

Supporting Information

Systematic Exploration of the Role of a Modified Layer on the Separator in the Electrochemistry of Lithium-Sulfur Batteries

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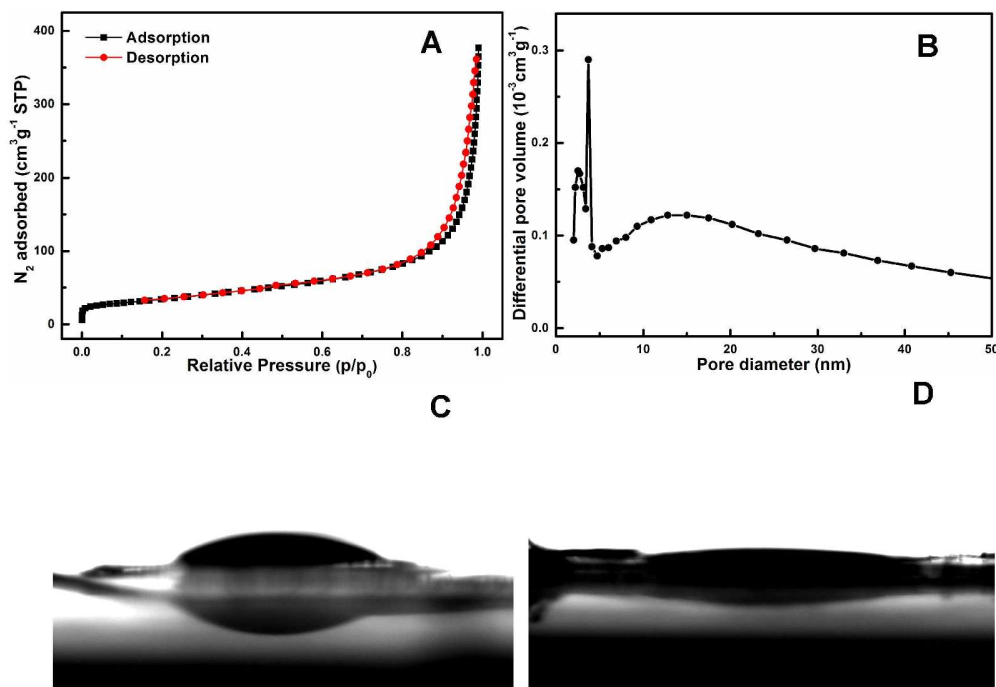


Figure S1. (A,B) N₂ adsorption-desorption isotherms and the corresponding pore size distribution of the mixture of AB/MWCNs. (C,D) the contact angle images of the electrolyte on AB/MWCNs modified separator (MS-300) and PP separator.

Note: In the range of low relative pressure, a remarkable absorption is visible resulting from the micropores. Another phenomenon is hysteresis in high relative pressure region, ascribed to the capillary condensation of mesopores. The pore size distribution curve in Figure S1B shows that the pore structure is mainly composed of micropores and mesopores caused by the accumulation of AB particles and MWCNs. After calculation, the BET surface area and pore volume are determined to be 116.9 m²/g and 0.58 cm³/g, respectively. Figure S1C,D describes the contact angle of the ether electrolyte on AB/MWCNs modified separator and pp separator. Upon dripping on the MS-300, the electrolyte immediately infiltrated, while the remarkable droplet can be observable with a contact angle of 48°. The better infiltration of electrolyte mainly resulted from such structures with mesopores and macropores.

