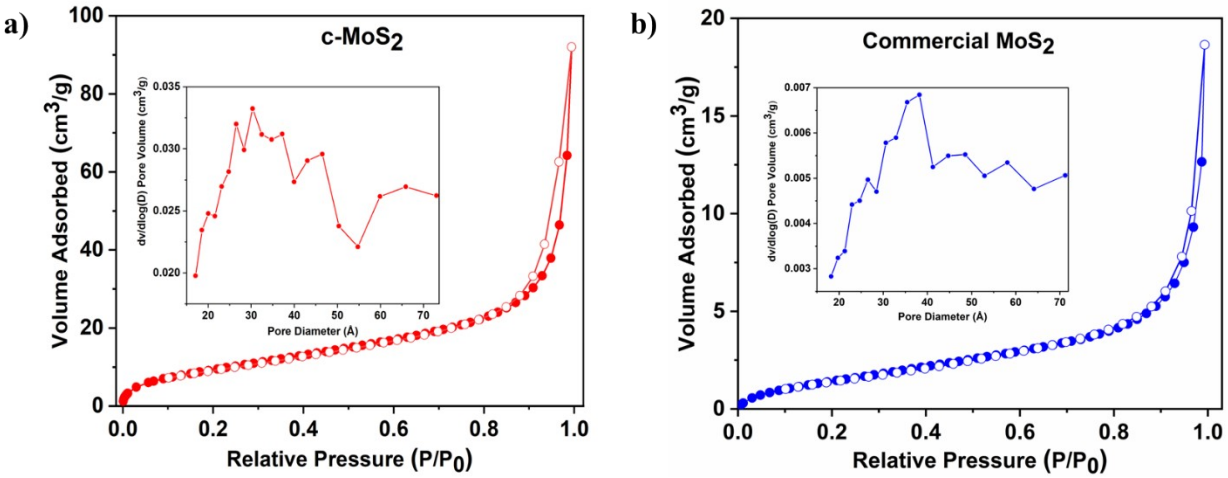

Figure S3: Surface area and pore size distribution of **a)** c-MoS_2 and **b)** Commercial/normal MoS_2.

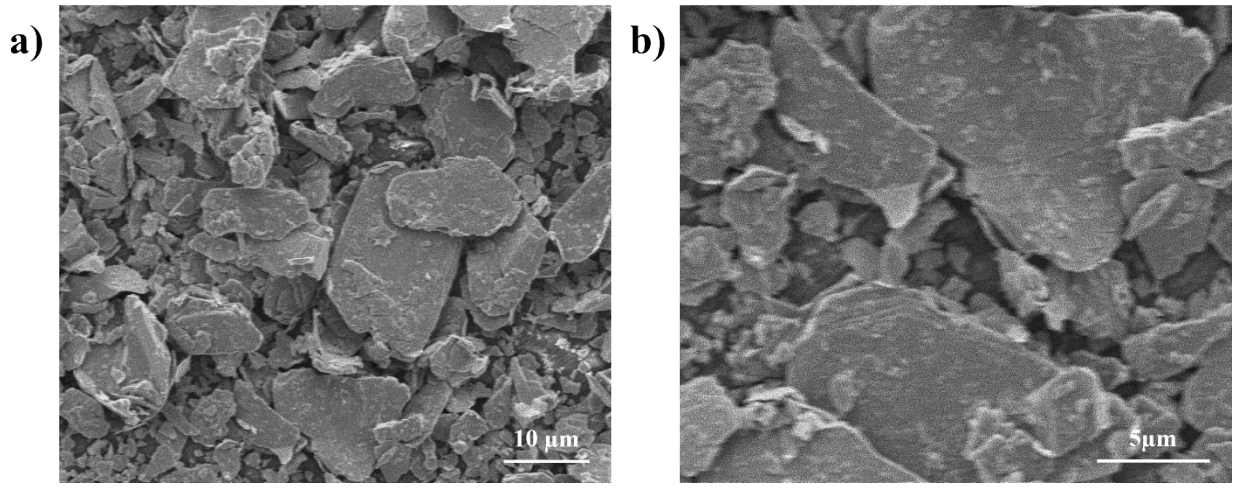

Figure S4. a, b) SEM images of commercial MoS_2, revealing the relatively large sizes of the particles.

