Supporting Information for

All-Solid-State Thin-Film Lithium-Sulfur Batteries

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Supplementary Figures

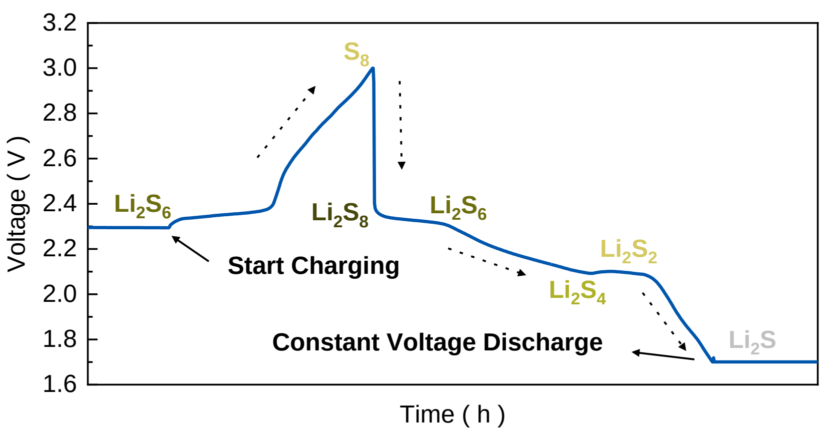

Fig. S1 Potential profiles of liquid-electrolyte lithium-sulfur battery using Li_2S_6 electrolyte

