

Electronic Supplementary Information (ESI):

**Self-supported, Three-Dimensional Porous Copper Film as Current
Collector for Advanced Lithium Metal Batteries**

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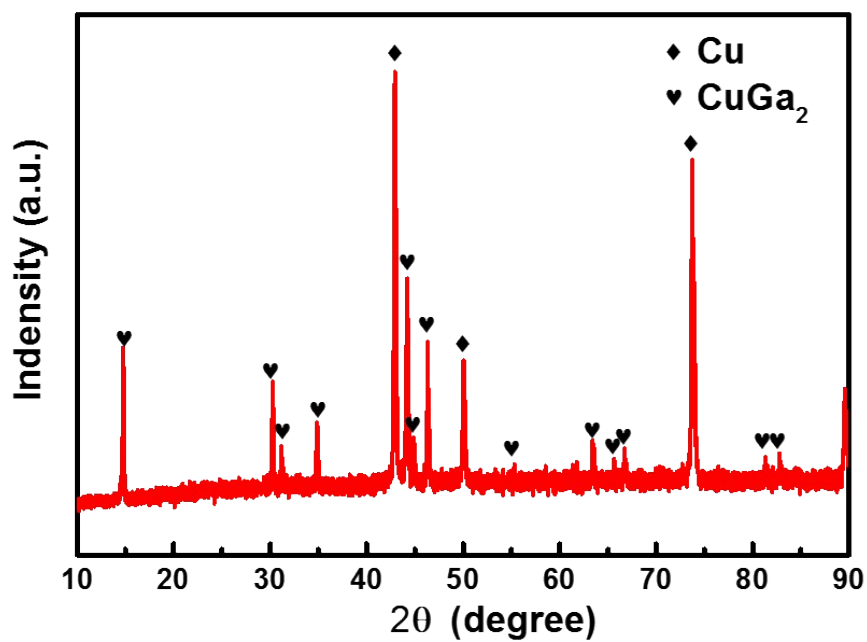


Fig. S1. XRD pattern of the liquid Ga-coated Cu foil after painting and annealing, indicating the formation of CuGa_2 intermetallic phase on the surface of Cu foil.

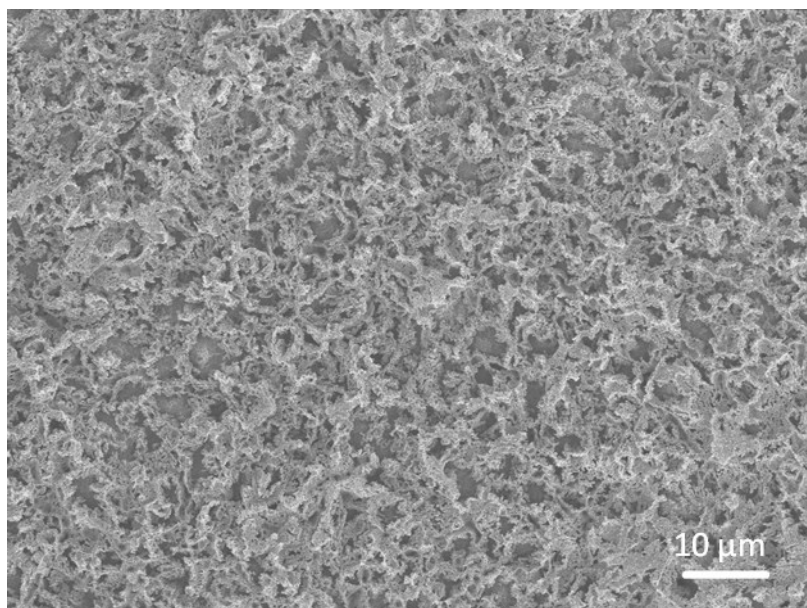


Fig. S2. SEM image of the 3D porous Cu foil.

