

Growing single-crystalline seeds on lithiophobic substrates to enable fast-charging lithium-metal batteries

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Supplementary Information

Supplementary Figure 1-27

Supplementary Table 1

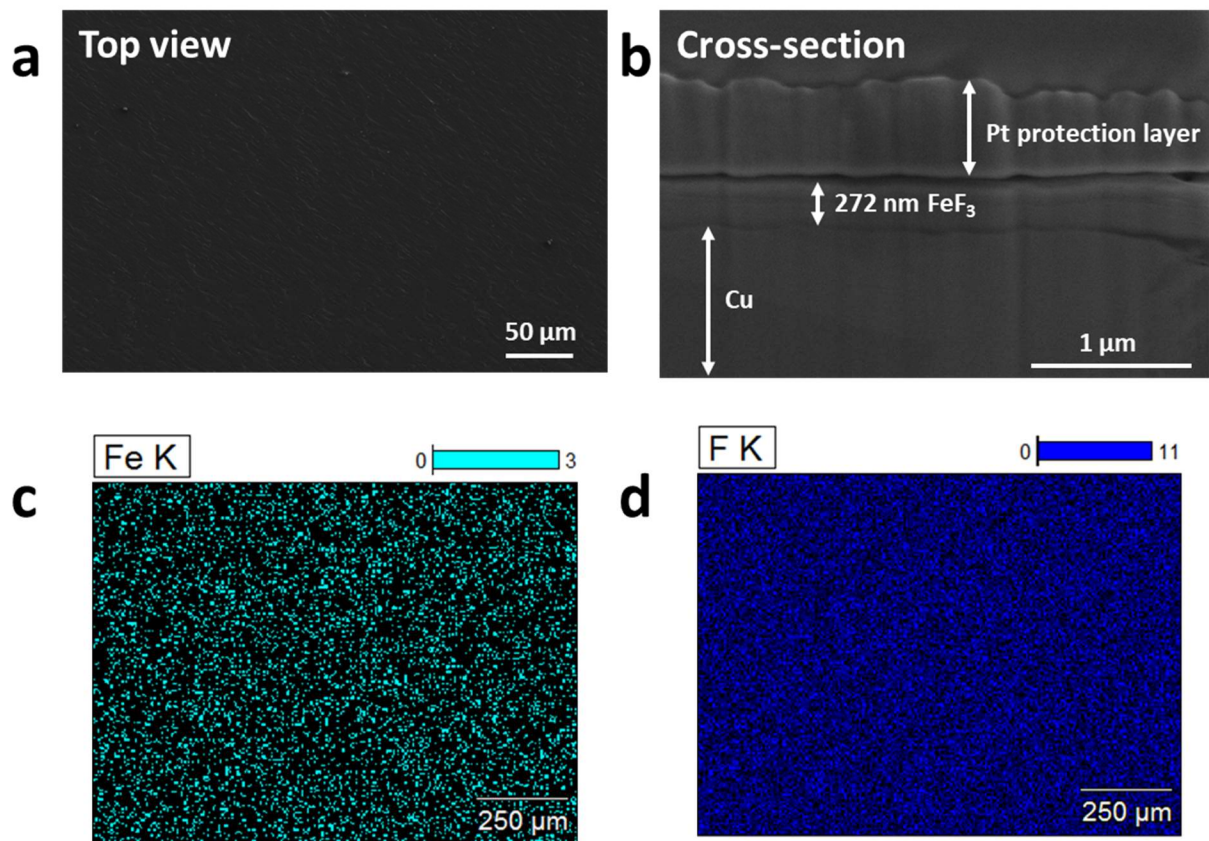


Figure S1. Morphological characterization of FeF_3 film. a, Top view SEM image of FeF_3 film. b, Cross-sectional image of FeF_3 by FIB-SEM. Energy dispersive X-ray spectroscopy (EDS) of FeF_3 film, c, Fe distribution, d, F distribution.

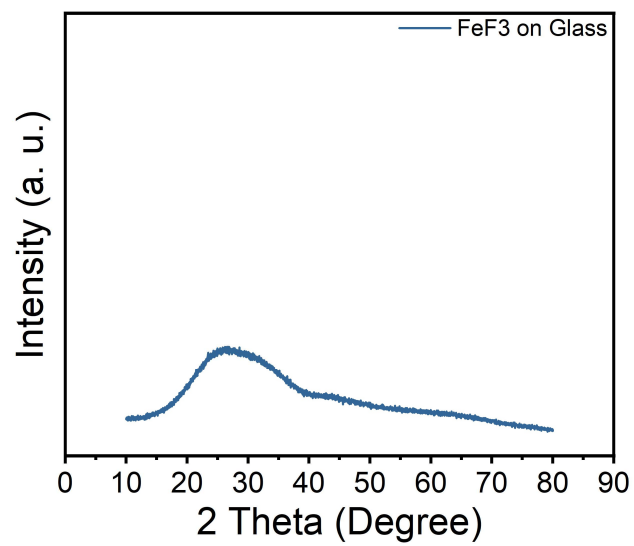


Figure S2. X-ray diffraction pattern of FeF₃ on glass prepared by thermal evaporation.

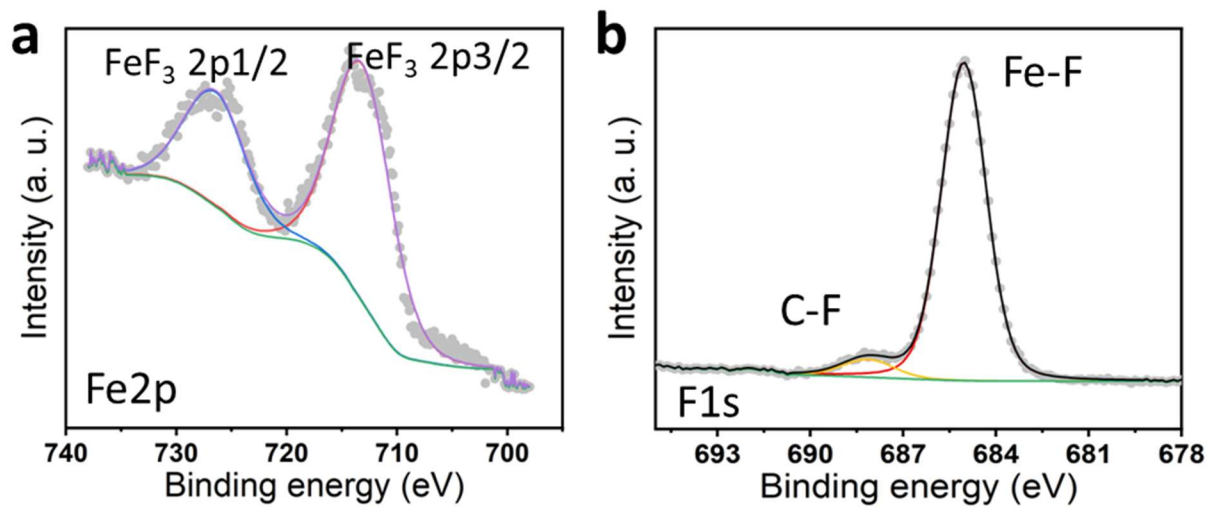


Figure S3. X-ray photoelectron spectroscopy of FeF₃ film. a, Fe2p spectra. b, F1s spectra.

Table S1. Elemental ratio between Fe, F, C, and O.