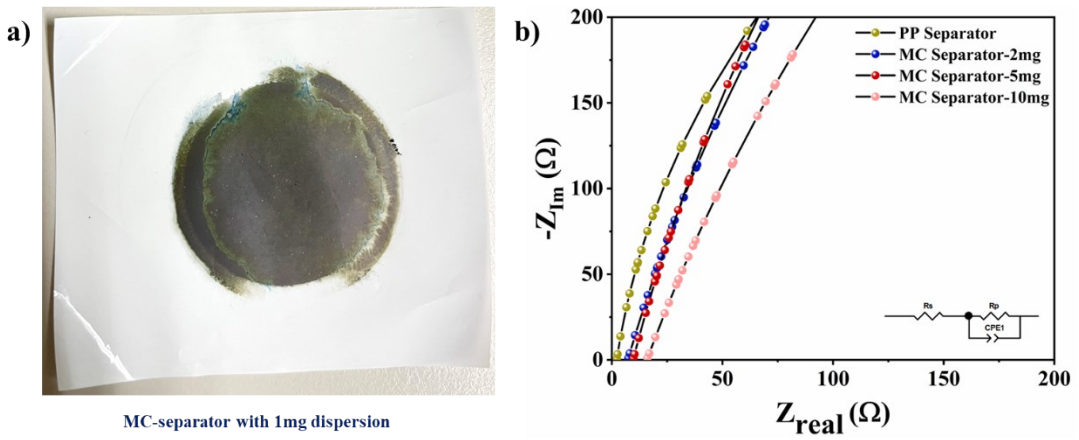

Figure S5. a) A digital photo of the MC-separator with 1mg dispersion. **b)** EIS spectra of SS‖Separator‖SS cell with PP separator, MC separator with 2mg, 5mg, and 10mg dispersion.