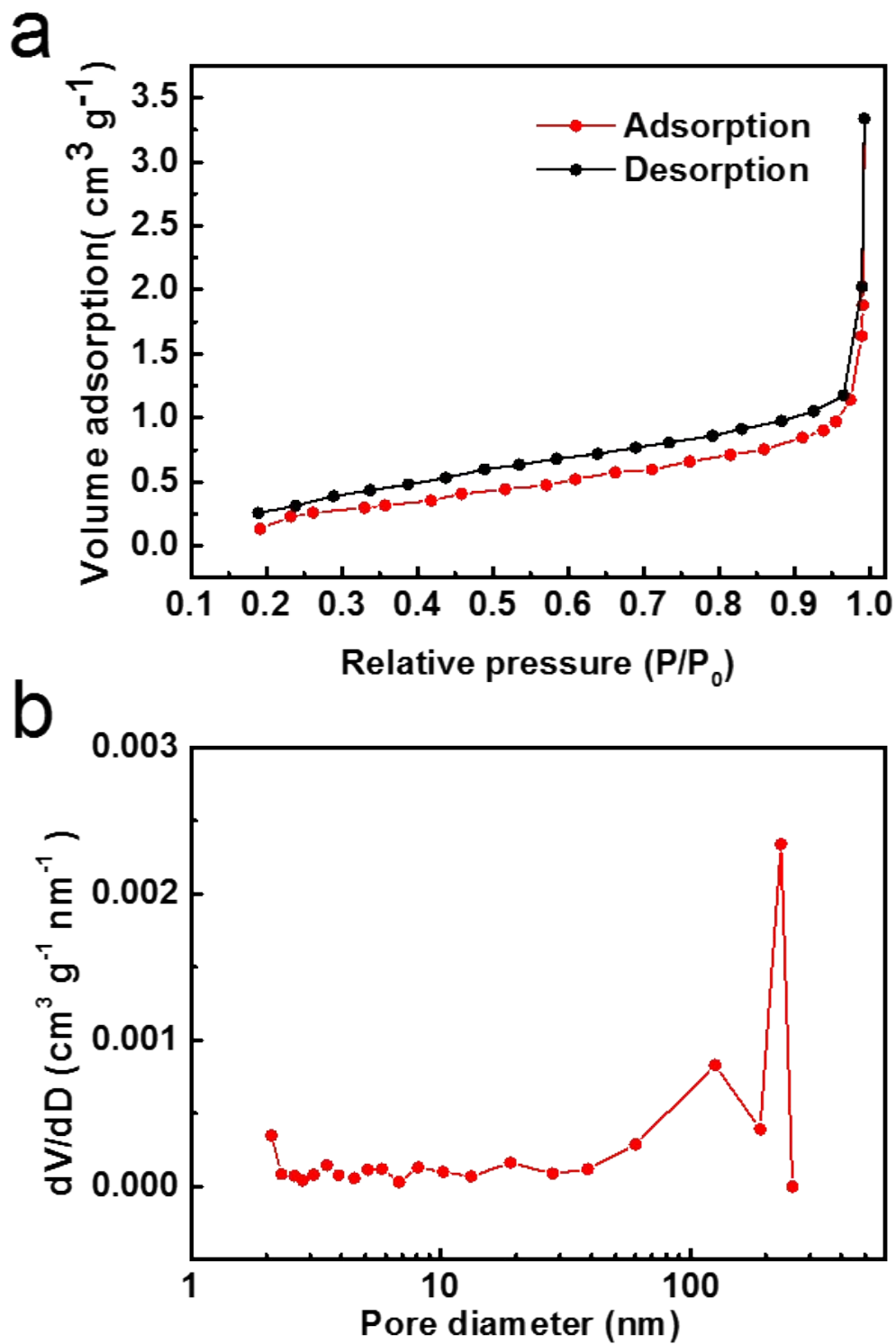


Fig. S3. (a) N_2 adsorption –desorption isotherms and (b) the pore size distribution of the 3D porous Cu.