Elements	Atomic ratio
Fe	13.27
F	36.94
C	29.28
O	20.51

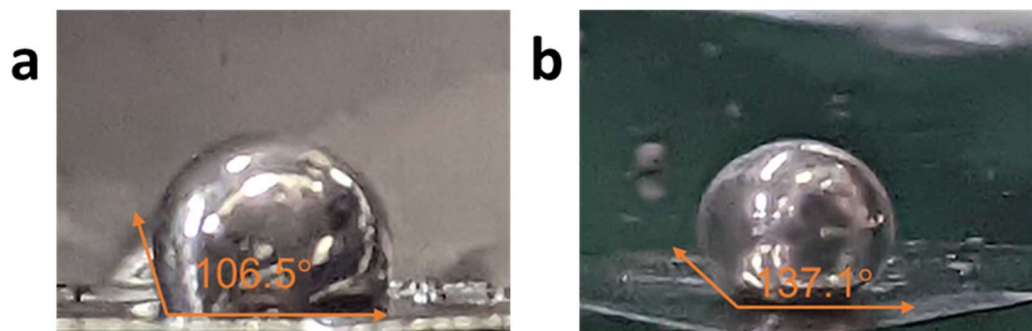


Figure S4. Contact angle between molten Li and different metal substrates. a, Stainless steel; b, Ti.

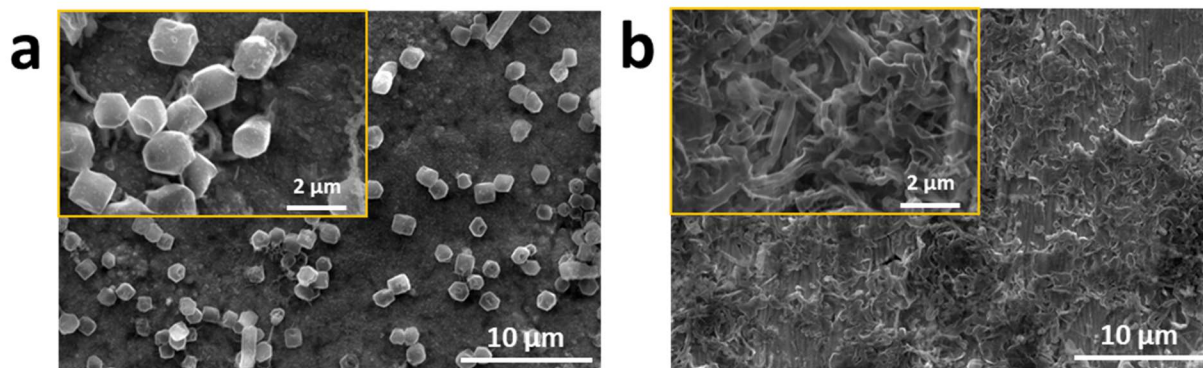


Figure S5. SEM images of 0.1 mAh cm⁻² Li deposited on a, Fe/LiF nanocomposite, b, Cu, under 1 mA cm⁻².

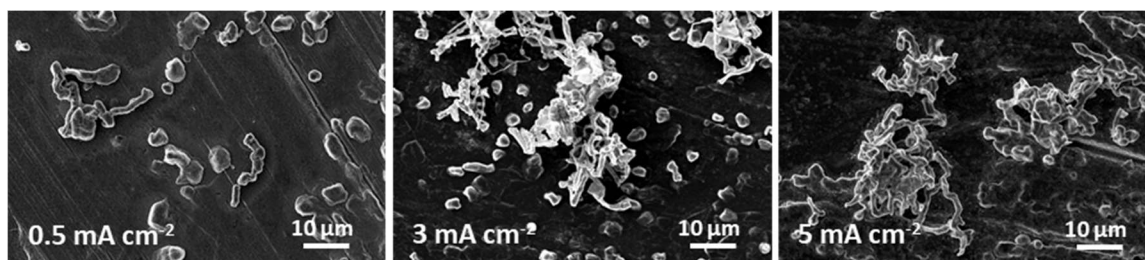


Figure S6. SEM images of 0.1 mAh cm^{-2} Li deposited on a Li foil under different current densities.

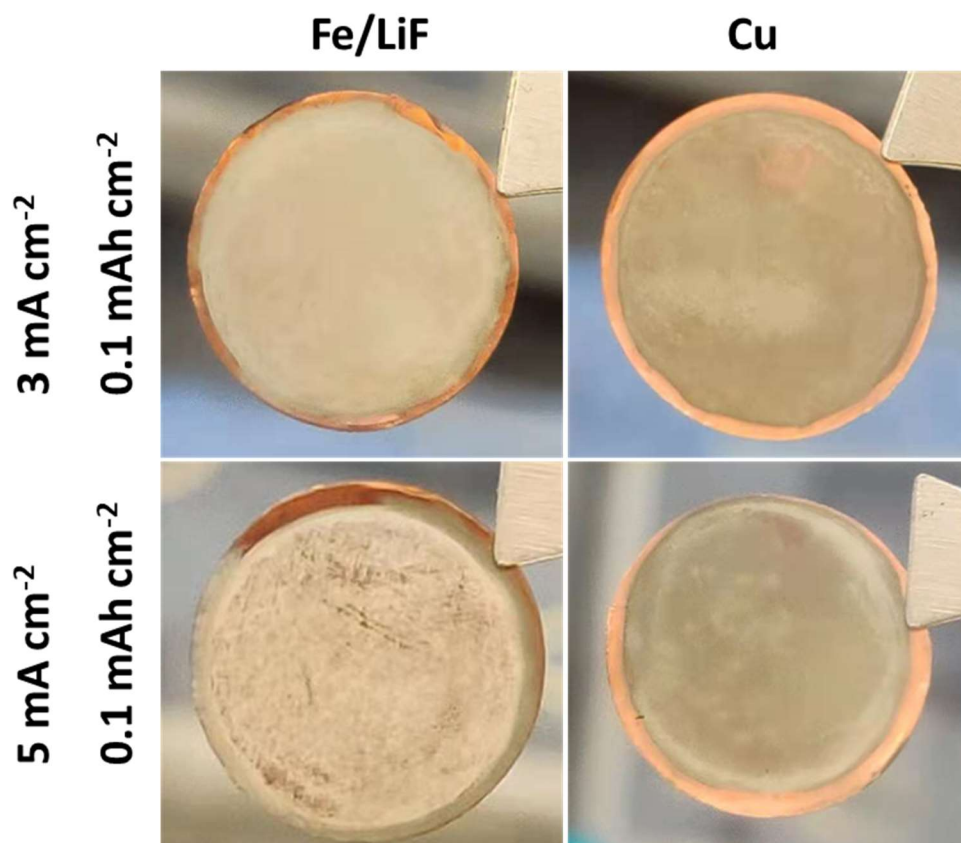


Figure S7. Optical images of 0.1 mAh cm^{-2} Li deposited on different substrates, under different current densities.

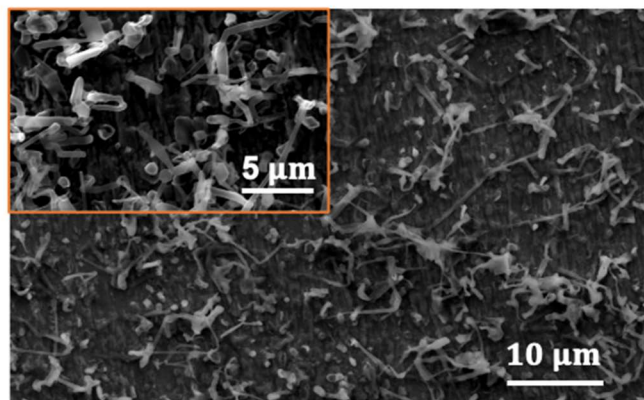


Figure S8. SEM images of 0.1 mAh cm^{-2} Li deposited on Fe_2O_3 , under 3.0 mA cm^{-2} .

