Supporting information

Fe₃C Decorated Folic Acid-Derived Graphene-Like Carbon Modified Separator as Polysulfide Barrier for High-Performance Lithium-Sulfur Battery

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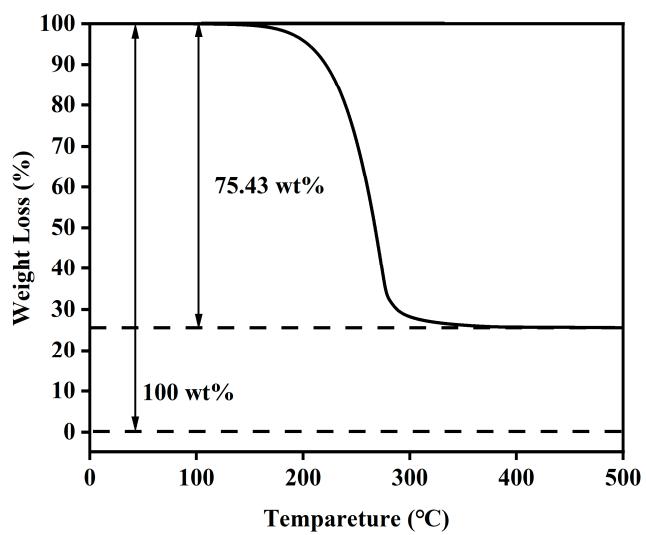
Figure S1. TGA curve of KB/S composites
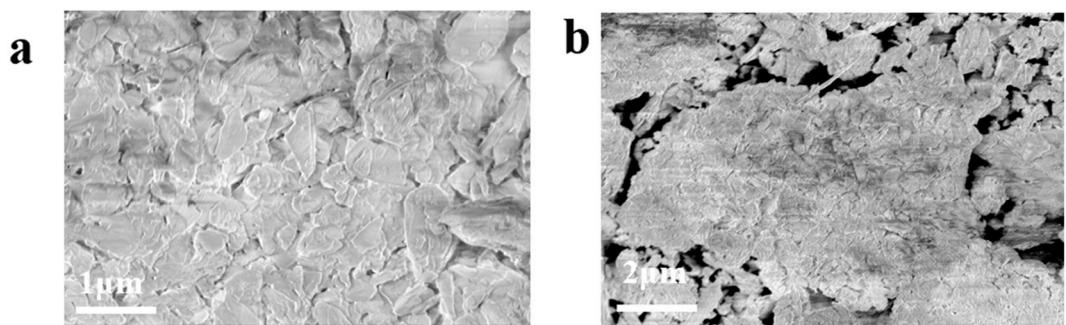
Figure S2. SEM images of raw folic acid without heat treatment
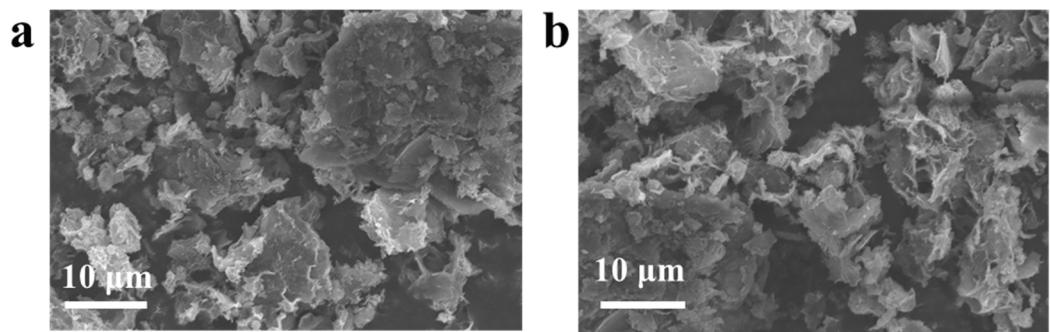
Figure S3. SEM images of N-CS
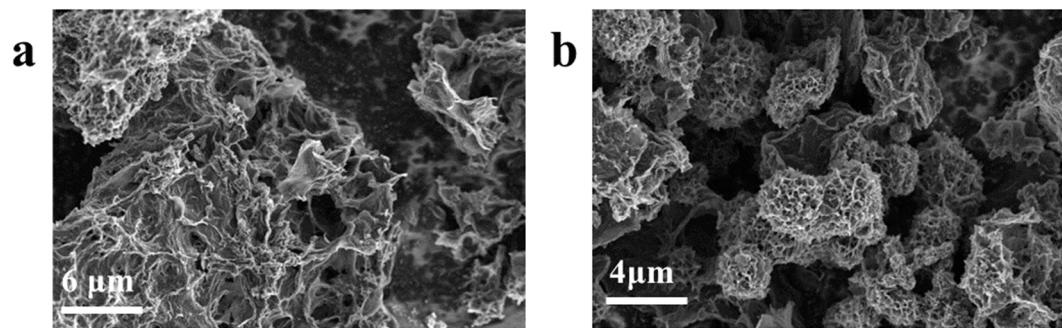
