ELECTRONIC SUPPLEMENTARY INFORMATION

Functional SrF$_2$ Coated Separator Enabling Robust and Dendrite-Free Solid Electrolyte Interphase on Lithium Metal Anode

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Figure S1. (a), (b) SEM images of the as-synthesized SrF$_2$ microspheres, taken at different magnifications (scale bars on bottom right).
Figure S1 cont. (c) XRD pattern of the as-synthesized SrF$_2$ microspheres.

Figure S2. SEM images for (a) the pristine PP separator and (b) the SrF$_2$ microspheres coated PP separator.
Figure S3. (a), (c) \( \text{N}_2 \) isotherm absorption-desorption curves of pristine and \( \text{SrF}_2 \) coated separator. (b), (d) Pore size distribution of pristine and \( \text{SrF}_2 \) coated separator.

Figure S4. (a) Expanded potential-time plots of the Li||Li cells using, (b) pristine separator, and (c), (d) \( \text{SrF}_2 \) coated separator.
Figure S5. (a) Cycling performance of Li||NCM cells with pristine and SrF$_2$ modified separators. Tested at a current density of 400 mA/g (2C) at an elevated temperature of 60 °C. (a) and (c) The galvanostatic charge-discharge data from which (a) was derived.
Figure S6. SEM images of the cross-sections of the post cycled Li metal anodes from Li||NCM cells (a) - (e) pristine separator, (f) - (j) SrF$_2$ coated separator. Samples are shown at 20$^{th}$, 40$^{th}$, 80$^{th}$, 160$^{th}$ and 200$^{th}$ cycles, tested at 200 mA/g for 2 hrs. per cycle.
Figure S7. Top-down (a) - (b) and cross-section (c) - (d) SEM images of the formed SEI morphologies of Li metal anodes from Li||NCM cells using the (a), (c) of pristine separator and (b), (d) of SrF$_2$ coated separator after 200 cycles at 400 mA/g (2C) and 60 °C.
Figure S8. (a) Pristine PP separator uncycled. (b) SrF$_2$ coated separator, uncycled. (c) Post-cycled Li metal anode with pristine. (d) Post-cycled Li anode with SrF$_2$ coated. (e) Post-cycled pristine separator. (f) Post-cycled SrF$_2$ coated separator.

Figure S9. (a) Nyquist plots of Li||NMC coin cells, comparing pristine and SrF$_2$ coated separators at the 100$^{th}$ cycle, tested at 400 mA/g for 1 h per cycle, and 60°C. The impedance spectra were collected at charged state of 4.1 V. (b) and (c) Enlarged view of the high-frequency region as labeled by the green rectangles.
Figure S10. XPS survey spectra for the Li metal anodes under different Li deposition times at 20 mA/g (C/10) for 1h, 2h, 4h, 8h and 10h, corresponding to total 20, 40, 80, 160 and 200 mAh/g, respectively using (a) - (e) the pristine separator, and (f) - (j) the SrF$_2$ coated separator.
Supplementary Figure S11. XPS survey spectra for the Li metal anodes under different electrochemical cycles of 20, 40, 80, 160 and 200 at 200 mA/g (1C) using (a) – (e) the pristine separator, and (f) – (j) the SrF$_2$ coated separator.
Figure S12. High resolution C1s spectra for the Li metal anodes under different Li deposition times of 1 h, 2 h, 4 h, 8 h and 10 h using (a) – (e) the pristine separator, and (f) – (j) SrF$_2$ coated separator. High resolution C1s spectra under different cycles of 20, 40, 80, 160 and 200 for using (k) – (o) the pristine separator, and (p) – (t) the SrF$_2$ coated separator.
Figure S13. High resolution O1s spectra for the Li metal anodes under different Li deposition times of 1 h, 2 h, 4 h, 8 h and 10 h using (a) – (e) the pristine PP separator, and (f) – (j) the SrF$_2$ coated PP separator. High resolution O1s spectra under different cycles of 20, 40, 80, 160 and 200 for using (k) – (o) the pristine separator, and (p) – (t) SrF$_2$ coated separator.
Figure S14. (a) - (f) and (a') - (f') High – resolution XPS spectra for post-cycled Li metal anodes with pristine vs. SrF$_2$ modified separator. (a) - (i) Testing conditions are the same as in Fig. 3, 20 mA g$^{-1}$ for 2h and 10h. (a') – (i') Tested for 40 and 160 cycles at 200 mA g$^{-1}$ for 2 hrs. (a, a') – (b, b') and (c, c') – (d, d') F1s spectra for baseline and SrF$_2$ coated, (e, e') – (f, f') Sr3d spectra for SrF$_2$ coated.
Figure S15. High resolution Sr3d spectrum for the as-prepared SrF$_2$ sample.