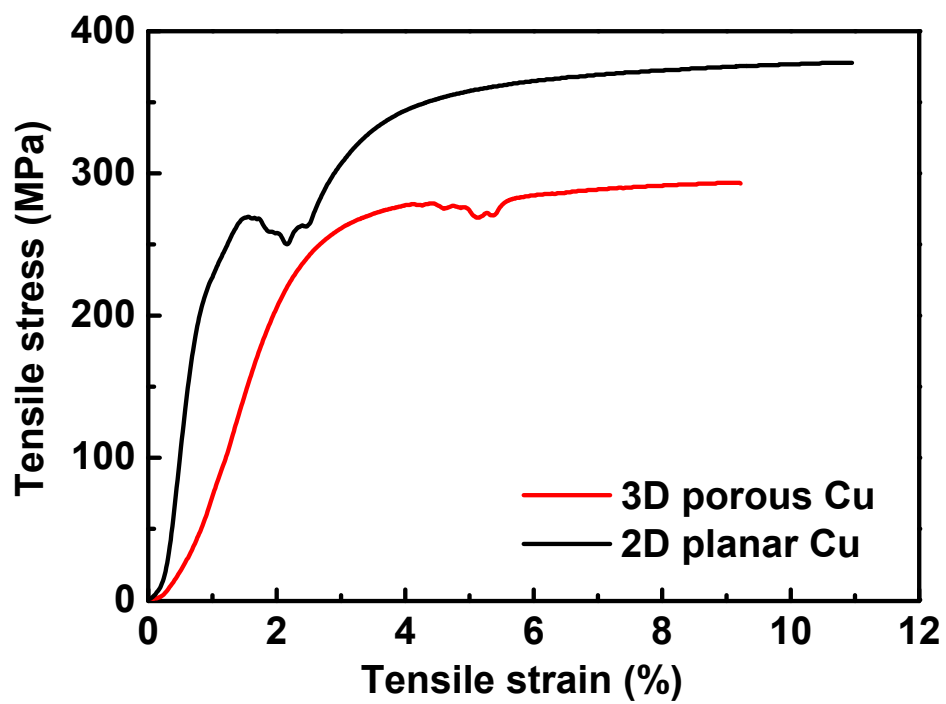


Fig. S4. The typical tensile stress-strain curves of the 3D porous Cu and 2D planar Cu samples.

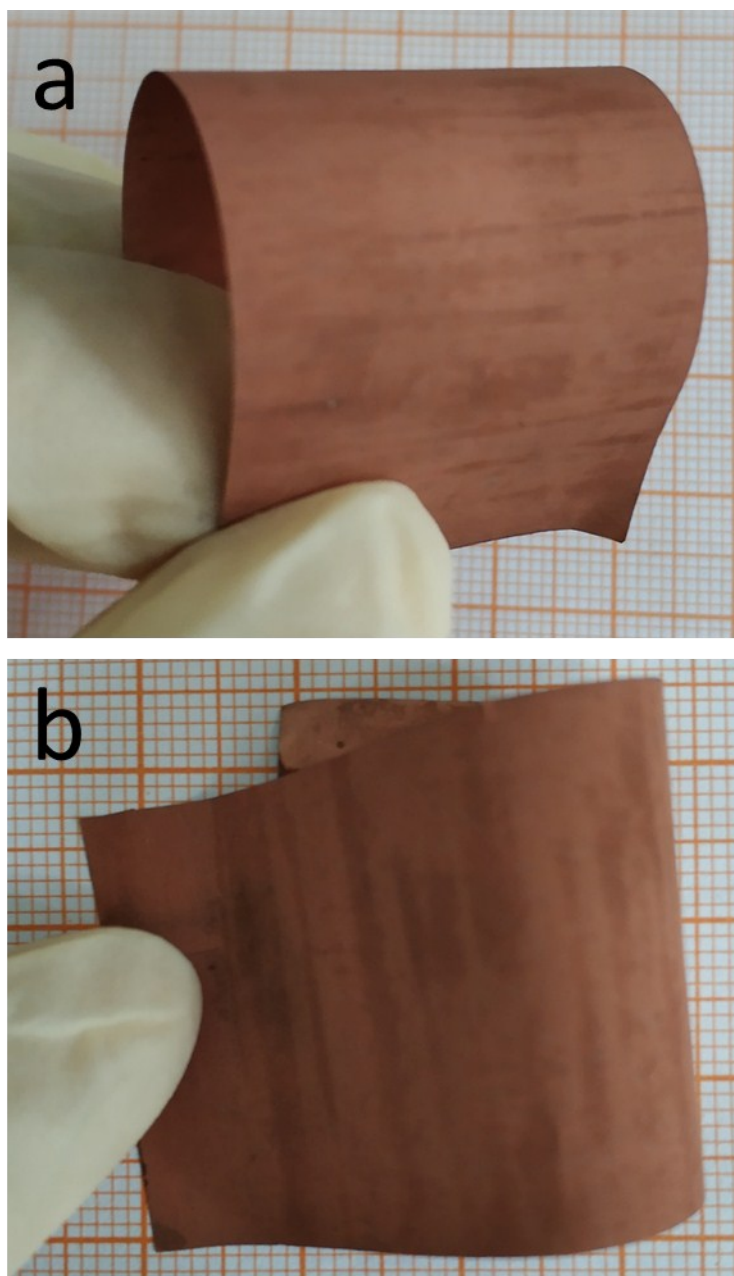


Fig. S5. Photographs showing the flexible, self-supported nature of the 3D porous Cu sample which is similar to that of the pristine Cu foil.