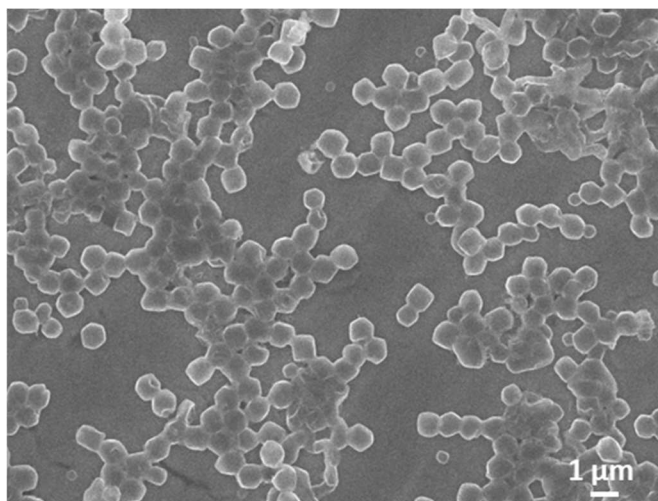


Figure S9. $0.1\text{mAh}/\text{cm}^2$ Li Deposited on Fe/LiF @Ti foil, at a current density of $3\text{mA}/\text{cm}^2$.



Figure S10. A large field-of-view dark-field TEM image of the substrate after reactions.

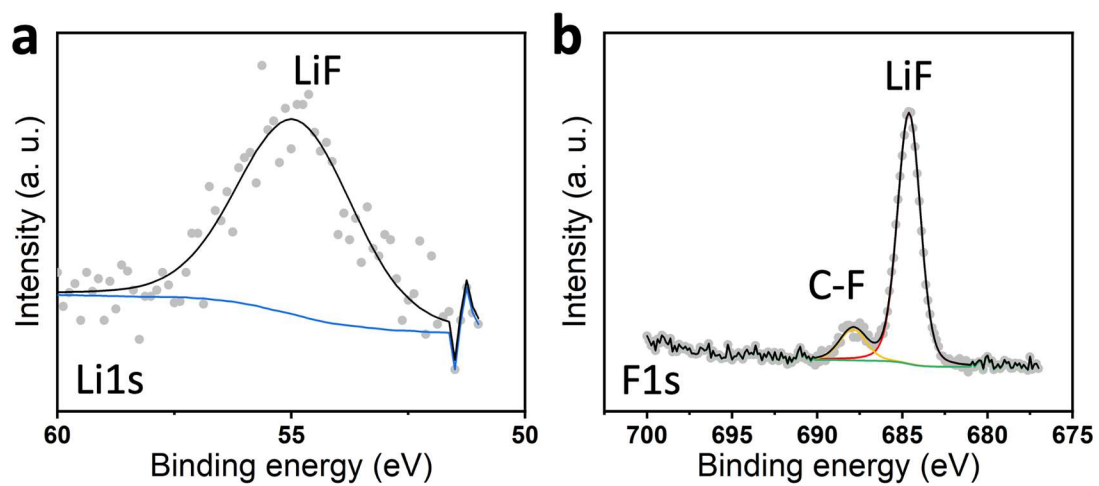


Figure S11. X-ray photoelectron spectroscopy of Fe/LiF film. a, Li 1s spectra. b, F 1s spectra.

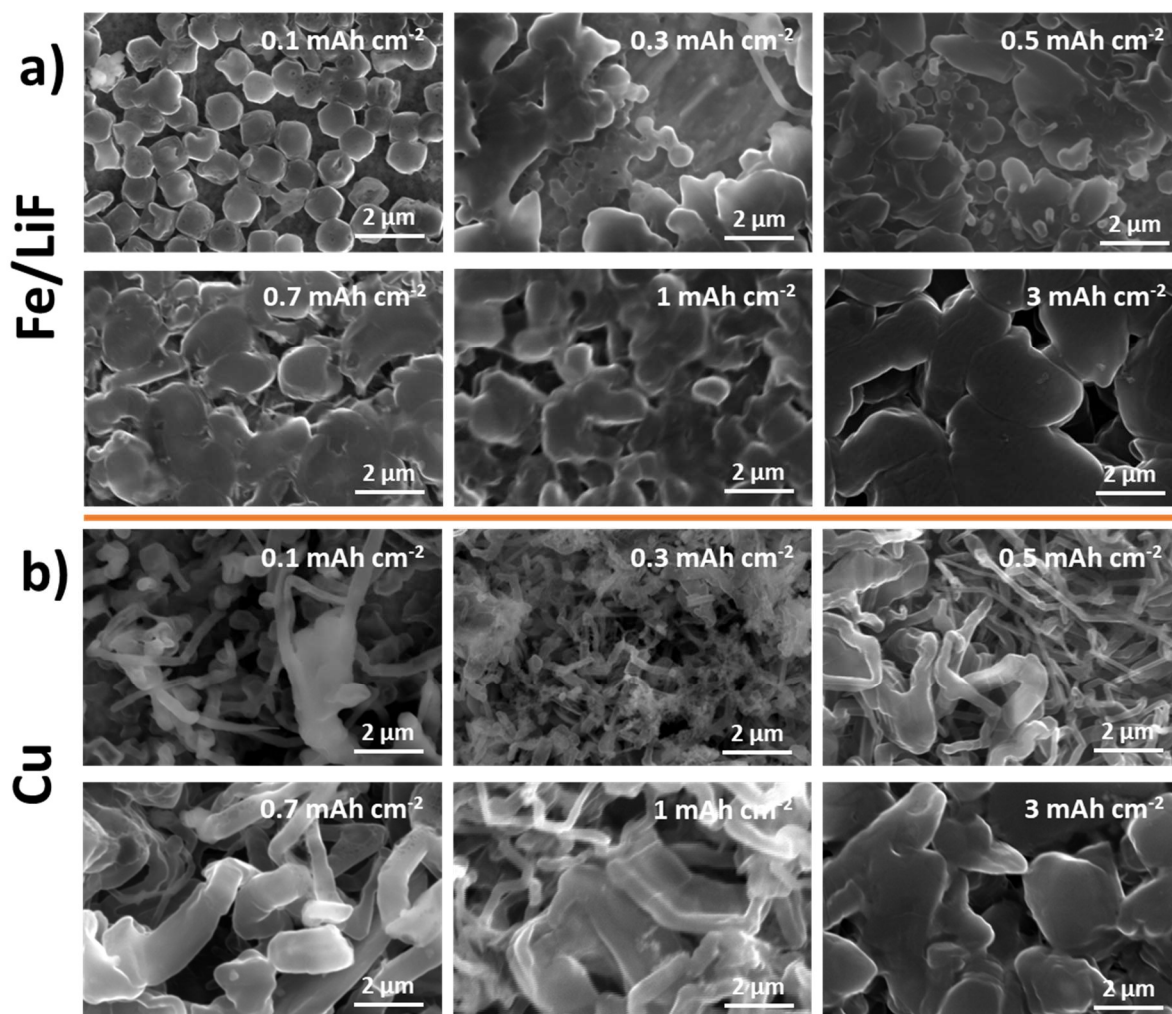


Figure S12. Top view SEM images of Li deposited on different substrates, under the same current density (3 mA cm^{-2}), with different capacities.

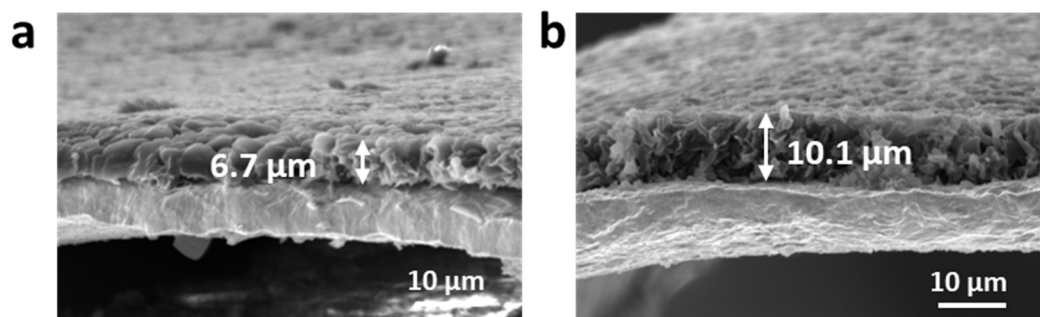


Figure S13. SEM images of 1 mAh cm^{-2} Li morphology under 1 mA cm^{-2} , a, on Fe/LiF substrate; b, on Cu substrate.