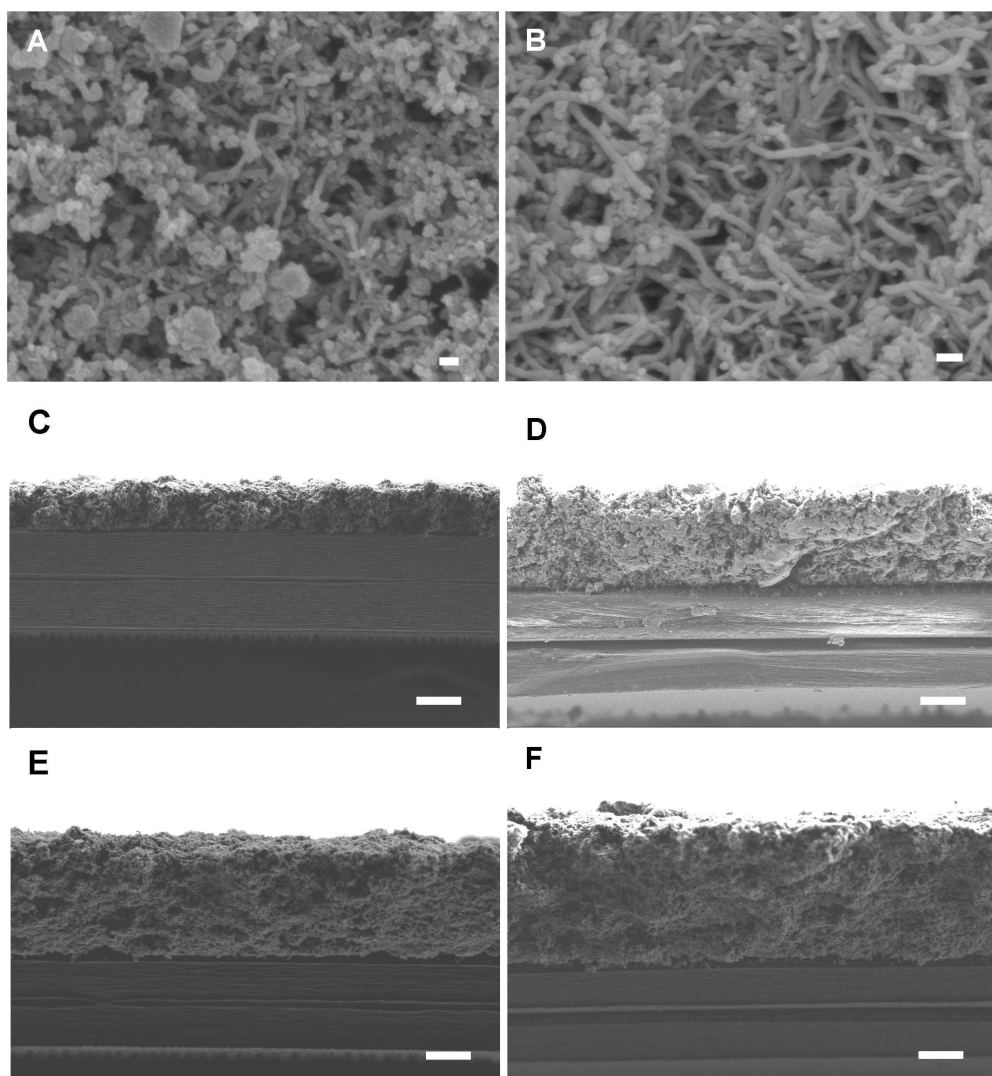


Figure S2. FESEM images of AB/MWCNs modified separators: (A,B) the top view and the cross section of (C) MS-100, 11 μm (D) MS-200, 23 μm (E) MS-300 28 μm and (F) MS-400 (35 μm). Scale bar: (A,B) 100 nm, (C-F) 10 μm .

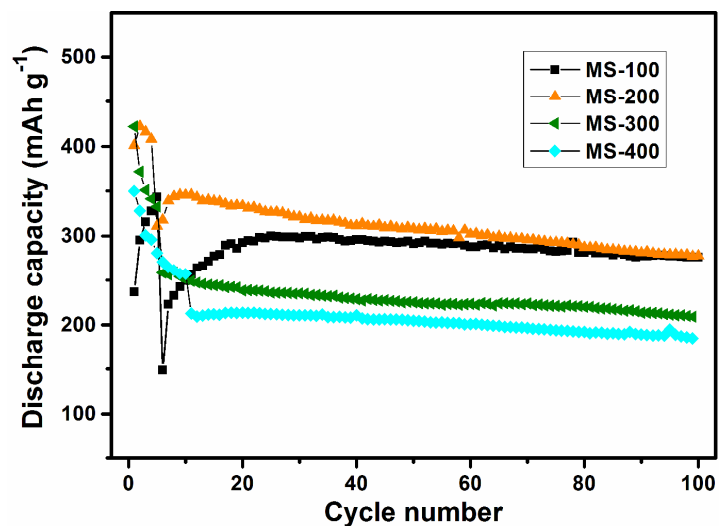


Figure S3. The discharge capacity plot based on the total weight of the sulfur cathode and the coating layer of AB/MWCNs.