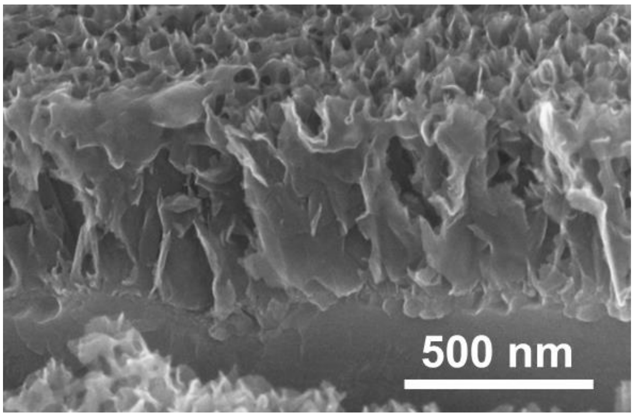

Fig. S2 Cross-section SEM image of the VGs

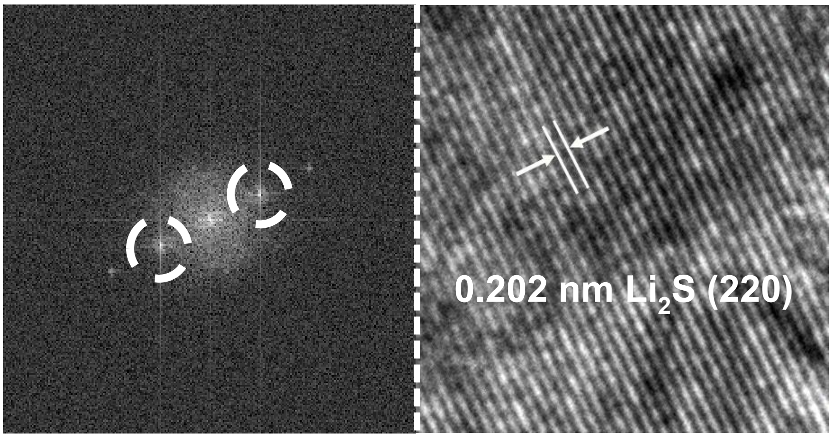

Fig. S3 FFT patterns, inverse FFT patterns

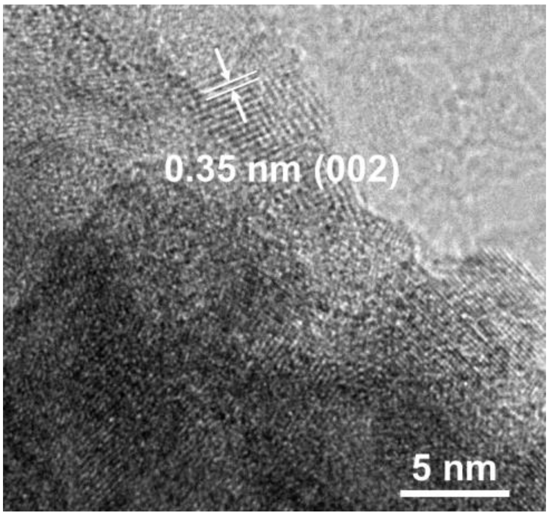

Fig. S4 HRTEM image of the graphene sheet.

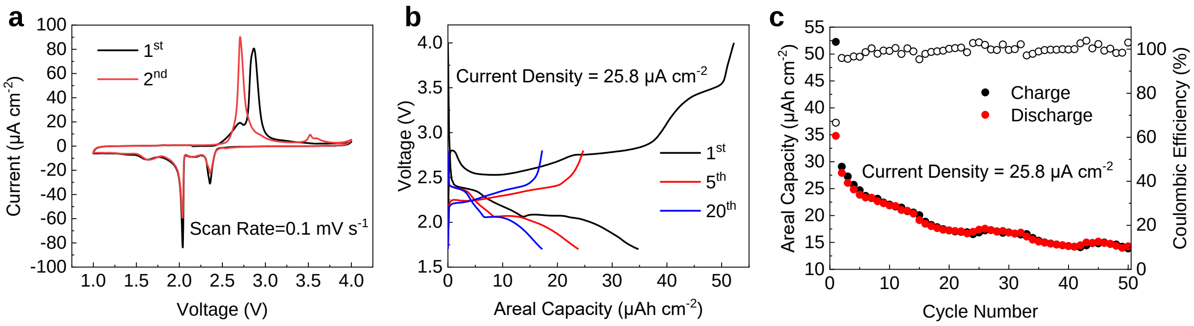

Fig. S5 Electrochemical performance of the VGs-Li_2S thin-film cathode in liquid system. **a** CV curves; **b** voltage profiles at a current density of 25.8 μA cm^{-2}; **c** cycling performances

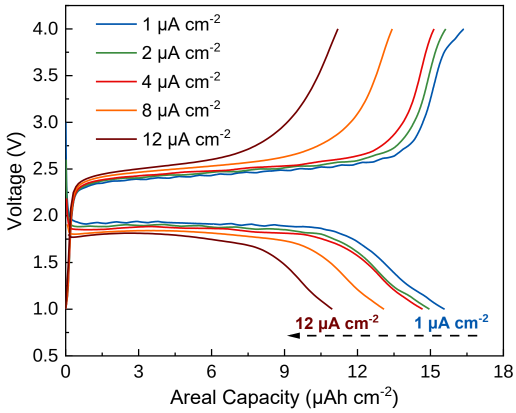

Fig. S6 Voltage profiles of the VGs-Li_2S thin-film cathode under different current densities

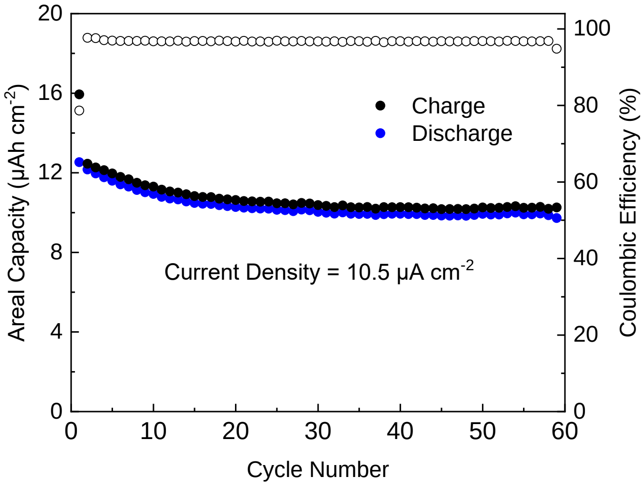

Fig. S7 Cycling performances of VGs-Li_2S/LiPON/Pre-Li cells at 10.5 μA cm^{-2} with an initial Coulombic Efficiency of 78.6%