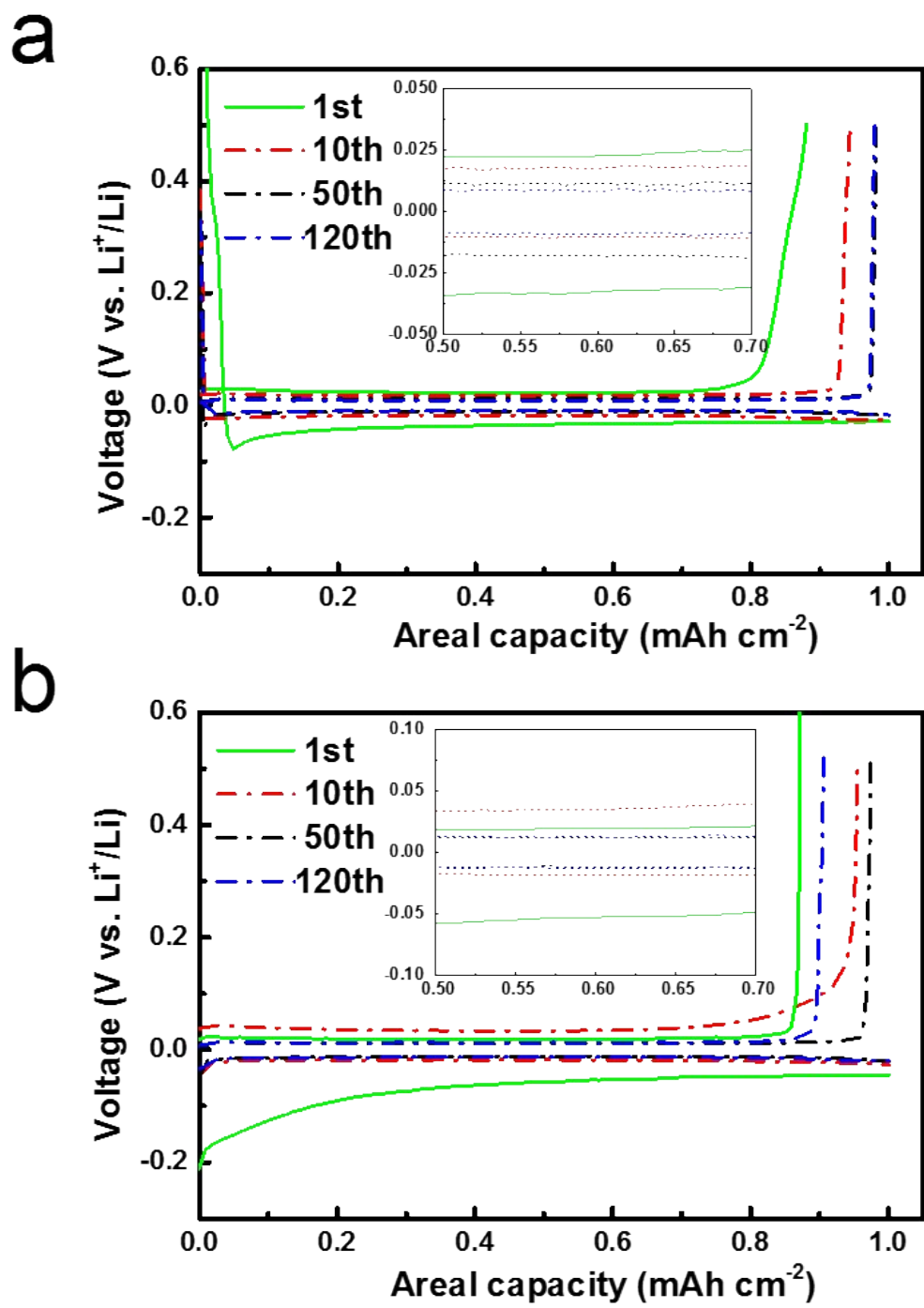


Fig. S6. Voltage profiles of Li plating/stripping on the (a) 3D porous current collector and (b) 2D planar current collector at 0.5 mA cm⁻² for total capacity of 1 mAh cm⁻².