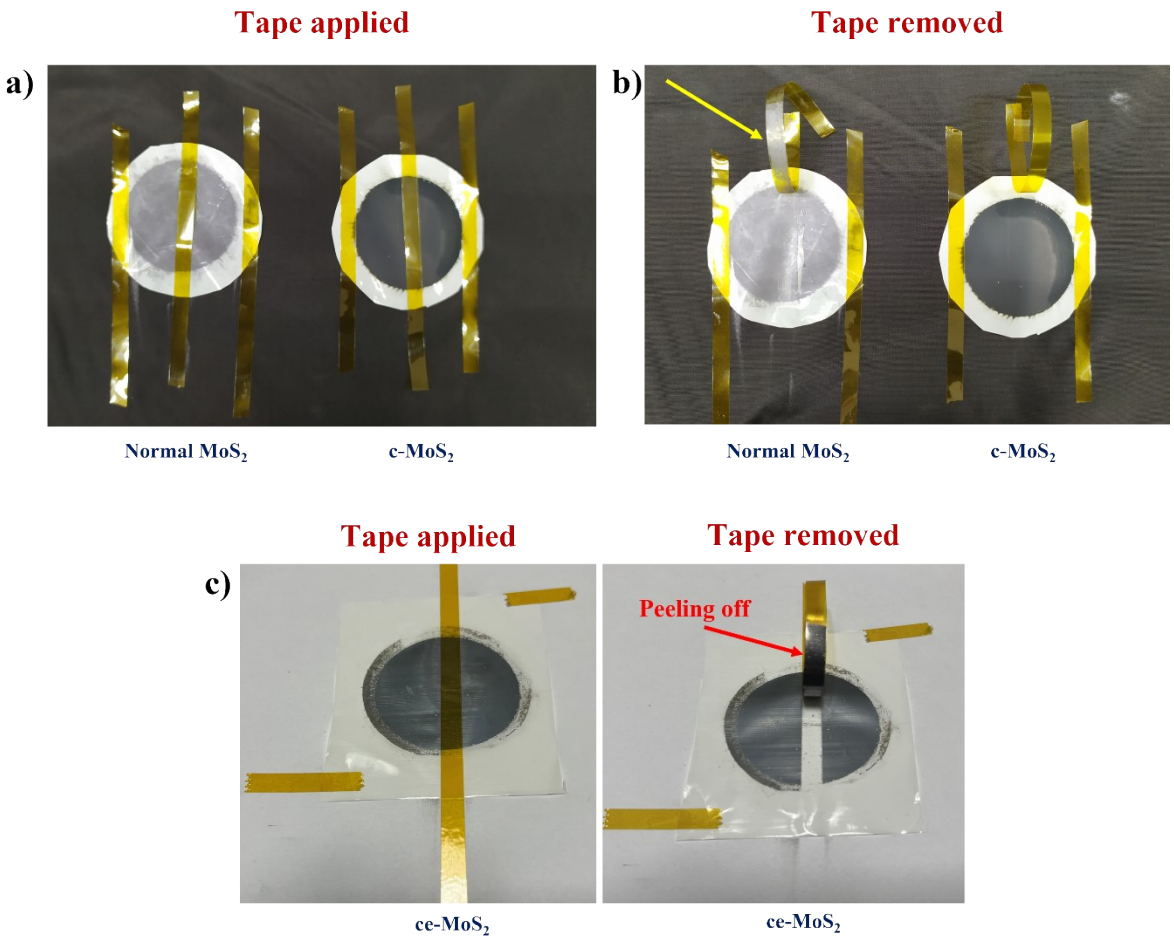

Figure S6. Tape adhesion tests for determining the adhesion strengths of normal/commercial a,b) MoS_2 and c-MoS_2 nanosheets on the PP separator, and c) ce-MoS_2 on the PP separator.