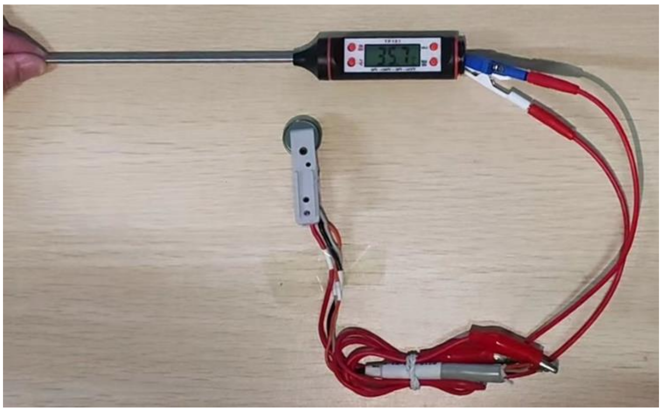

Fig. S8 Digital photos of the VGs-Li_2S/LiPON/Pre-Li cell (sealed with CR2025-type coin cell) connected with a small thermometer

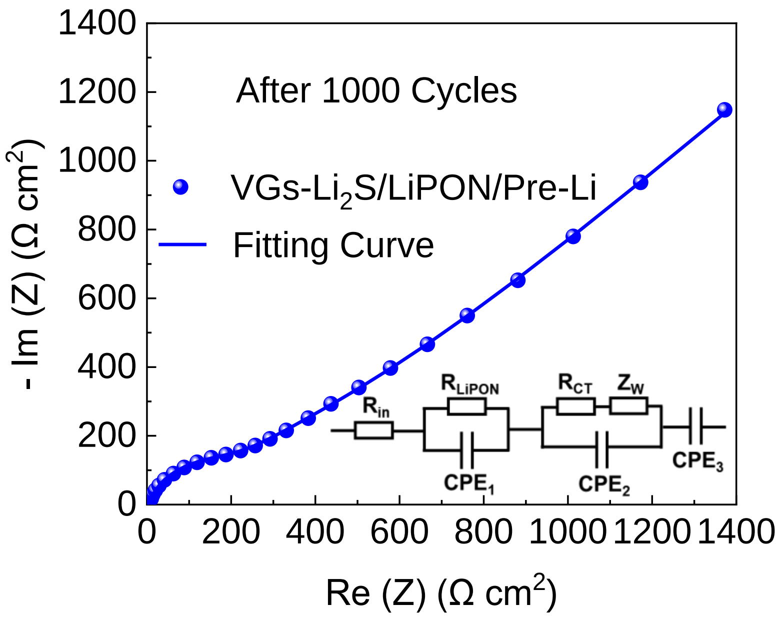

Fig. S9 The fitted Nyquist plots of the VGs-Li_2S/LiPON/Pre-Li cell after 1000 cycles