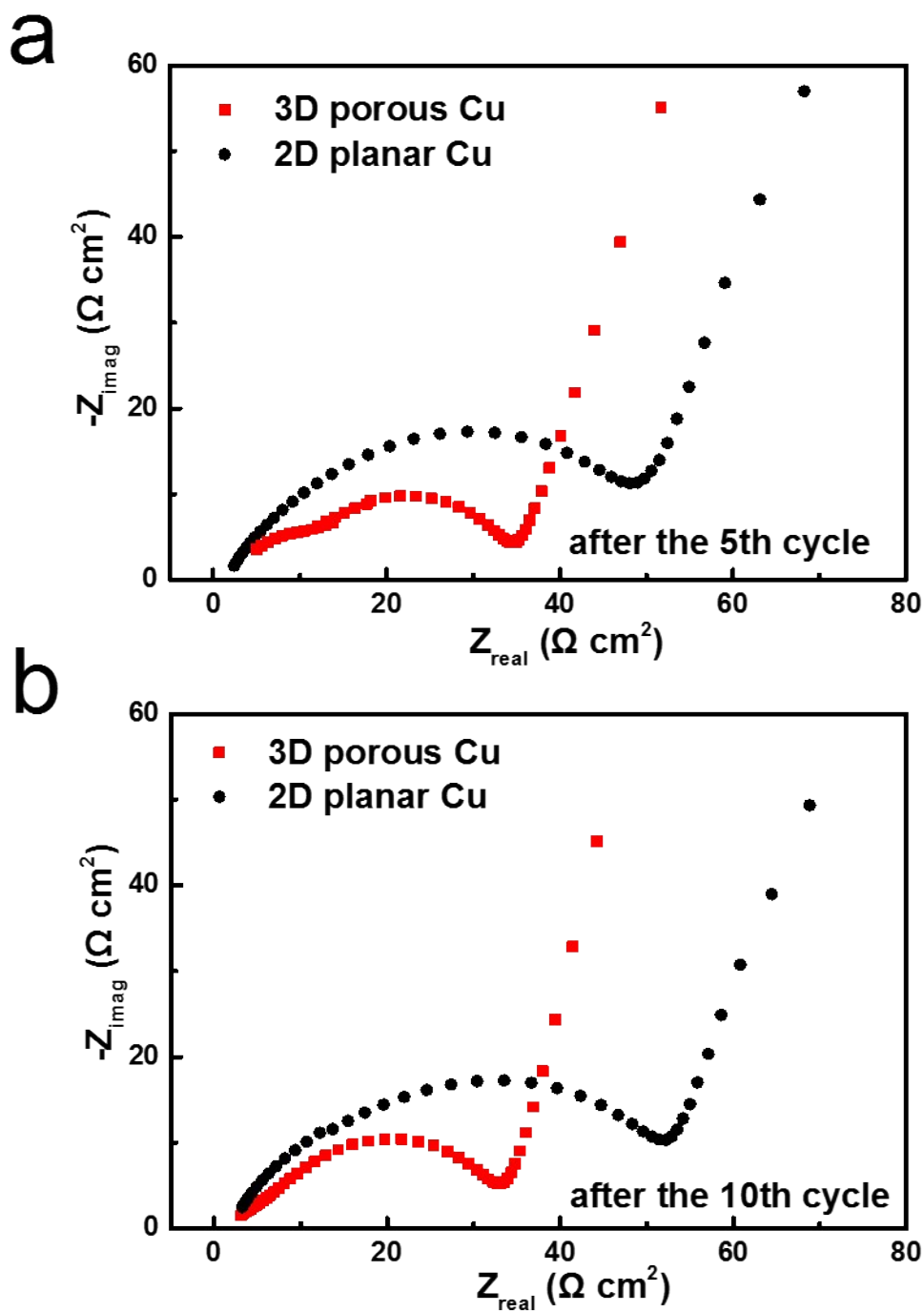


Fig. S7. EIS spectra of the 2D planar Cu and 3D porous current collectors after (c) 5 and (d) 10 cycles.

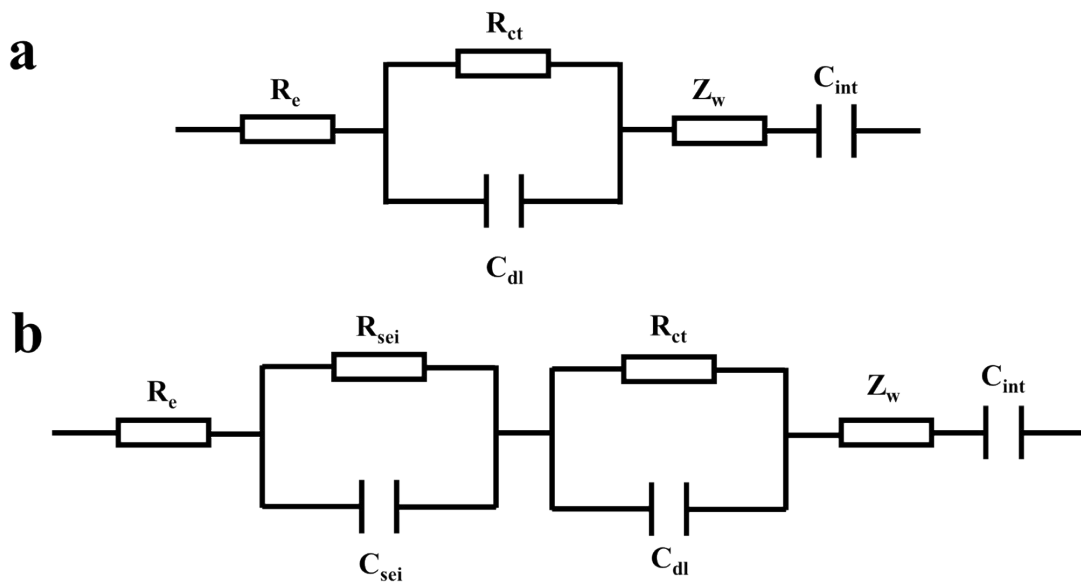


Fig. S8. Equivalent electrical circuits corresponding to Nyquist plots (a) before cycling and (b) after cycling.