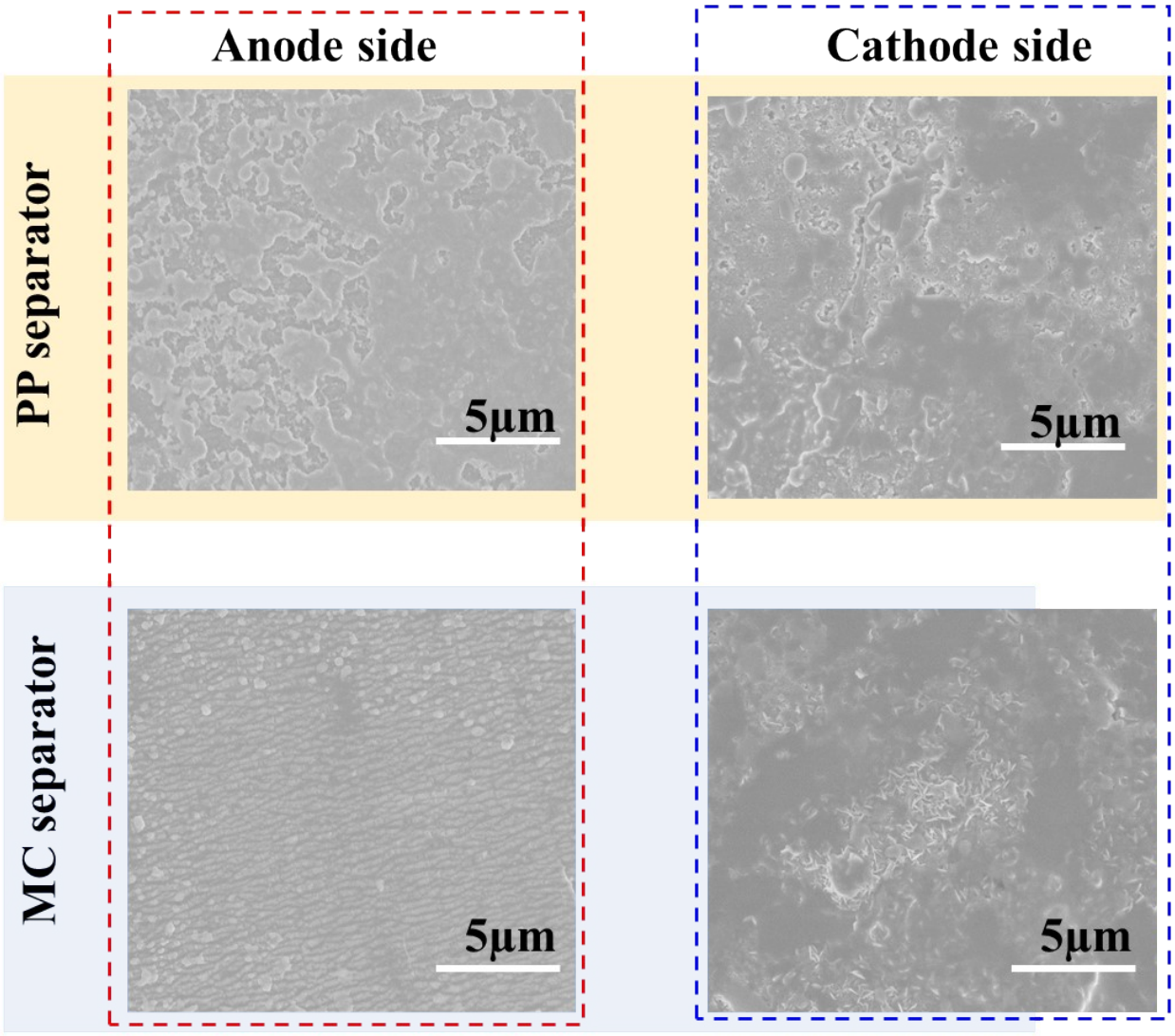

Figure S7. SEM images of the anode- and cathode-facing sides of the PP and MC separators (after 20 cycles).

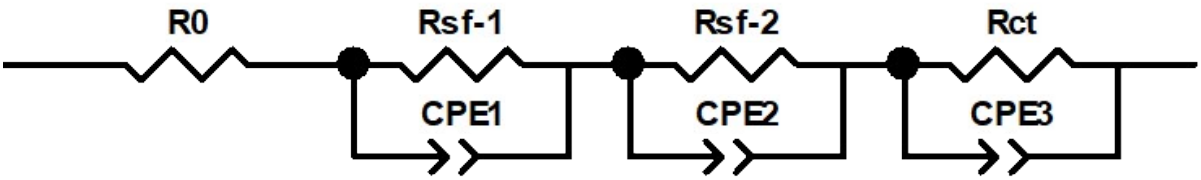

Figure S8. Equivalent circuit model used for EIS fitting.