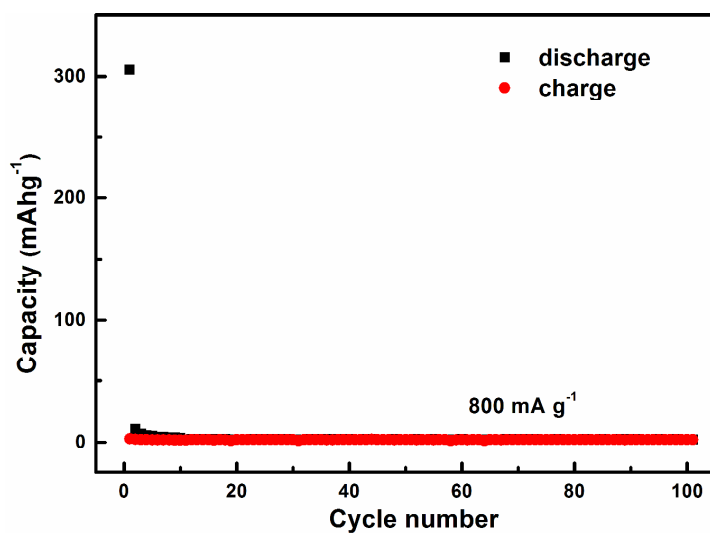


Figure S4. Cycling performance of a cell with original aluminum foil as cathode, MS-300 as separator and lithium as counter electrode at a current density of 800 mA g⁻¹.

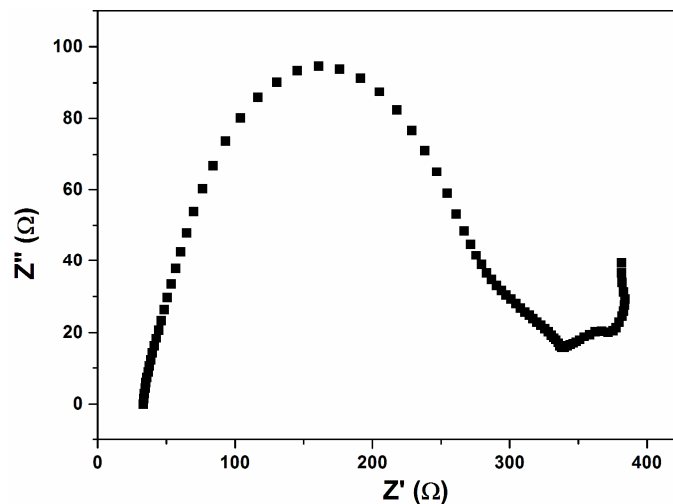


Figure S5. EIS curve of cells after 3 cycles at a current density of 800 mA g^{-1} with original PP membrane.