Figure S4. SEM images of Fe$_3$C@N-CS
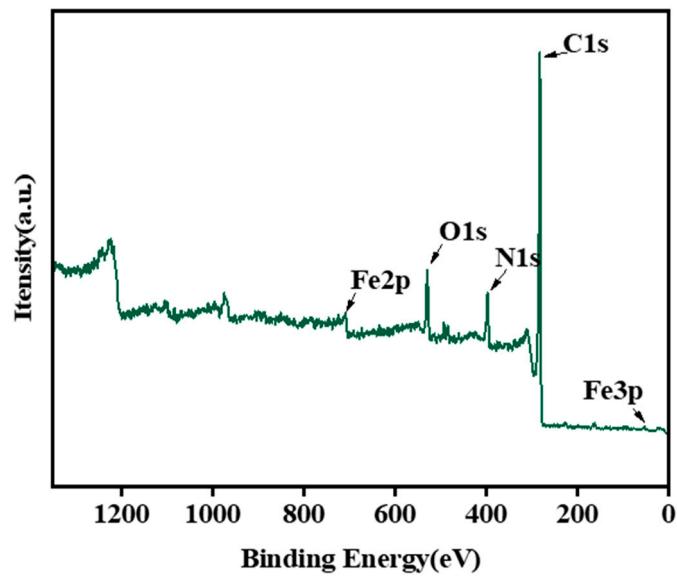
Figure S5. XPS spectrum of Fe₃C@N-CS
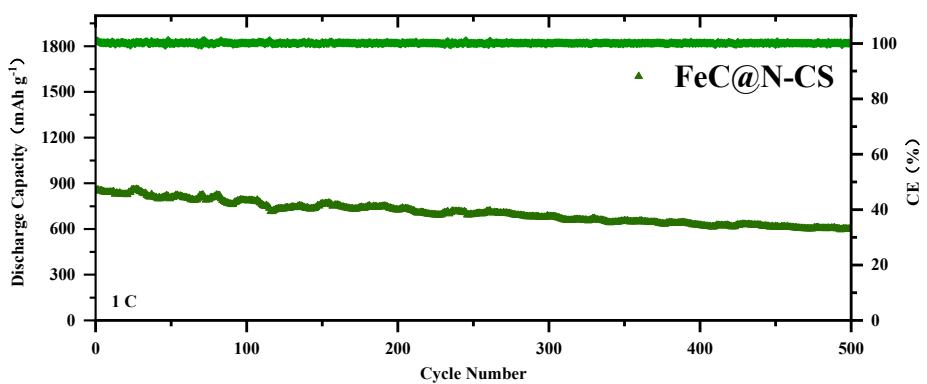
Figure S6. Long cycle performance of Li-S battery with Fe$_3$C@N-CS modified separator at 1 C
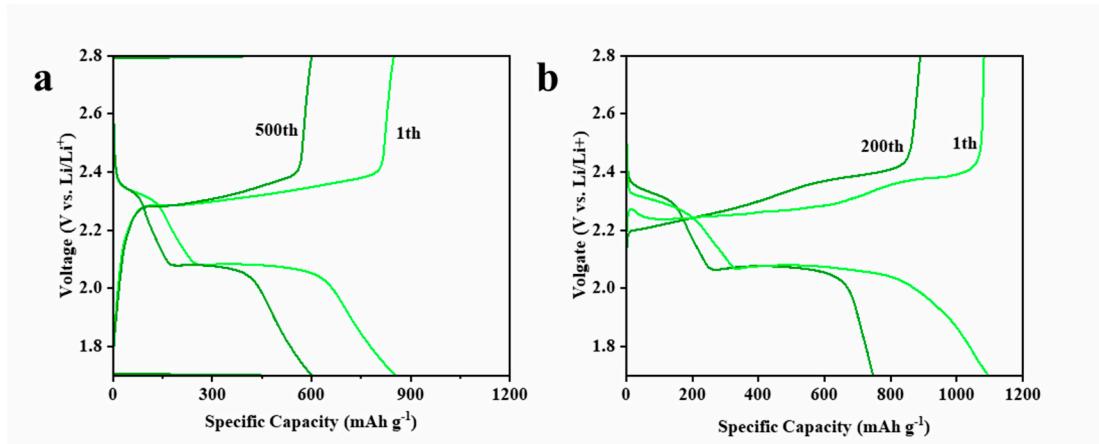
Figure S7. Galvanostatic charge/discharge profiles of Li-S battery with Fe₃C@N-CS modified separator at 1 C (a) and Li-S batteries with Fe₃C@N-CS modified separator under high S loading of 4 mg cm⁻² at 0.2 C (b)
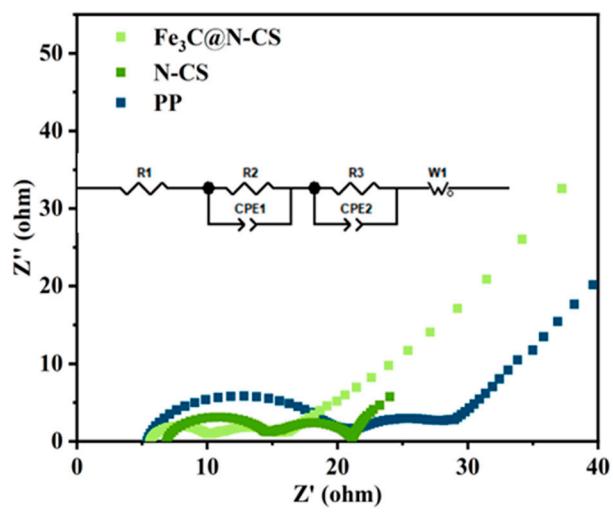