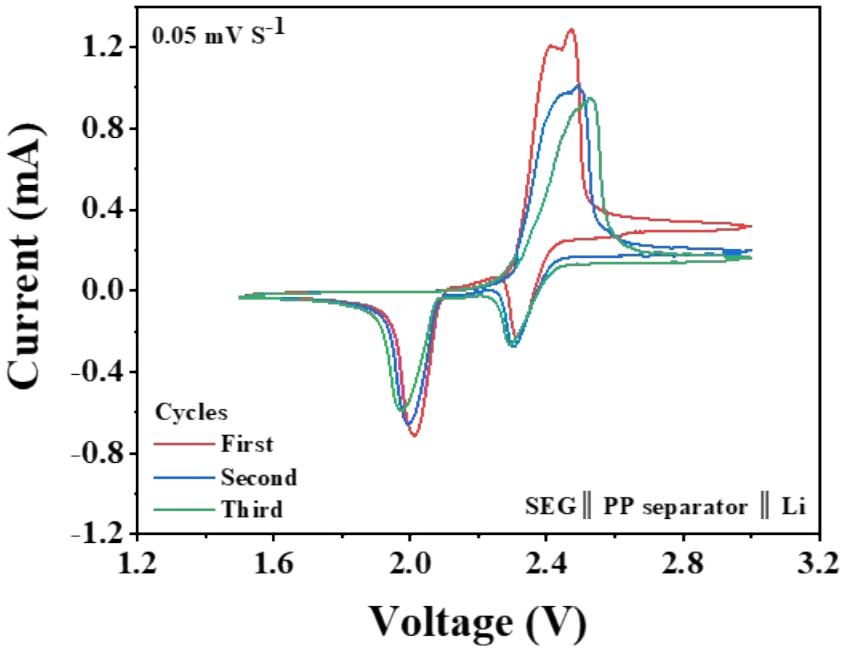

Figure S9. CV traces of an LSB featuring a PP separator, scanned at 0.05 mV s^{-1}.

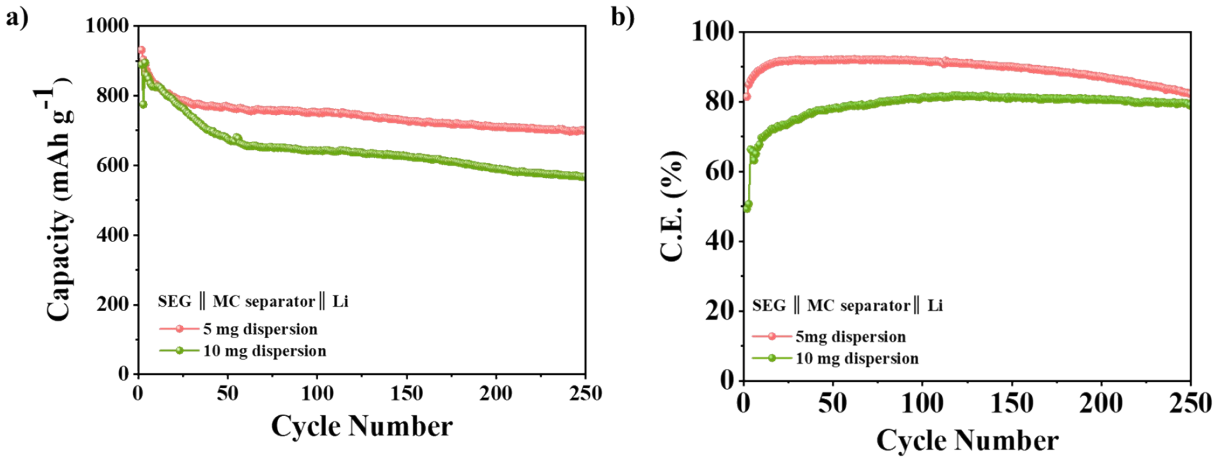

Figure S10. a) Electrochemical performance at 0.5C rate and **b)** CEs of LSBs incorporating MC separators prepared with 5 and 10 mg of the c-MoS_2 dispersion.

