

Supporting Information for A Novel Device Structure for a Low-cost Li-S Battery

By Zhen Liu etc.

S1 Detail of Experiment:

Fabrication of the novel Li-S battery:

2032-type coin cells were fabricated in an Ar-filled glove box (MIKROUNA, China). The S powder (50 mg/cm²) was stored in the bottom of the battery and there was no direct contact with the current collector. A porous electrode (Ni foam here, 30 mg/cm²) was employed as the current collector and electro-chemical reaction region. Li₂S₈ (0.2 M), Lithium bis(trifluoromethanesulfonyl)imide (0.5 M) and LiNO₃ (0.5 M) in 1,2-dimethoxyethane and 1,3-DOL (1:1 vol%) was employed as the electrolyte. Double layer Celgard 2400 separators were employed as the separator of the battery.

Between the Li metal anode and the separator was placed with a Al foil (30 mg/cm²) and all the two metal foil was infiltrated by the electrolyte.

For the S-Se-Battery, 5% mass ratio Se powder was mixed with the S powder.

Characterization and measurements

The Al/Li alloy was characterized by X-ray diffraction (XRD) (D/MAX 2500/PC). The morphology of the samples was characterized by SEM. The coin cells were cycled from 1.0 to 3.0 V versus Li⁺/Li with a multichannel battery tester (NEWARE BTS). Specific charge–discharge capacities were calculated based on the mass of S or Se/S mixture and S in the electrolyte.

S2 The rapid reaction between low order polysulfide ions and S powder.

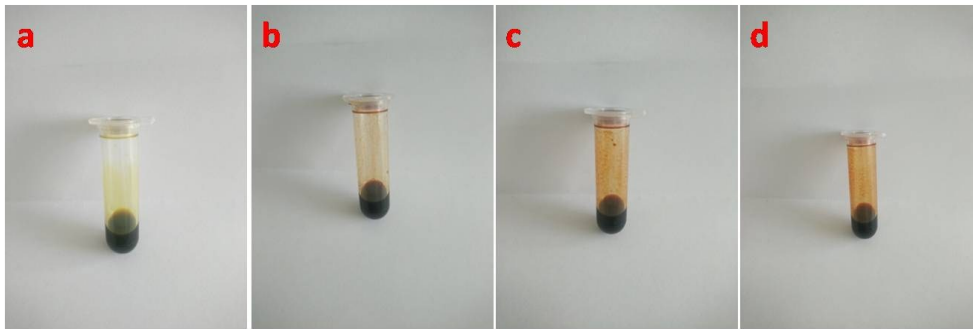


Figure S1 (a) 1M Li_2S_4 solution. (b), (c) and (d) 1 min, 10 min and 60 min after the addition of S powder into the 1M Li_2S_4 solution under Ar protected.

As is indicated in figure S1, after the addition of excessive S powder, color of the Li_2S_4 solution rapidly changed to reddish-brown at room temperature after 1 min and showed no apparently change in the following 60 min. the results means that the S_4 ions could rapidly react with the S powder and form S_8 in room temperature.

S3 The charge process and the rapid reaction between high order polysulfide ions and Li_2S .

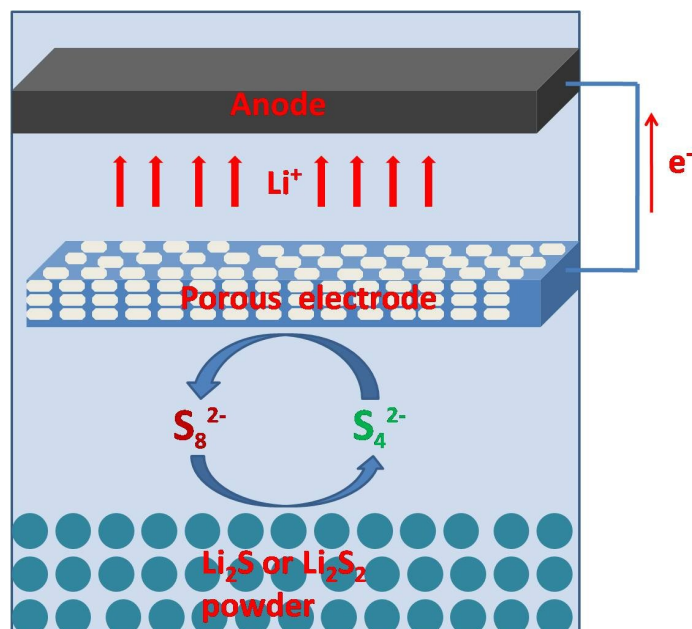


Figure S2 Charge process of the Li-S battery based on the novel device structure.