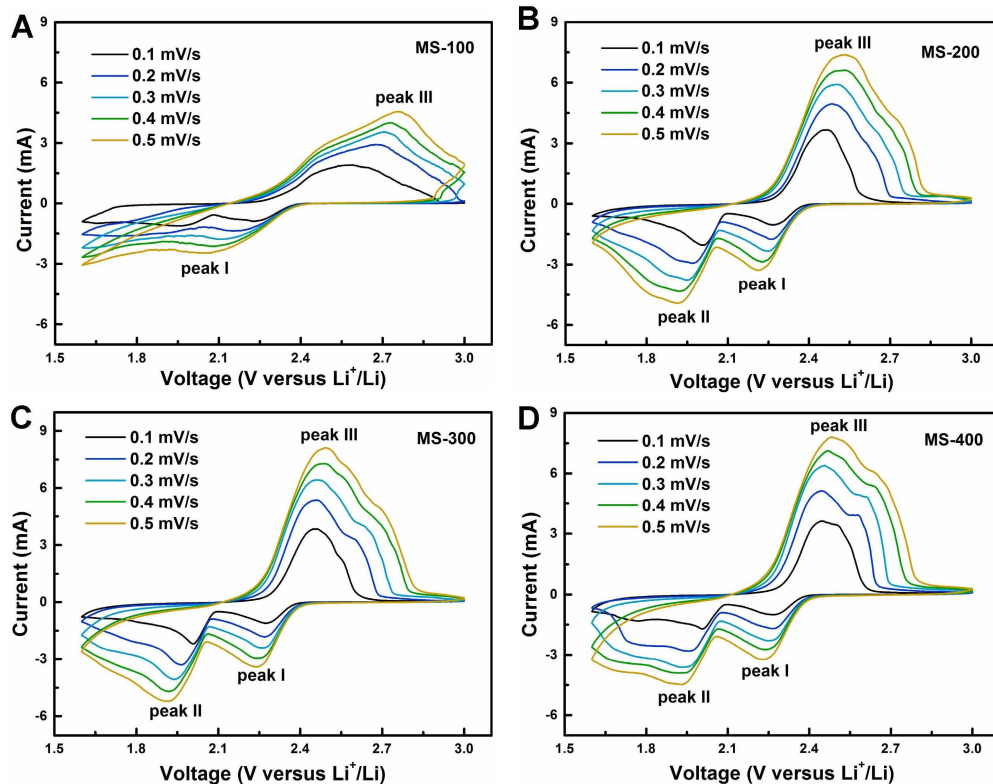


Figure S6. CV curves of cells with (a) MS-100, (b) MS-200, (c) MS-300 and (d) MS-400 at scanning speeds from 0.1 to 0.5 mV/S with the potential range of 1.6-3.1 V versus Li^+/Li .

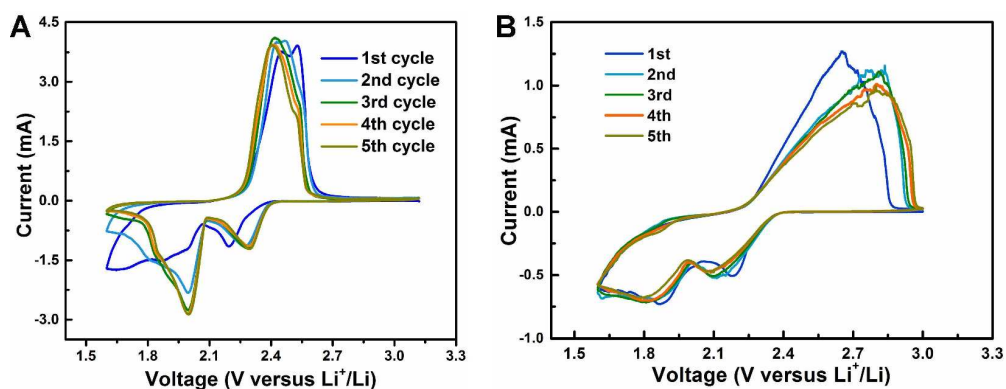


Figure S7. CV curves of cells with MS-300 (A) and original PP (B) membrane for the first 5 cycles at a scanning rate of 0.1 mV/S within the potential range of 1.6-3.1 V versus Li^+/Li .

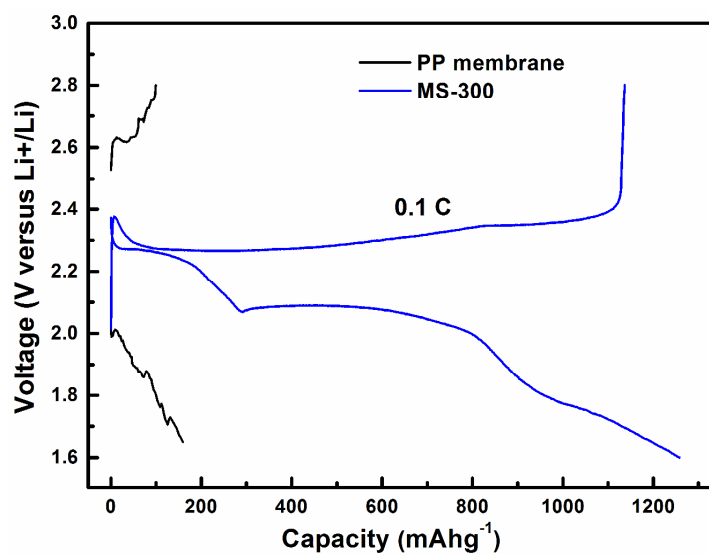


Figure S8. The galvanic charge-discharge voltage curves of sulfur cathodes for the first cycle at a current rate of 0.1C with PP membrane and MS-300.