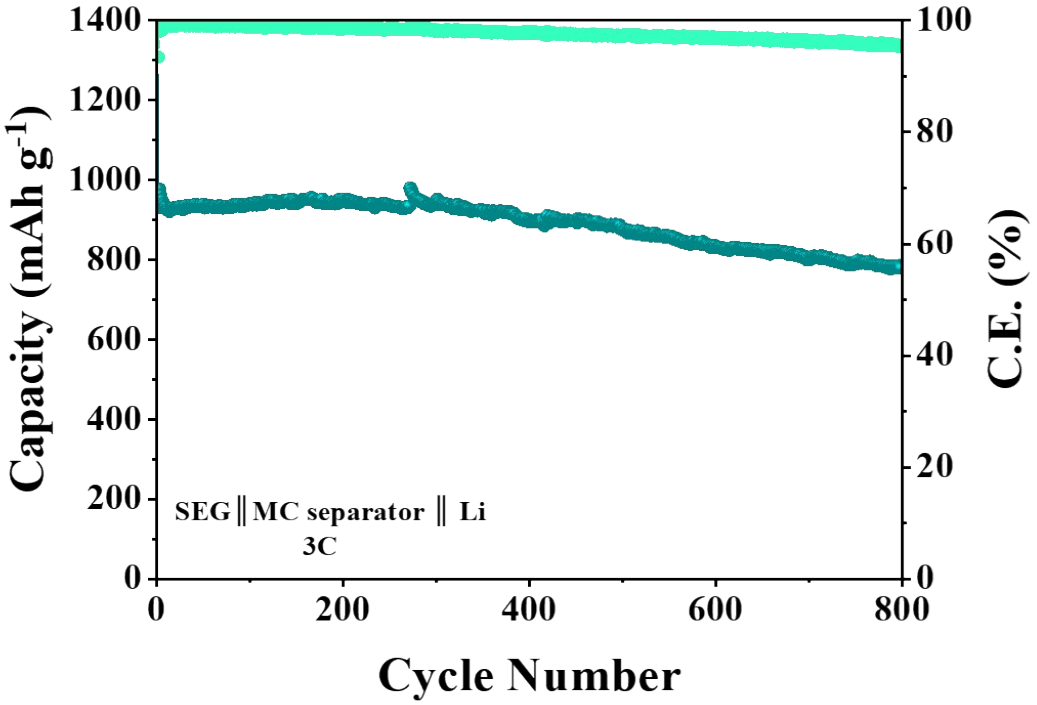

Fig. S11. Electrochemical performance and CE of an LSB incorporating an MC separator (2 mg), recorded at a rate of 3C.

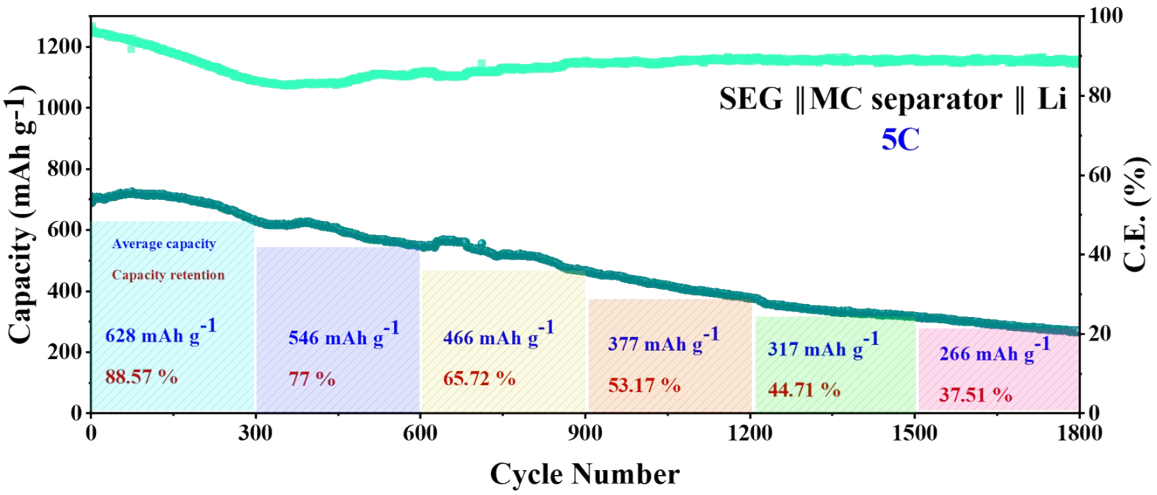

Fig. S12. Electrochemical performance and CE of an LSB incorporating an MC separator (2 mg), recorded at a rate of 5C. Average capacity (values in blue) and capacity retention (values in red) were determined within the highlighted cycle zones.

