Supporting Information

Realizing stable lithium deposition by in-situ grown Cu₂S nanowires inside commercial Cu foam for lithium metal anodes

Zhijia Huang,¹ Chen Zhang,¹ Wei Lv,³* Guangmin Zhou,⁴ Yunbo Zhang,² Yaqian Deng,⁵ Haoliang Wu,³ Feiyu Kang ²⁶ and Quan-Hong Yang*³

¹ Tsinghua-Berkeley Shenzhen Institute (TBSI), Tsinghua University, Shenzhen 518055, China
² Shenzhen Geim Graphene Center (SGC), Engineering Laboratory for Functionalized Carbon Materials, Graduate School at Shenzhen, Tsinghua University, Shenzhen 518055, China
³ Nanoyang Group, State Key Laboratory of Chemical Engineering, School of Chemical Engineering and Technology, Tianjin University, Tianjin 300072, China
⁴ Department of Materials Science and Engineering, Stanford University, Stanford, CA 94305, USA
**Figure S1.** Nitrogen adsorption/desorption isotherm of the 3D Cu$_2$S NWs/Cu sample.

**Figure S2.** SEM image of the morphology of Li deposition on a) bare Cu foam and b) 3D Cu$_2$S NWs/Cu with current density of 1 mA cm$^{-2}$ for a total capacity of 1 mAh cm$^{-2}$ after 100 cycles.

**Figure S3.** SEM images of the morphology of Li deposited on (a, c) bare Cu foam and (b, d) 3D Cu$_2$S NWs/Cu with current density of 2 mA cm$^{-2}$ for a total capacity of 1 mAh cm$^{-2}$ after 20 cycles. SEM images of (e, g) bare Cu foam and (f, h) 3D Cu$_2$S NWs/Cu after the 50th plating.
Figure S4. SEM images of the morphology of Li deposited on (a, c) bare Cu foam and (b, d) 3D Cu$_2$S NWs/Cu with current density of 0.5 mA cm$^{-2}$ for a total capacity of 2 mAh cm$^{-2}$ after 50 cycles.

Figure S5. Illustration of the discharge/charge process of the 3D Cu$_2$S NWs/Cu current collector.

Figure S6. (a) CV for the as-prepared 3D Cu$_2$S NWs/Cu-Li cell. (b) S2p XPS spectra analysis of the SEI.
layers for the 3D Cu$_2$S NWs/Cu current collector.

**Figure S7.** Coulombic efficiency of bare Cu foam and 3D Cu$_2$S NWs/Cu at 0.5 mA cm$^{-2}$ with a total capacity of 1 mAh cm$^{-2}$.

**Figure S8.** Long cycling performance of 3D Cu$_2$S NWs/Cu at a current density of 1 mA cm$^{-2}$ with a total capacity of 1 mAh cm$^{-2}$. Inset shows the voltage-time curve with cycle time for 3D Cu$_2$S NWs/Cu.

**Figure S9.** Coulombic efficiency of Cu(OH)$_2$ NWs/Cu current collector at 1 mA cm$^{-2}$ with a total capacity of 1 mAh cm$^{-2}$ and (b) Voltage profiles for Li nucleation on the Cu(OH)$_2$ NWs/Cu current collector.
**Figure S10.** Electrochemical impedance spectra (EIS) of bare Cu foam and 3D Cu$_2$S NWs/Cu (a) after 5 cycles and (b) after 50 cycles.

**Figure S11.** Voltage-time profiles of symmetric Li$\text{‖}$Cu-Li and Li$\text{‖}$3D Cu$_2$S NWs/Cu-Li cells at 1 mA cm$^{-2}$ with a cycling capacity of 1 mAh cm$^{-2}$.

**Figure S12.** Cycling performance of full cell with LiFePO$_4$ cathode and Li anode at 0.5 C.