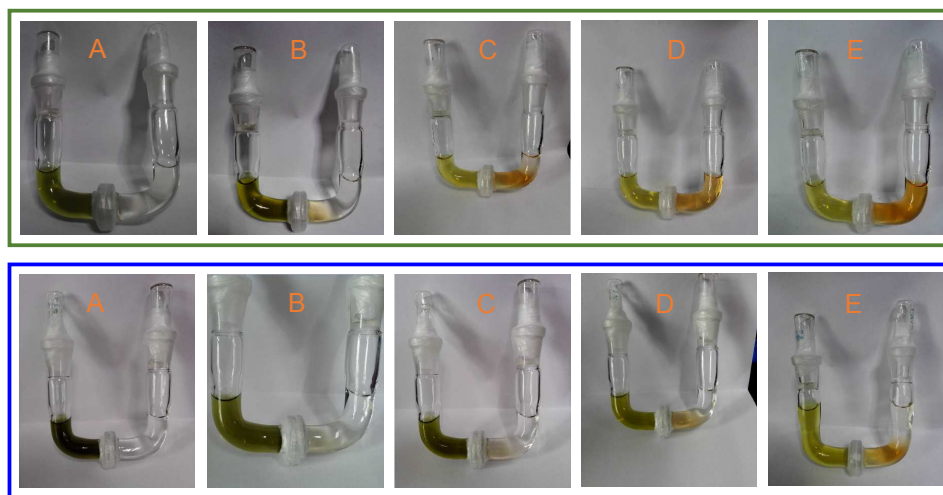


Figure S9. The polysulfide permeation test with (top) pp membrane and (bottom) MS-300: (A) 0, (B) 2 h, (C) 6 h, (D) 12 h, (E) 24 h.

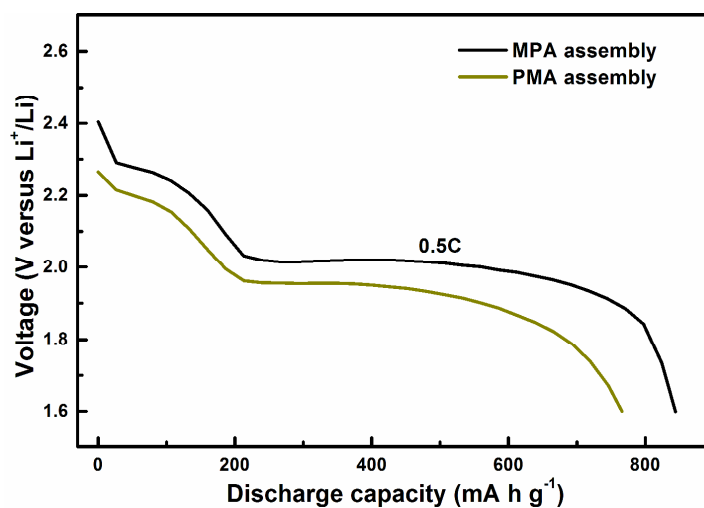


Figure 10. Galvanostatic discharge voltage profile at the current rate of 0.5 C of sulfur cathodes in MPA and PMA with MS-300 with 1.6-2.8 V versus Li⁺/Li.