Figure S8. The EIS spectra of the cells with different separators after 50 cycles at 1 C
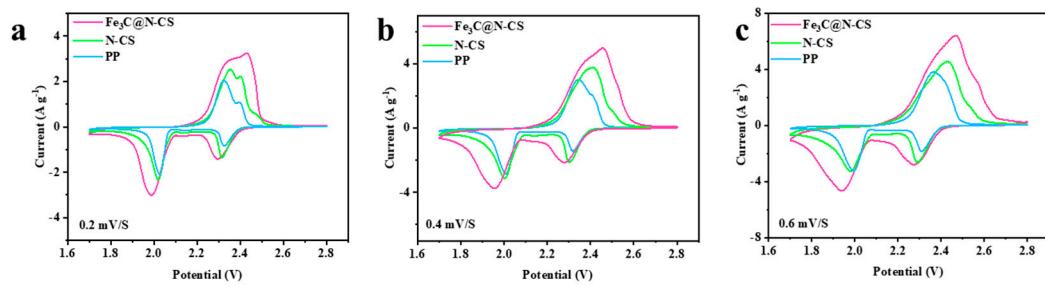
Figure S9. CV curves of Li-S battery with Fe₃C@N-CS, N-CS, and PP separators at 0.2 mV s⁻¹ (a), 0.4 mV s⁻¹ (b), and 0.6 mV s⁻¹ (c)
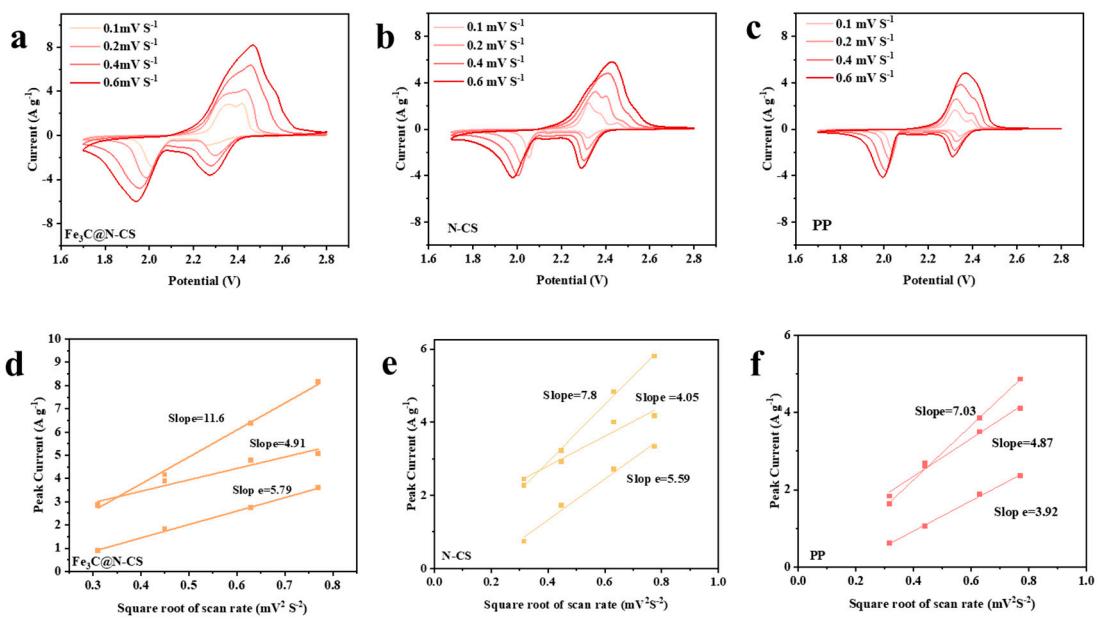
Figure S10. CV curves of cells with Fe$_3$C@N-CS (a), N-CS (b), PP (c) separators at 0.1-0.6 mV s^{-1}, and Slope images of fitting linear curves of the peak currents versus square roots of scan rate (d, e, f).