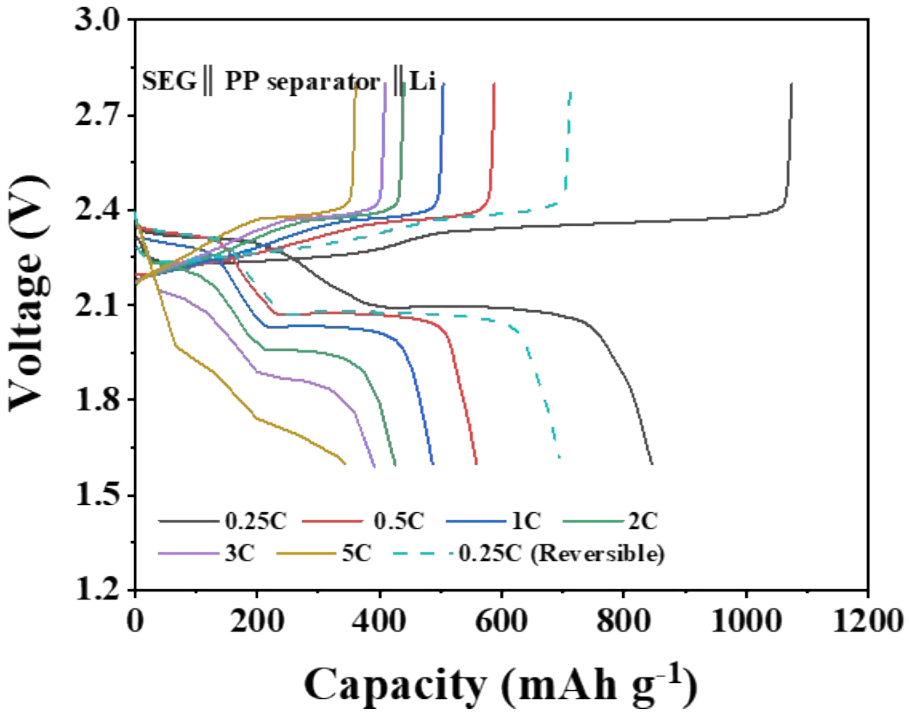

Figure S13. GCD plateaus of LSBs incorporating PP separators, recorded at various C-rates.

Table S1. EIS-determined resistances of PP and MC separators, measured before and after 20 cycles.

Cell (SEG/ separator/ Li)	R_0 (Ω)	R_{sf-1} (Ω)	R_{sf-2} (Ω)	R_{ct} (Ω)
PP separator (Before cycles)	**3.39**	**74.23**	**17.45**	**14.15**
PP separator (After 20 cycles)	**7.43**	**74.15**	**90.63**	**64.62**
MC separator (Before cycles)	**2.9**	**15.77**	**25.2**	**86.1**
MC separator (After 20 cycles)	**2.29**	**4.86**	**13.16**	**7.72**

Table S2. Comparison of electrochemical performance of MC separator with other modified separators.

Separator Design	Sulfur content (%)	Sulfur loading (mg cm^{-2})	Capacity (mAh g^{-1}) and C-rate	Cycle performance	Reference
Ni/NiO-C nanorods coated separator	70	1.2-3.8	~1200, 0.5C	100	1
CeO_2 doped nano porous carbon coated separator	70	1.3	1074, 0.5C ~800, 2C	200 1000	2
SnS_2 modified separator	70	3.1	1040, 0.2C 927, 2C	150 500	3
FeOOH modified separator	80	1.0 -1.5	1149, 0.2C ~720, 1C	100 500	4
CoFe@NC coated separator	70	~1.4	889.9, 0.5C	300	5
Dual-sulfonate COF modified separator	75	1.3-1.5	795, 1C	800	6
Crumpled MXene/MoS_2 modified separator	60	~2	1336, 0.1C 810, 1C	100 500	7
Ni-WS_2@rGO	80	1.0-1.44	1160, 0.2C 943.7, 1C	100 500	8
MoS_2/Celgard	65	N/A	808, 0.5C	600	9
Crumpled MoS_2 (c-MoS_2) coated separator	*70*	*1.5-2*	*1242, 0.5C* *1034, 1C* *930, 3C* *709, 5C*	*500* *500* *750* *1800*	*This work*

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