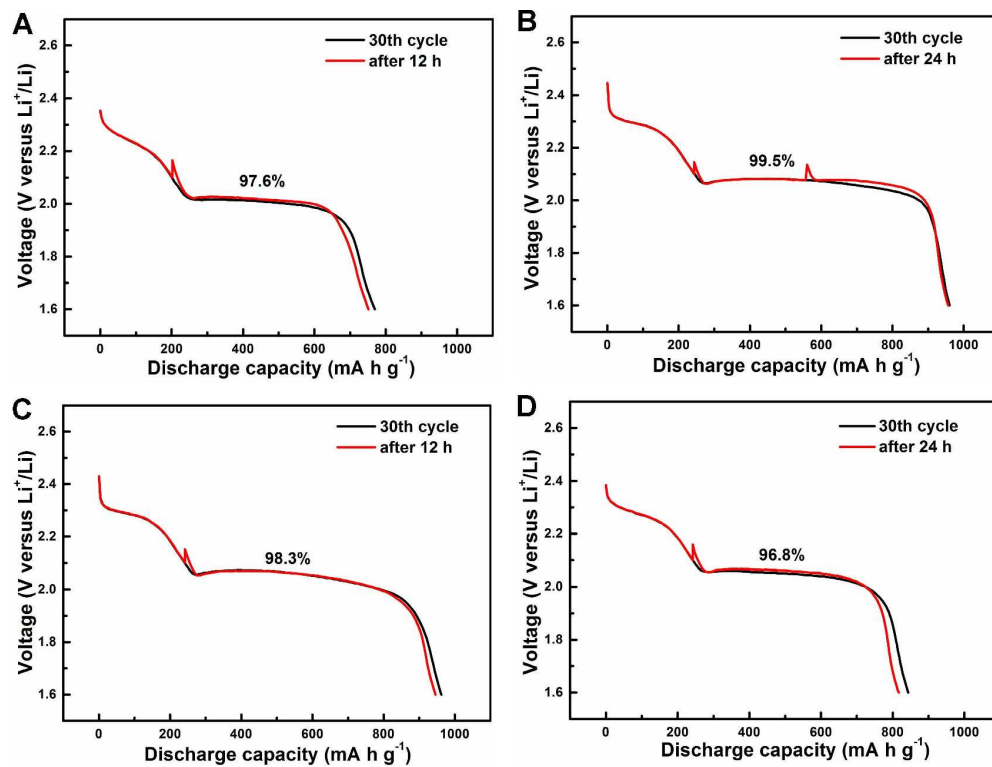


Figure S11. The galvanic charge-discharge curves of Li-S cells cycling at 800 mA g^{-1} for 20 cycle to stay for 12 h and 24 h with (A,B) MS-100 and (C,D) MS-200.

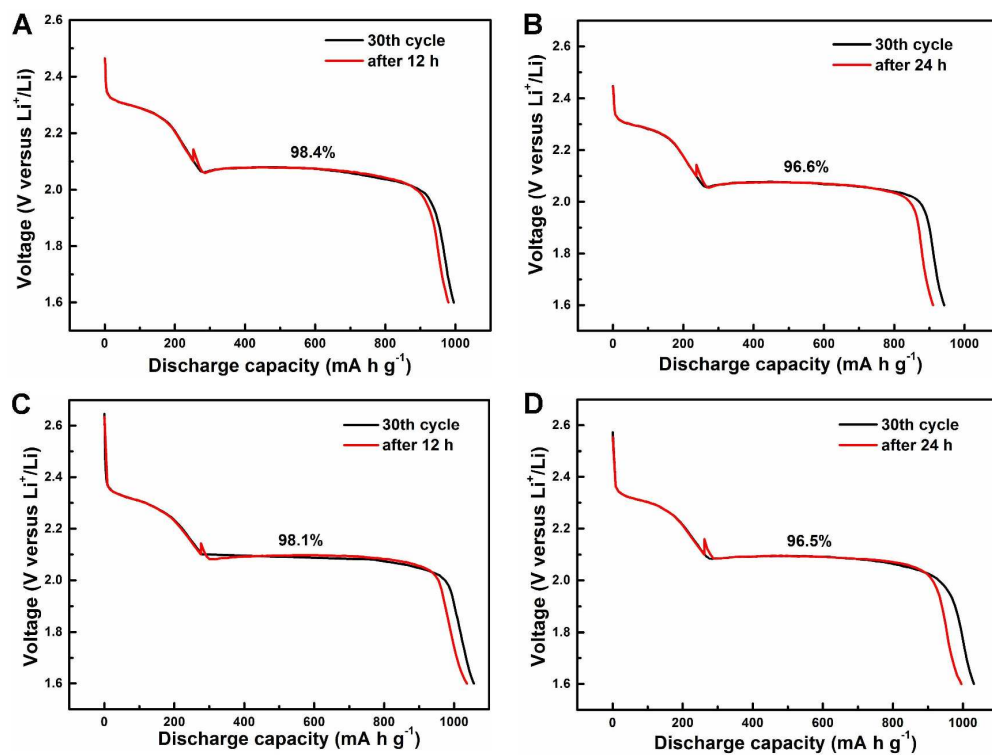


Figure S12. The galvanic charge-discharge curves of Li-S cells cycling at 800 mA g^{-1} for 20 cycle to stay for 12 h and 24 h with (A,B) MS-300 and (C,D) MS-400.

Table S1. Diffusion coefficient of Li⁺ (D_{Li+}) with different separators.

Calculation of the diffusion coefficient of lithium ions (D_{Li+}):

$$I_p = 2.69 \times 10^5 n^{1.5} A D_{Li+}^{0.5} C_{Li+} \nu^{0.5}$$

in which I_p (A) is the peak current, and n is the number of electrons in the reaction involved ($n = 2$, here), A indicates the electrode area (1.2 cm^2 , here), C_{Li+} (mol mL^{-1}) represents the lithium ion concentration, and ν means the scanning rate (V s^{-1}).

Separator	D _{Li+} ($10^8 \text{ cm}^2 \text{ S}^{-1}$)		
	Peak I	Peak II	Peak III
MS-100	2.19	-	5.95
MS-200	4.49	7.37	12.07
MS-300	4.75	8.07	16.00
MS-400	4.34	6.45	15.70