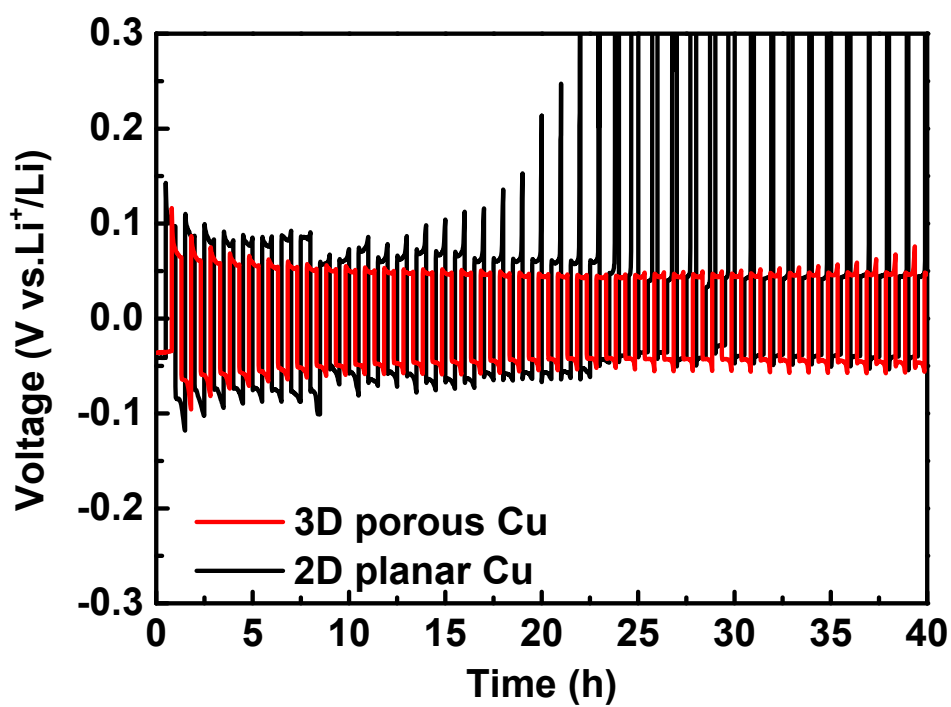


Fig. S9. Voltage profiles of Li plating/stripping on the 2D planar and 3D porous Cu current collectors at 2 mA cm^{-2} with the capacity of 1 mAh cm^{-2} . The plating/stripping of Li was controlled by the capacity.

