Electronic Supplementary Information

Sulfur-hydrazine hydrate-based chemical synthesis of Sulfur@graphene composite for Lithium-sulfur batteries

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**Fig. S1** Digital graph of (left) hydrazine hydrate and (right) the solution of sulfur-hydrazine hydrate.
Fig. S2 (A,B) FESEM and (C,D) TEM images of S/N-rGO composite. Scale bars: (A-D) 1 μm.
Fig. S3 (A) FESEM image of S/N-rGO composite and (B) the corresponding elemental mapping images collected from the rectangular area marked in panel A. Scale bars: (A) 350 nm, (B) 200 nm.
Fig. S4 EDX spectrum of S@N-rGO composite.
Fig. S5 The galvanostatic charge–discharge profiles of the S@N-rGO (A) and S/N-rGO (B) cathodes between 1.7-2.8 V versus Li$^+$/Li at different rate densities.
Fig. S6 EIS results of S@N-rGO before and after cycling at 0.8 A g\(^{-1}\) for 15 cycles.
Fig. S7 FESEM images of S@N-rGO after 30 cycles at the current density of 0.8 A g\(^{-1}\).
(Scale bar: 200 nm for both)
Fig. S8 The digital photo of N-rGO in a polysulfide solution: (A) fresh Li$_2$S$_4$/DME, (B) Li$_2$S$_4$/DME after stirring with N-rGO for 2 h.
Fig. S9 (A) TGA curve of S@N-rGO with 63%S, (B) Cycling performance of S@N-rGO with 63%S and 76%S for 170 cycles at a current rate of 1C.