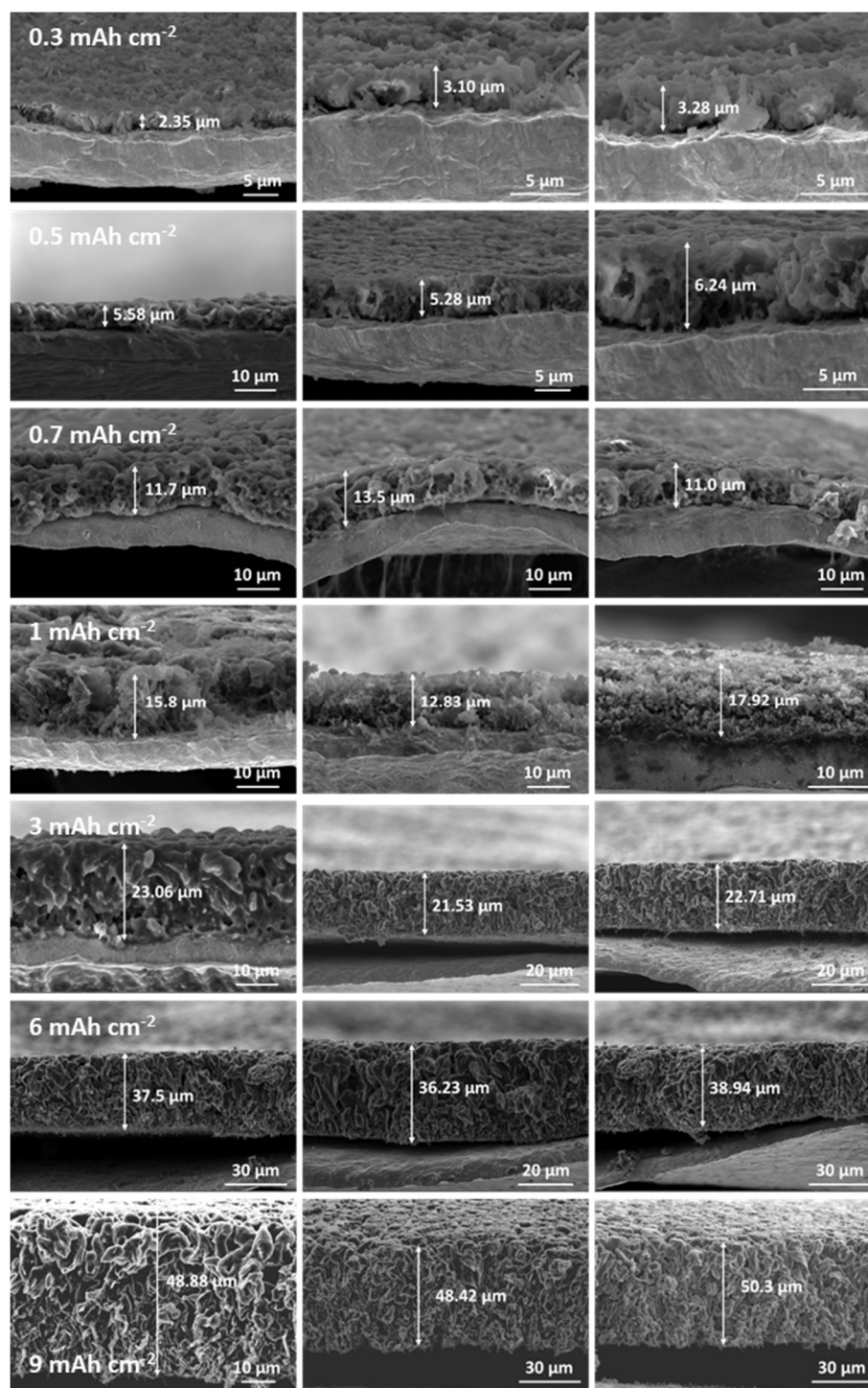


Figure S14. Cross-section SEM images of Li deposited on Cu under 3 mA cm^{-2} , different capacities.

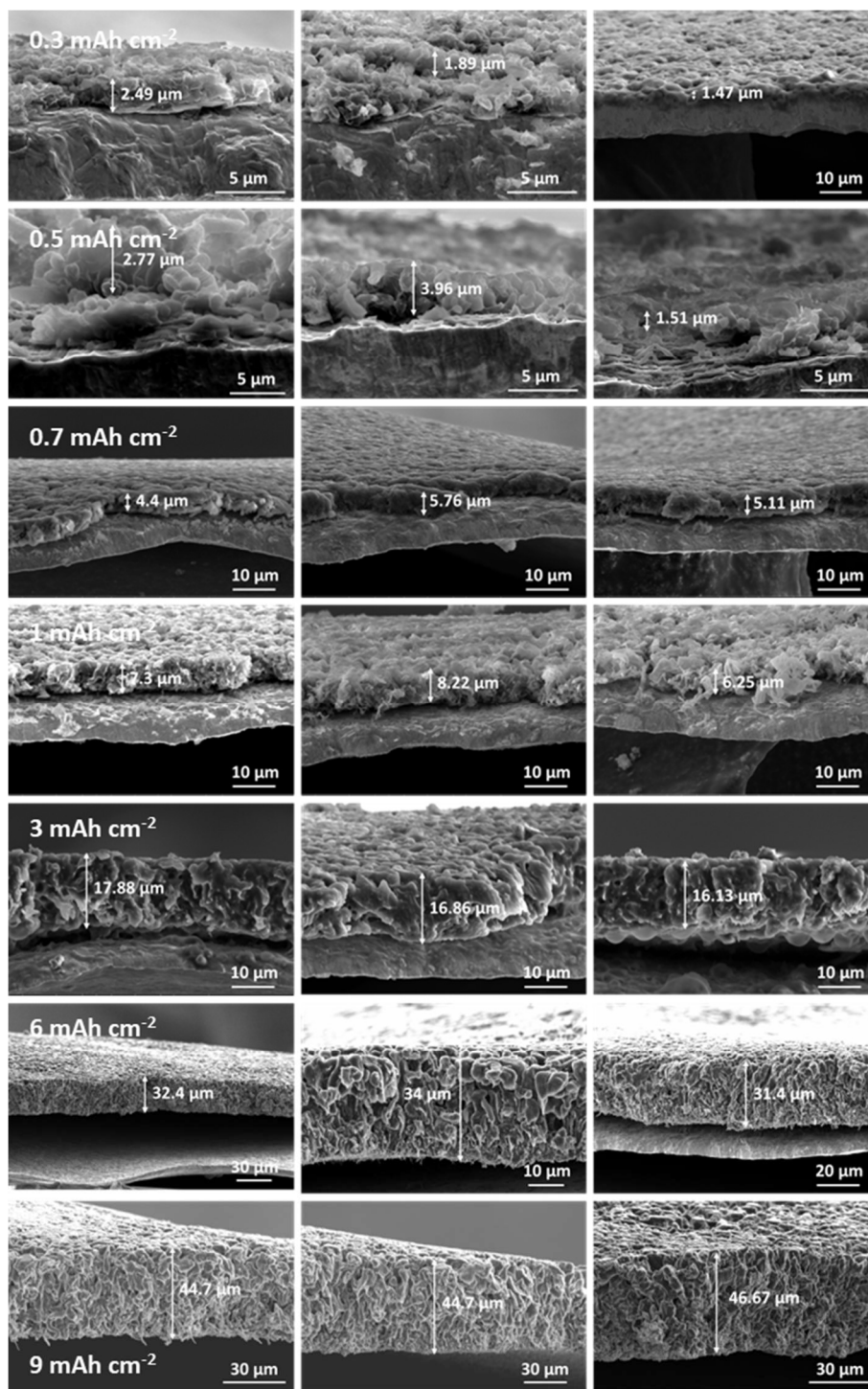


Figure S15. Cross-section SEM images of Li deposited on Fe/LiF at 3 mA cm^{-2} , different capacities.