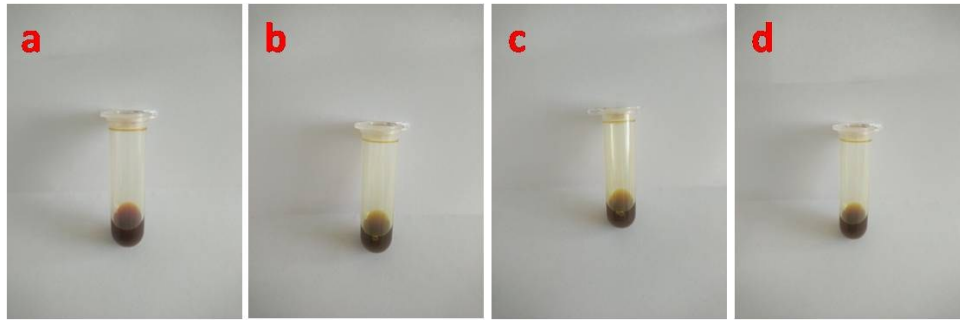


Figure S3 (a) 0.5 M Li_2S_8 solution. (b), (c) and (d) 1 min, 10 min and 60 min after the addition of Li_2S powder into the 1M Li_2S_8 solution under Ar protected.

As is indicated in figure S3, after the addition of excessive Li_2S powder, color of the Li_2S_4 solution rapidly changed to yellow-green at room temperature after 5 min and showed no apparently change in the following 60 min. the results means that the S_8^{2-} ions could rapidly react with the Li_2S powder and form S4 in room temperature.

S4 Charge and discharge curves of the battery with 50 mg/cm² S powder and Li metal anode at the first cycle.

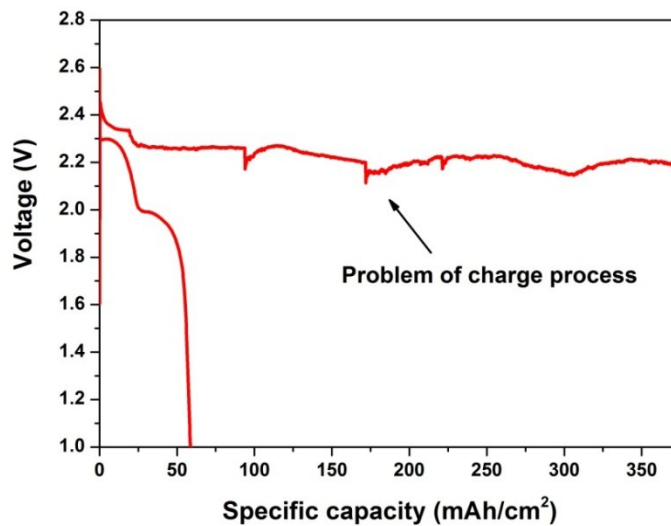


Figure S4 First cycle curves of the battery with 50 mg/cm² S powder and Li metal anode.

S5 SEM of the porous current collector (Ni foam) before and after 3 cycles and charged to 3.0 V.