Table 1. The table of the performance comparison between this work and relevant research.

Material	Sulfur loading [mg cm^{-2}]	Capacity at the low rate	Capacity at the high rate	Cycles (rate)/ Decay rate [%]	Ref.
Fe$_3$C@N-CS	1.278	1260 (0.2 C)	890 (1 C)	500 (1 C)/0.06	**This work**
Fe$_3$C-N-rGO	0.7-1	1075 (0.1 C)	580.5 (4 C)	100 (1 C)/0.068	[S1]
Fe$_3$S$_4$/rGO	1	1293 (0.2 C)	684 (1 C)	300 (1 C)/0.052	[S2]
Fe$_2$O$_3$/Fe-SA@NC	1.2	1192 (0.2 C)	…	800 (1 C)/ 0.025	[S3]
Fe$_3$C/CNF	2.3~2.8	1177 (200 mA/g)	…	100 (x200 mA/g)/0.24	[S4]
Fe$_3$C/Fe@NC/ G	1.5	1200 (0.2 C)	850 (1 C)	500 (1 C)/0.062	[S5]
Fe$_3$C-CNF	~ 2.0	1087 (0.2 C)	1040 (1 C)	250 (1 C)/0.091	[S6]
Fe$_3$C-FeN@NCF	… (71.8 wt%)	1028 (0.5 C)	…	400 (0.5 C)/0.1	[S7]
KB&Fe$_3$O$_4$-GF	0.7	1004.9 (0.5 C)	869.3 (1 C)	80 (1 C)/0.075	[S8]

S1 H. Pan; Z. Tan; H. Zhou; L. Jiang; Z. Huang; Q. Feng; Q. Zhou; S. Ma; Y. Kuang. Fe_3C-N-doped carbon modified separator for high performance lithium-sulfur batteries. *Journal of Energy Chemistry* **2019** 39 101-108.

S2 L. Li; H. Liu; B. Jin; Q. Sheng; Q. Li; M. Cui; Y. Li; X. Lang; Q. Jiang. Functional Separator Modified with Reduced Graphene Oxide and Fe_3S_4 for High-Performance Lithium–Sulfur Batteries. *ACS Applied Nano Materials* **2023** 6 1161-1170.

S3 S. Zhang; Y. Zhang; L. Ma; C. Ma; C. Zhang; Y. Chen; L. Chen; L. Zhou; W. Wei. Dual Active Sites of Oversaturated Fe-N$_{(5)}$ and Fe$_{(2)}$O$_{(3)}$ Nanoparticles for Accelerating Redox Kinetics of Polysulfides. *Small* **2023** e2300293.

S4 J.-Q. Huang; B. Zhang; Z.-L. Xu; S. Abouali; M. Akbari Garakani; J. Huang; J.-K. Kim. Novel interlayer made from Fe_3C/carbon nanofiber webs for high performance lithium–sulfur batteries. *Journal of Power Sources* **2015** 285 43-50.

S5 S. Wang; X. Liu; H. Duan; Y. Deng; G. Chen. Fe_3C/Fe nanoparticles embedded in N-doped porous carbon nanosheets and graphene: A thin functional interlayer for PP separator to boost performance of Li-S batteries. *Chemical Engineering Journal* **2021** 415 129001.

S6 K. Wu; Y. Hu; Z. Cheng; P. Pan; M. Zhang; L. Jiang; J. Mao; C. Ni; Y. Zhang; Z. Wang; X. Gu; X. Zhang. Fe_3C composite carbon nanofiber interlayer for efficient trapping and conversion of polysulfides in lithium-sulfur batteries. *Journal of Alloys and Compounds* **2020** 847 156447.

S7 M. Zhang; J. Mu; Y. Li; Y. Pan; Z. Dong; B. Chen; S. Guo; W. Yuan; H. Fang; H. Hu; M. Wu. Propelling polysulfide redox by Fe_3C-FeN heterostructure@nitrogen-doped carbon framework towards high-efficiency Li-S batteries. *Journal of Energy Chemistry* **2023** 78 105-114.

S8 R. Zhu; S. Lin; J. Jiao; D. Ma; Z. Cai; K. Hany; T.M. Hamouda; Y. Cai. Magnetic and mesoporous Fe_3O_4-modified glass fiber separator for high-performance lithium-sulfur battery. *Ionics* **2019** 26 2325-2334.