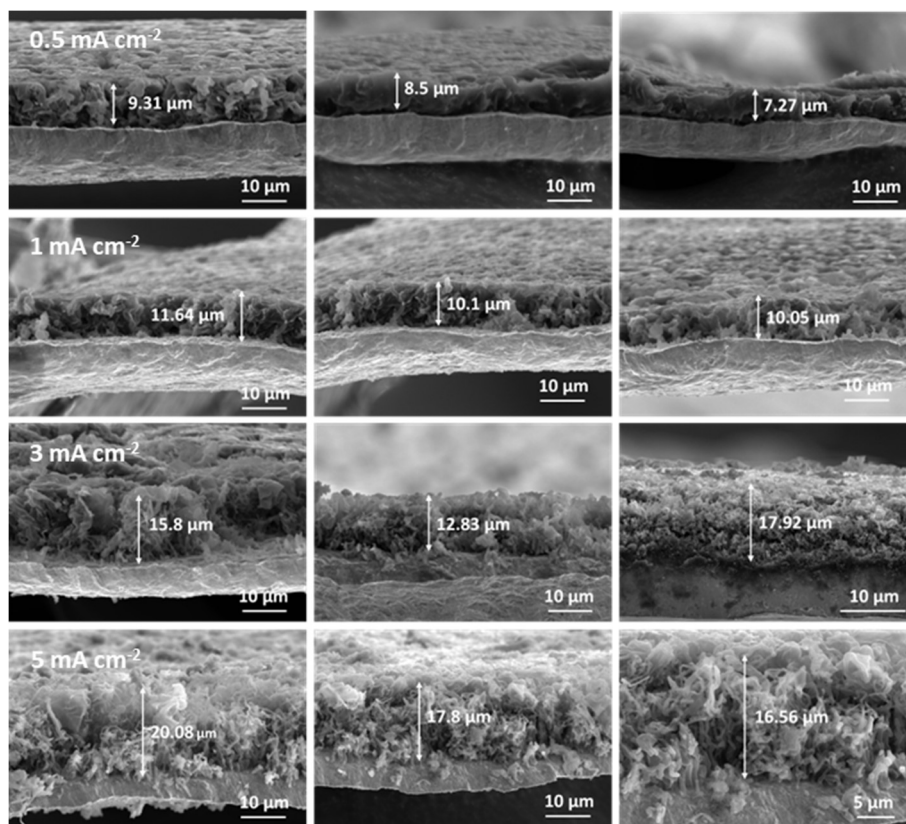


Figure S16. SEM images of 1 mAh cm^{-2} Li deposited on Cu at different current density.

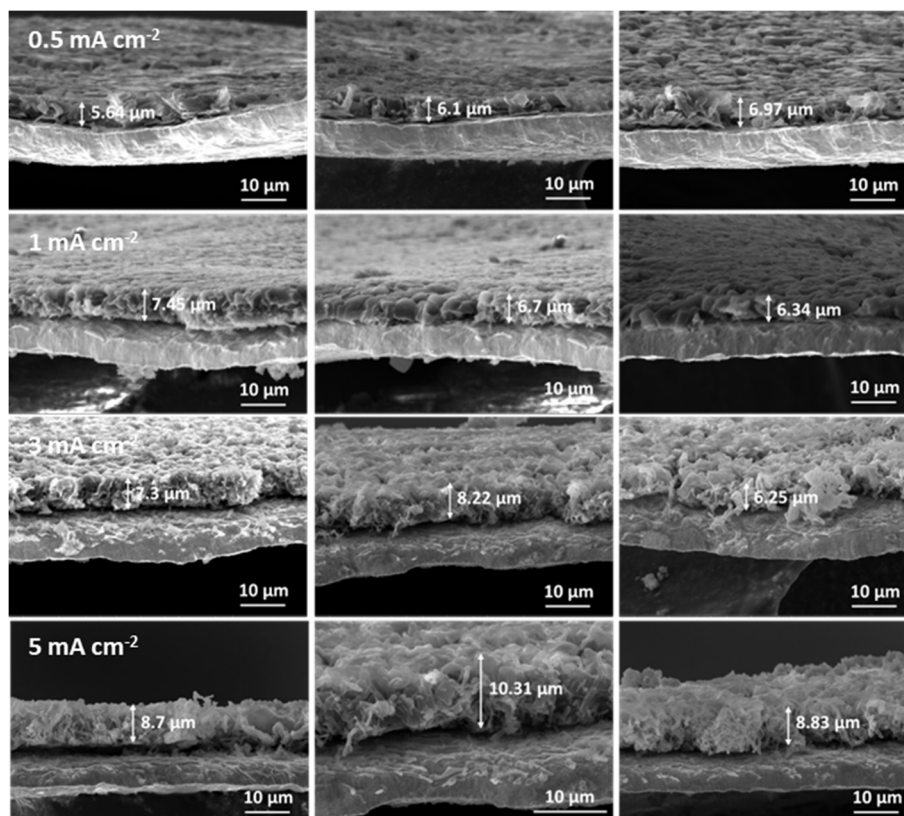


Figure S17. SEM images of 1 mAh cm^{-2} Li deposited on Fe/LiF at different current density.