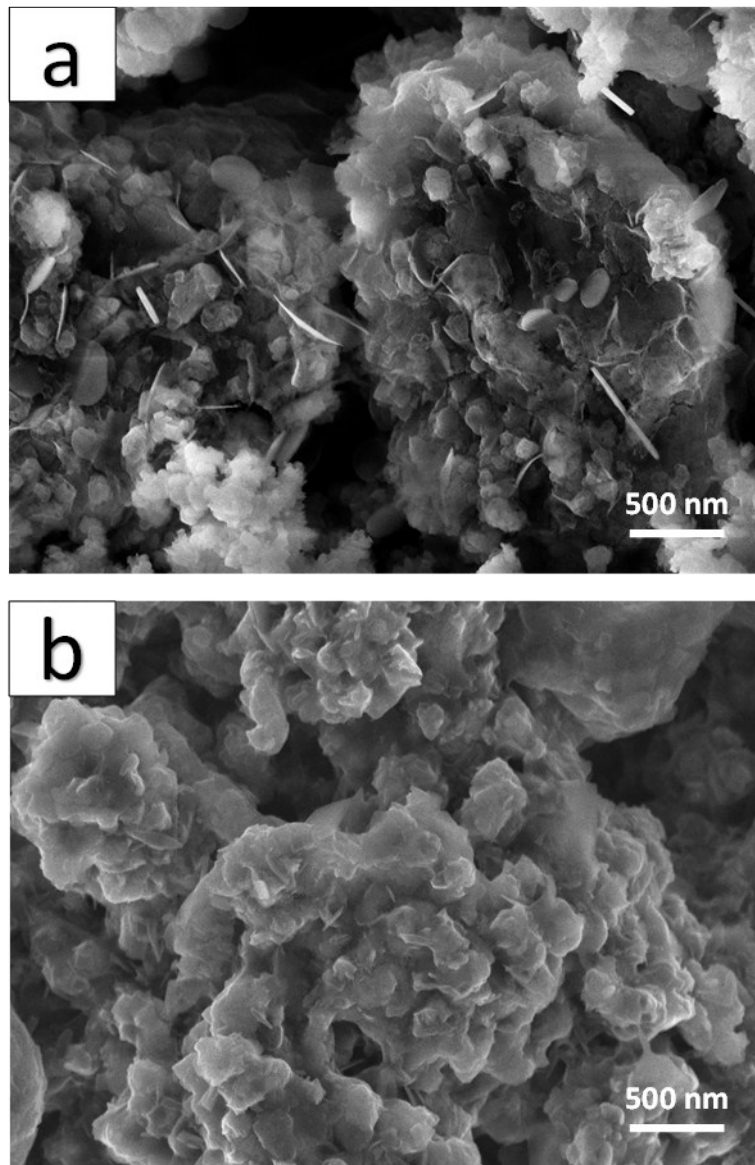


Fig. S10. High-magnification SEM images of the morphology of Li deposited on (a) 2D planar and (b) 3D porous Cu current collectors at 0.5 mA cm^{-2} for a total capacity of 1 mAh cm^{-2} .

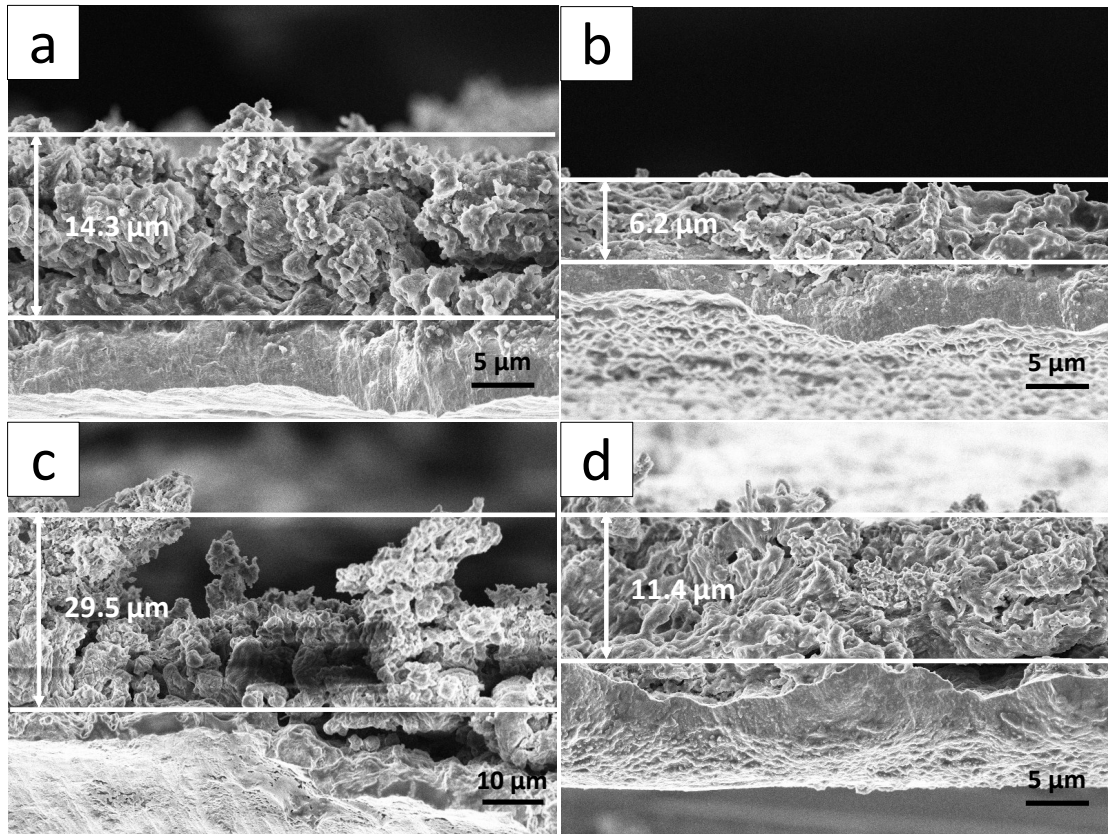


Fig. S11. Cross-sectional SEM images of Li deposited on 2D planar and 3D porous Cu current collectors with a current density of 0.5 mA cm^{-2} for a total capacity of 1 mAh cm^{-2} . (a, c) SEM images of the 2D planar current collector after the 1st and 20th Li plating. (b, d) SEM images of the 3D porous current collector after the 1st and 20th Li plating.