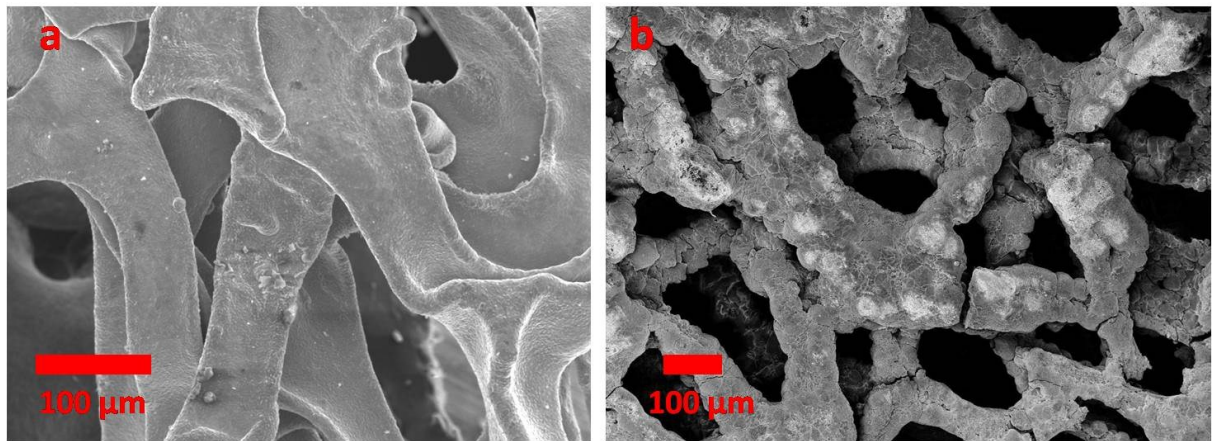


Figure S5 SEM of the porous current collector before and after 3 cycles and charged to 3.0 V.

As is indicated in figure S5, after several cycles, the current collector was coated with a layer of S film (It won't be other Li_2S_x compound because the sample had been washed by water before test).

S6 SEM and EDS of the current collector of the S-Se-battery after 3 cycles and charged to 3.0 V.

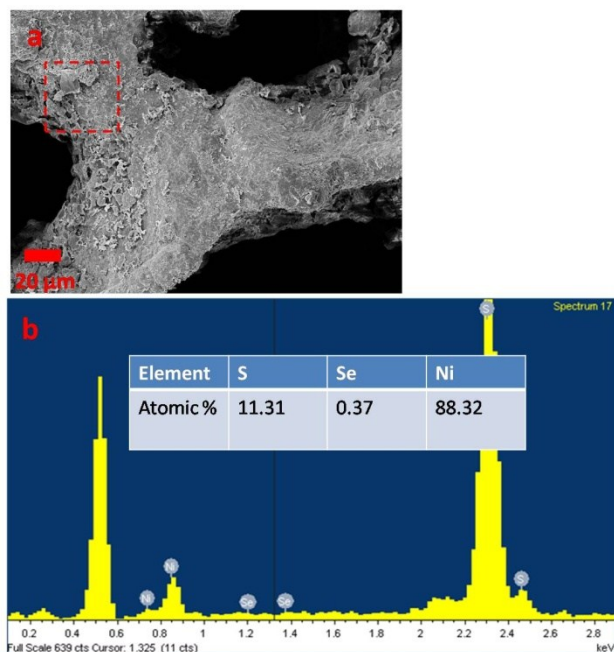


Figure S6 (a) SEM of the current collector of the S-Se-battery after 3 cycles and charged to 3.0 V. (b) EDS of the marked position in figure a.

As is indicated in Figure S6, composite deposited on the surface of the Ni foam was composed by S and Se with an atomic ration of $\sim 30 : 1$. This means that the S film coated on the Ni foam could be doped by the additional Se powder in the S store region of the battery.