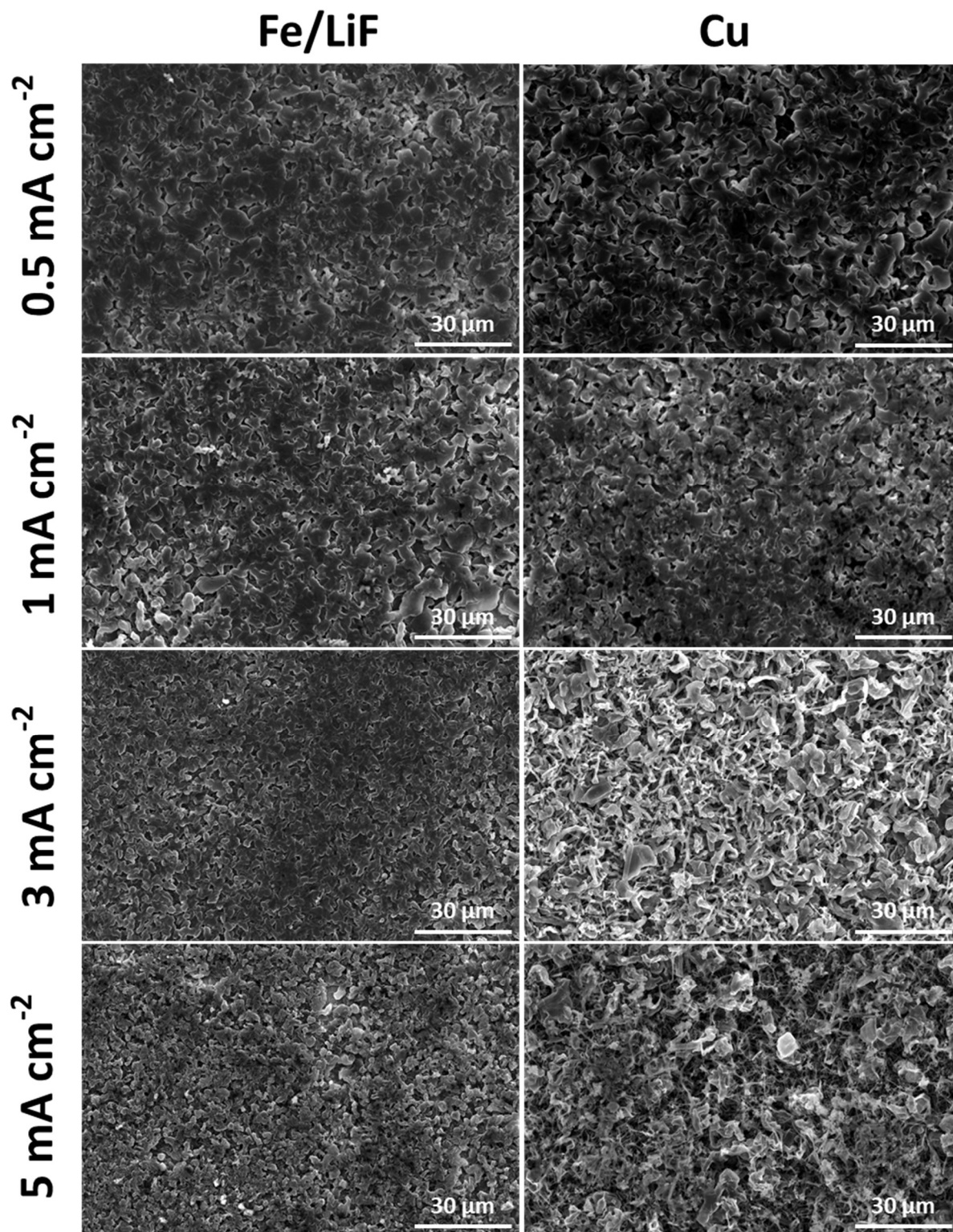


Figure S18. Top view SEM images of 1 mAh cm⁻² Li deposited on different substrates, under different current densities (0.5-5 mA cm⁻²).

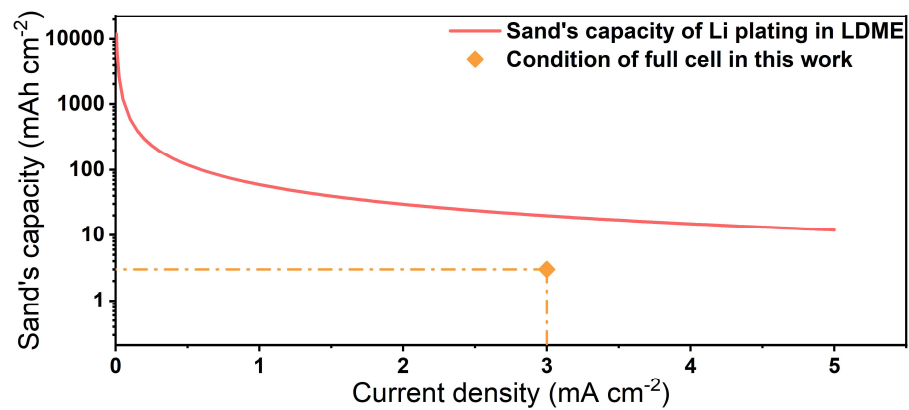


Figure S19. Sand's capacity Li plating in LDME electrolyte, and the condition of the full cell in this work.

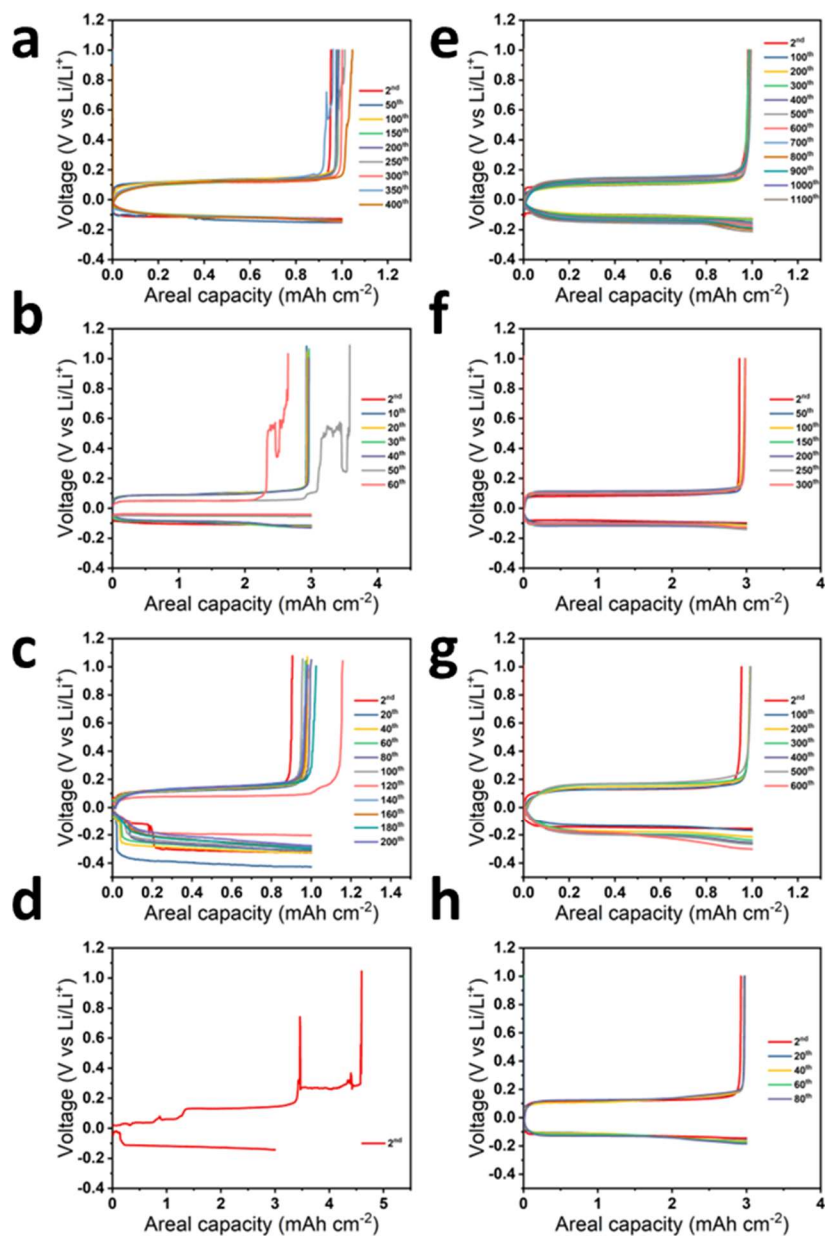


Figure S20. Voltage profiles of half-cells with different substrates. Voltage profiles of Li||Cu cells under different cycling conditions, a, 3 mA cm^{-2} , 1 mAh cm^{-2} ; b, 3 mA cm^{-2} , 3 mAh cm^{-2} ; c, 5 mA cm^{-2} , 1 mAh cm^{-2} ; d, 3 mA cm^{-2} , 5 mAh cm^{-2} . Voltage profiles of Li||Fe/LiF cells under different cycling conditions, e, 3 mA cm^{-2} , 1 mAh cm^{-2} ; f, 3 mA cm^{-2} , 3 mAh cm^{-2} ; g, 5 mA cm^{-2} , 1 mAh cm^{-2} ; h, 3 mA cm^{-2} , 5 mAh cm^{-2} .