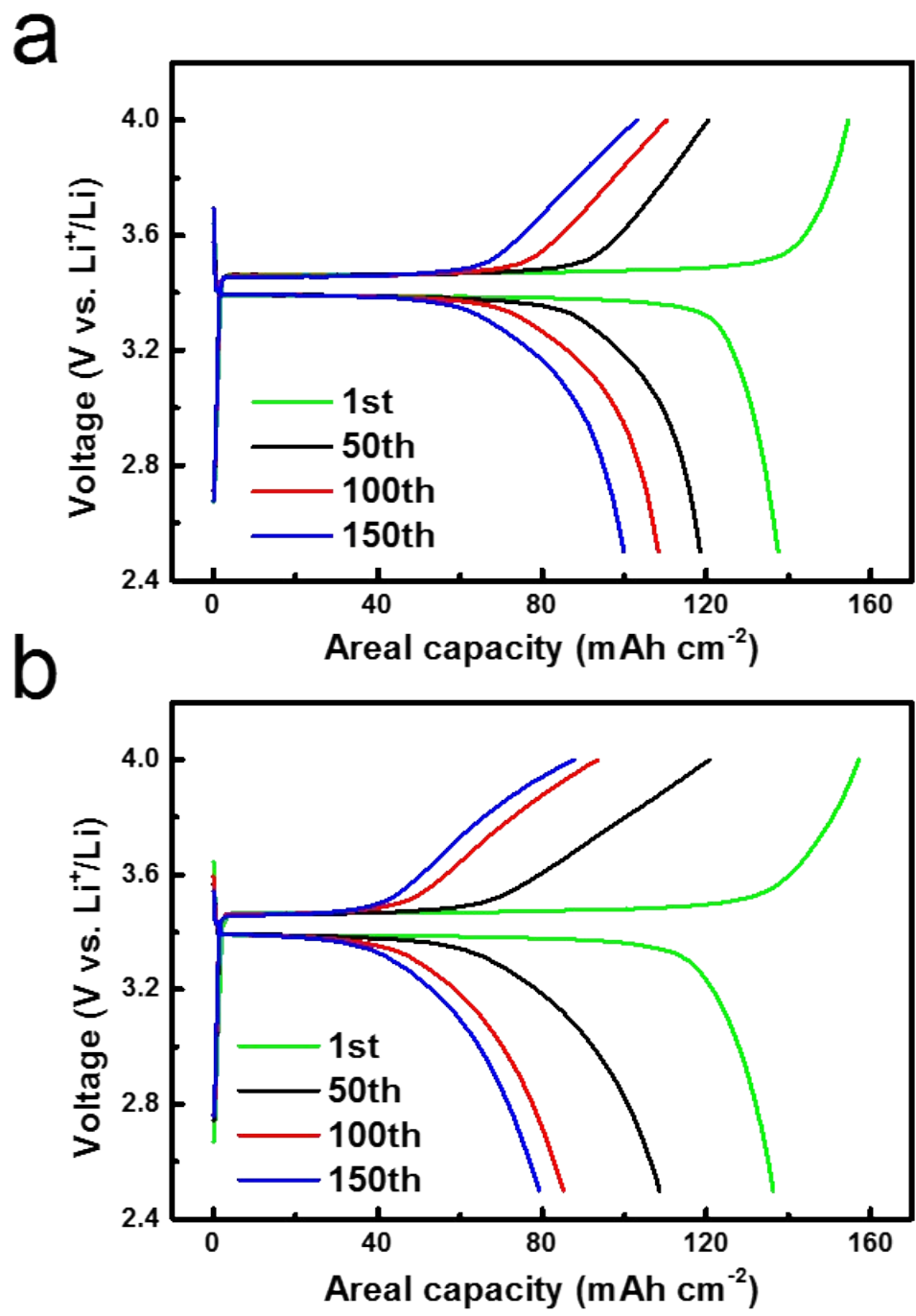


Fig. S12. Voltage profiles of Li anode with (a) 3D porous Cu and (b) 2D planar Cu current collectors in full cells with the LiFePO₄ cathode.

Table S1. Simulated results of EIS test of 2D planar Cu

State	$R_e(\Omega)$	$R_{sei}(\Omega)$	$R_{ct}(\Omega)$	$R_{sei}+R_{ct}$
Before cycling	1.5	/	459.2	459.2
After the 1st cycle	1.6	13.2	144.7	157.9
After the 5th cycle	1.4	7.2	33.9	41.1
After the 10th cycle	2.0	24.9	22.8	47.7

Table S2. Simulated results of EIS test of 3D porous Cu

State	$R_e(\Omega)$	$R_{sei}(\Omega)$	$R_{ct}(\Omega)$	$R_{sei}+R_{ct}$
Before cycling	1.2	/	123.9	123.9
After the 1st cycle	2.1	11.0	43.9	54.9
After the 5th cycle	1.9	16.3	18.8	35.1
After the 10th cycle	1.9	5.2	26.5	31.7