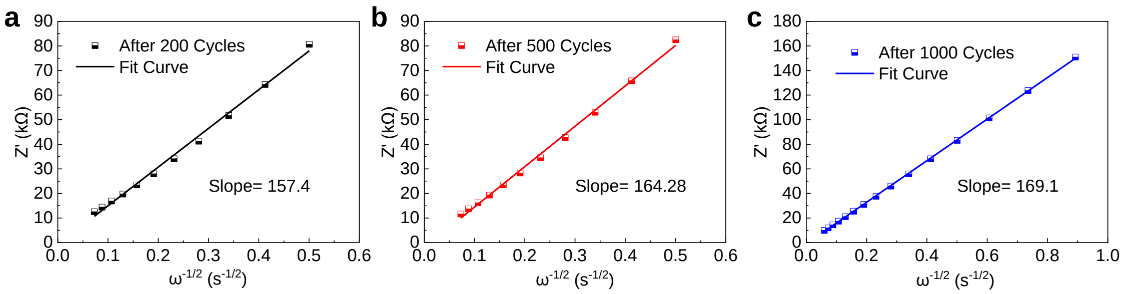

Fig. S10 The corresponding relationship between Z_{Re} and $\omega^{-1/2}$ in the low frequency region of after (**a**) 200, (**b**) 500 and (**c**) 1000 cycles

The Li+ diffusion coefficient has been calculated from plots in the low frequency region using the following equation:

$$D = R^2T^2/2A^2F^4C^2{\sigma_W}^2 \qquad (S1)$$

Where R is the gas constant, T is the absolute temperature, A is the area of the cathode thin film, F is the Faraday constant, C is the concentration of Li^+, and σ_W is the Warburg impedance coefficient, which can be obtained from the slope of the real part of resistance (Z_{Re}) and the inverse square root of angular frequency ($\omega^{-1/2}$).

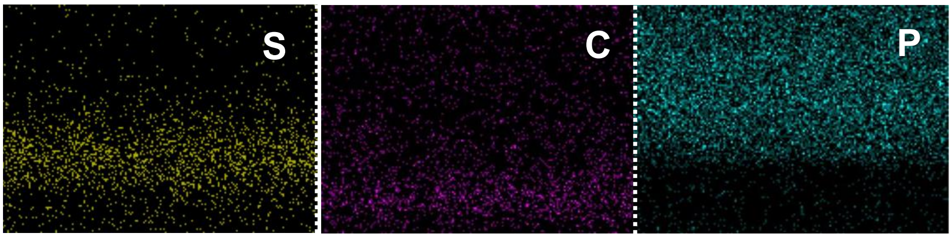

Fig. S11 EDS elemental mapping of S, C, and P at the VGs-Li_2S/LiPON interface before cycling

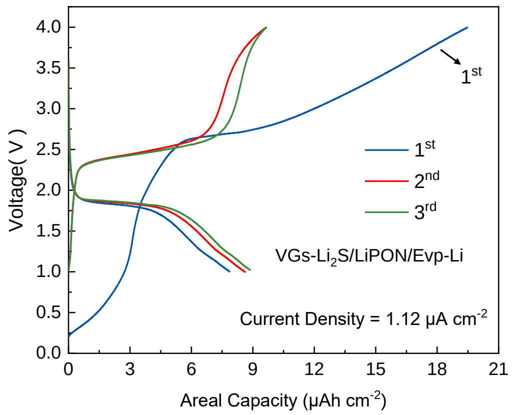

Fig. S12 Voltage profiles of the VGs-Li_2S/LiPON/Evp-Li cell at the first three cycles under a current density of 1.12 μA cm^{-2}

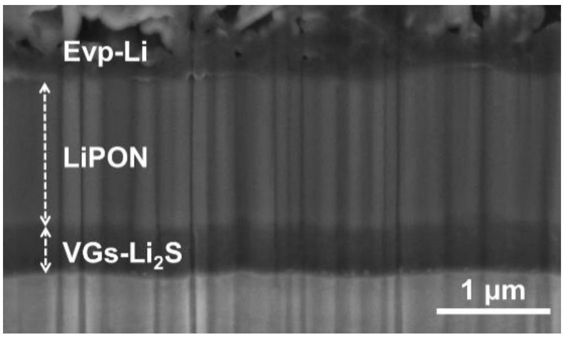

Fig. S13 FIB-SEM image of VGs-Li_2S/LiPON/Evp-Li cell after cycling