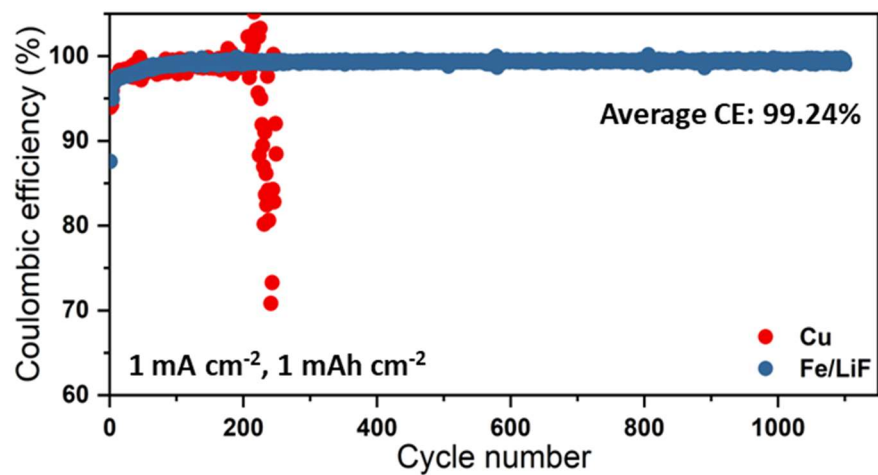


Figure S21. Electrochemical performance of half-cell with different substrates. Coulombic efficiency versus cycle number of Li||Cu or FeF₃ cell under 1 mA cm⁻², 1 mAh cm⁻².

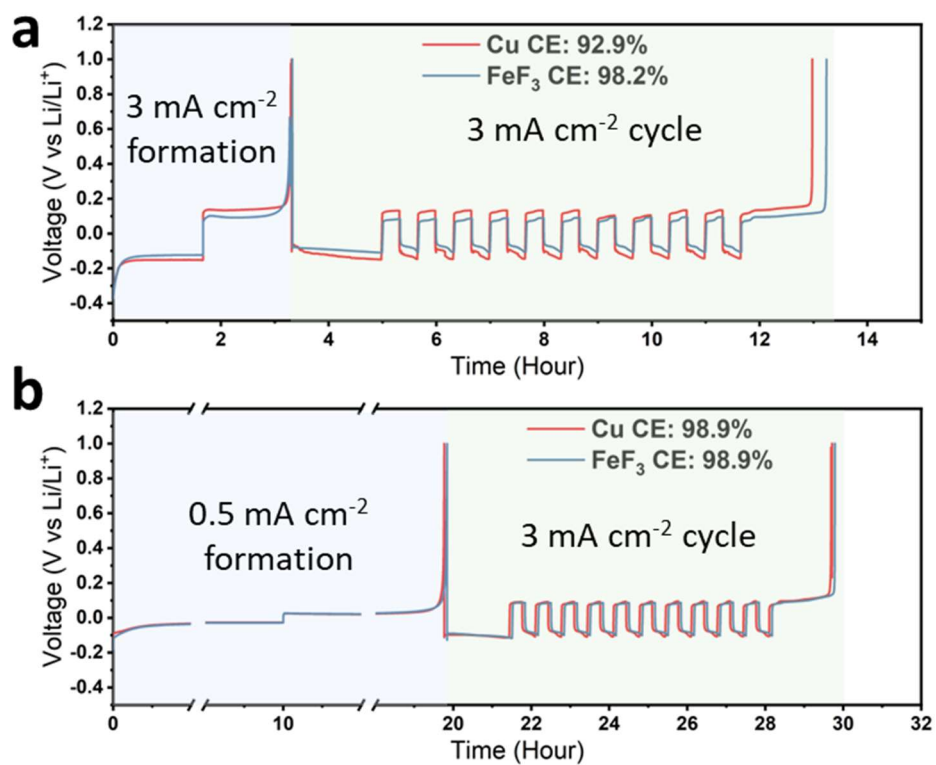


Figure S22. Coulombic efficiency measurement of half cells with different substrates. a, voltage profiles with 3 mA cm⁻², 5 mAh cm⁻² formation cycle. b, voltage profiles with 0.5 mA cm⁻², 5 mAh cm⁻² formation cycle.

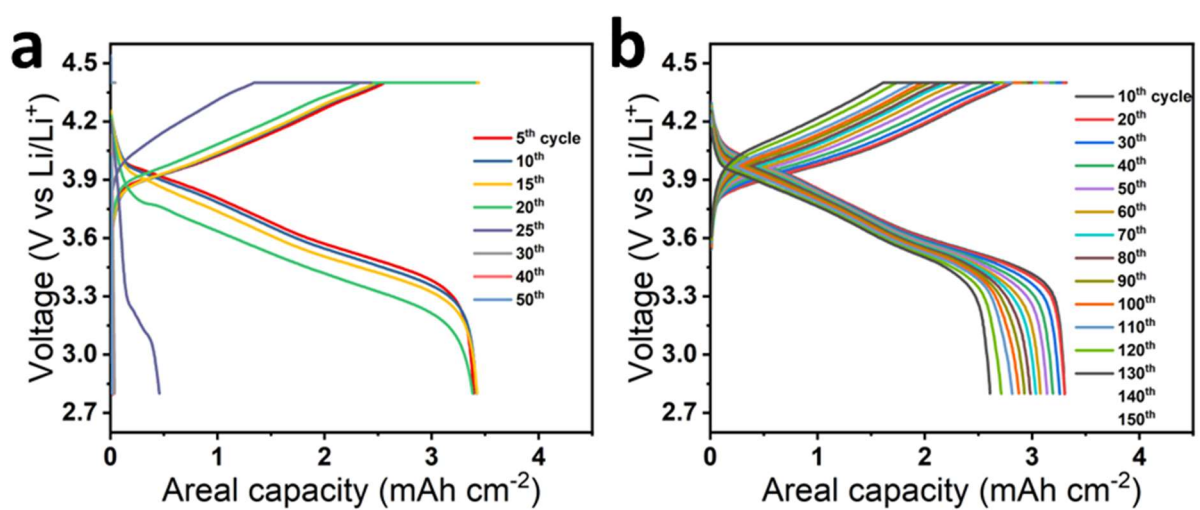


Figure S23. Voltage profiles for 3 mAh NMC811 full cell with different anodes. a, 3 mAh cm⁻² Li deposited on Cu. b, 3 mAh cm⁻² Li deposited on Fe/LiF nanocomposite. Cells were cycled under 1C rate, between 2.8 and 4.4 V.