S7 EDS mapping of Li/Al alloy anode in both fresh and cycled status

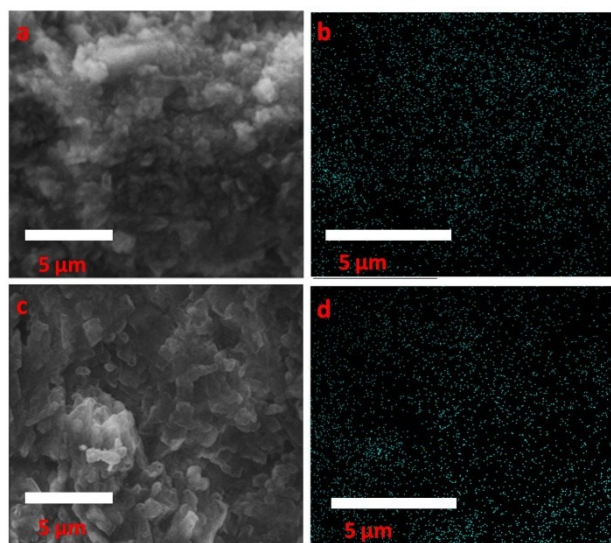


Figure S7 EDS mapping (Al element) of Li/Al alloy anode in both fresh (a-b) and cycled status (c-d).

S8 Digital photos of the S-Se powders formed electrode before and after cycles.

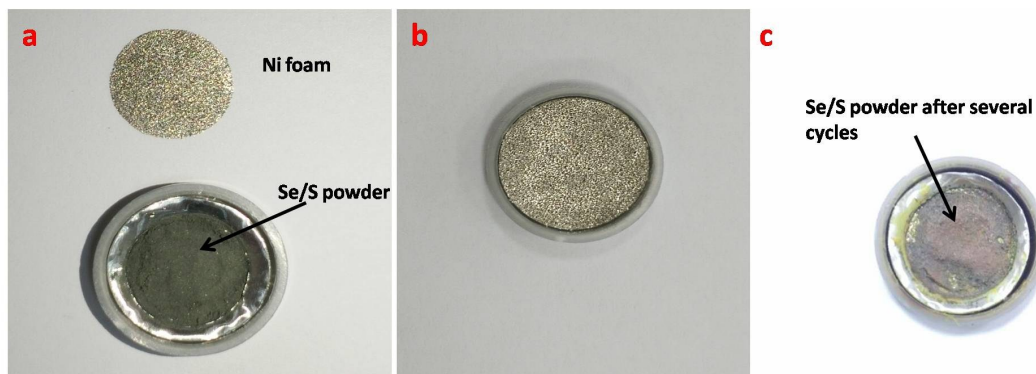


Figure S8 Digital photos of the S-Se powders formed electrode before (a-b) and after cycles (c).

S9 Charge and discharge curves of Se-battery with only Se was stored in the storage region

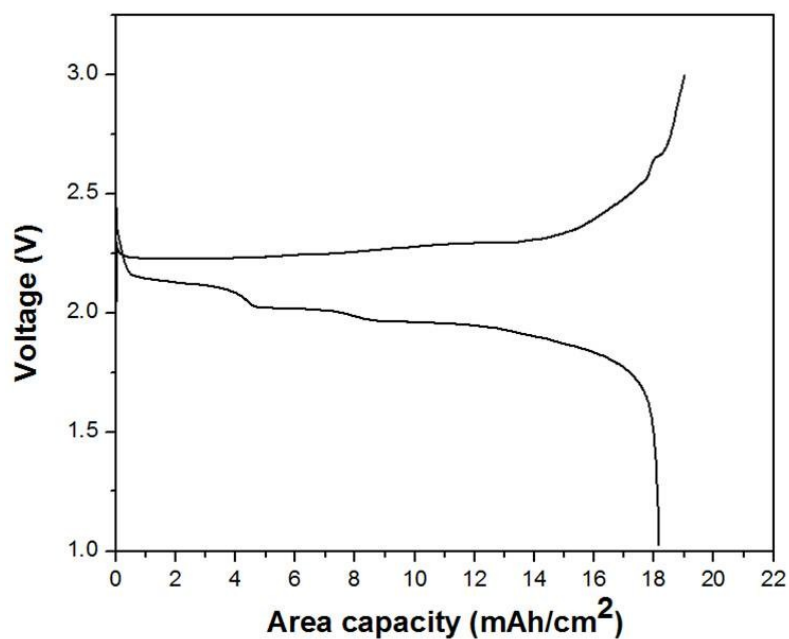


Figure S9 Charge and discharge curves of Se-battery with only Se was stored in the storage region