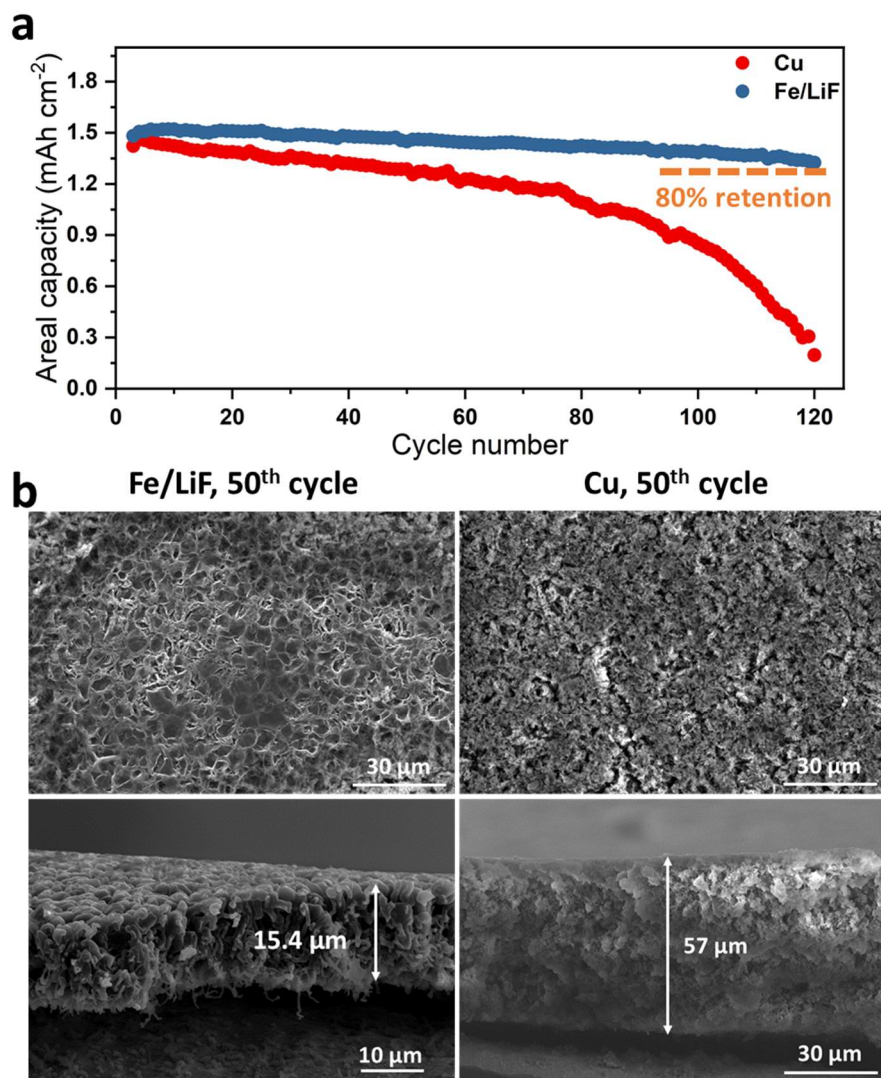


Figure S24. Electrochemical performance of full cell with different substrates. a, capacity retention of full cell with 1.5 mAh cm⁻² NMC811 as the cathode, Li plated on different substrates as the anode. 3 g Ah⁻¹ electrolyte was added to each cell. Cells were cycled at 1C rate, with the voltage window of 2.8-4.4 V. b, Top and cross-sectional view SEM image of Li morphology after 50 cycles.

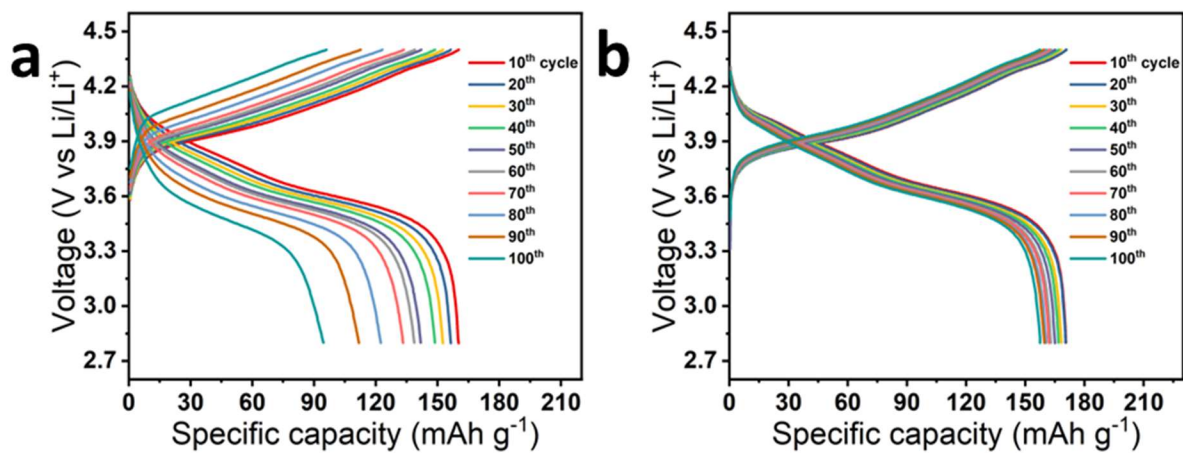


Figure S25. Voltage profiles for 1.5 mAh NMC811 full cell with different anodes. a, 1.5 mAh cm⁻² Li deposited on Cu. b, 1.5 mAh cm⁻² Li deposited on Fe/LiF nanocomposite. Cells were cycled under 1C rate, between 2.8 and 4.4 V.

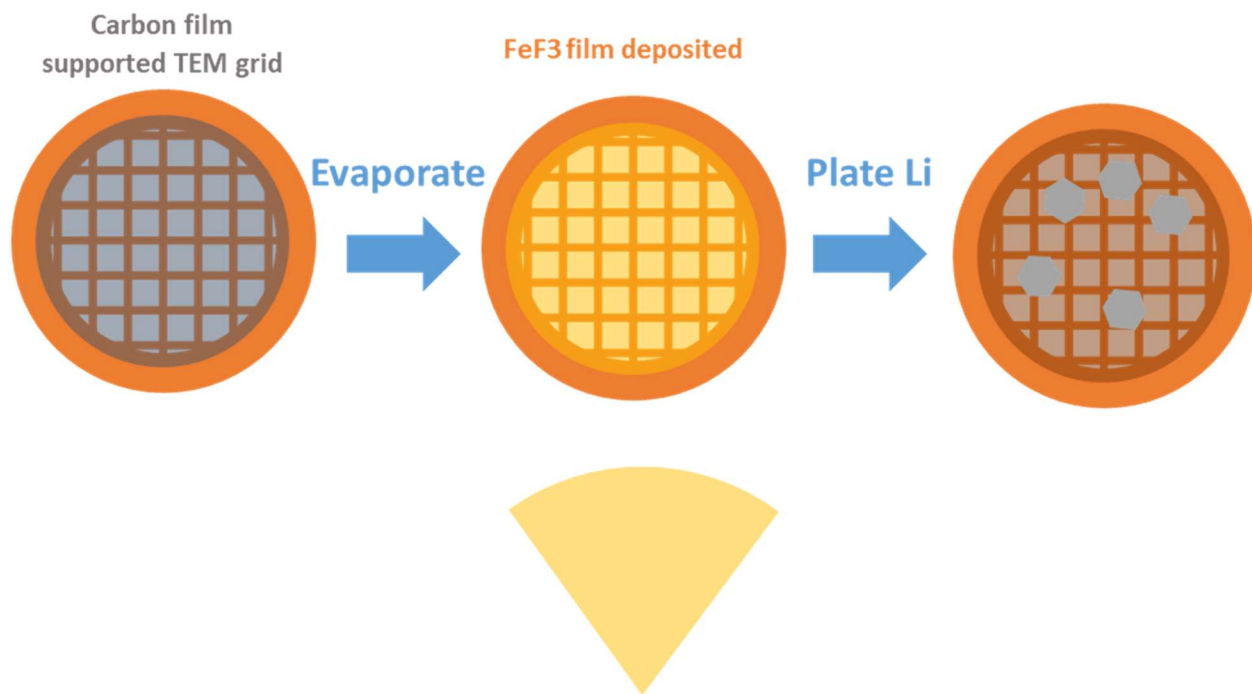


Figure S26. Schematic of method for preparing TEM sample.

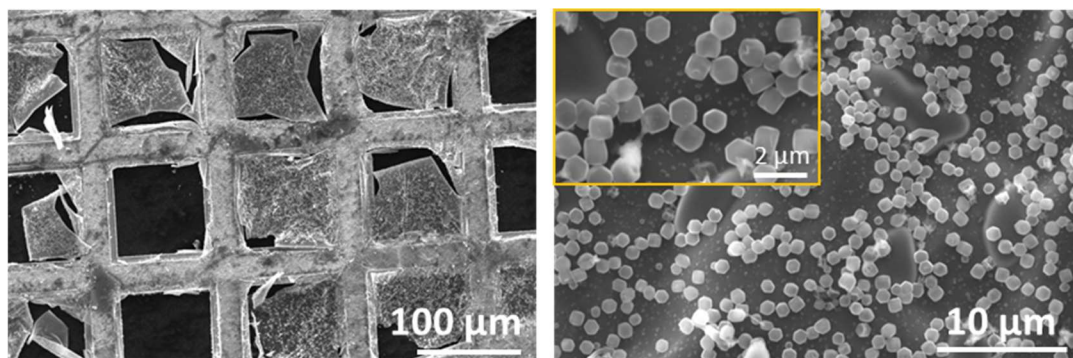


Figure S27. SEM images of 0.1 mAh cm^{-2} Li deposited on Fe/LiF nanocomposite coated carbon film supported on TEM grid.