Supplementary Material for

A zwitterionic polyethyleneimine binder in lithium-sulfur batteries: synergistic effects of polysulfide anchoring and Li^+ transport promotion

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Supplementary data

Methods:

Synthesis of lithium 3-chloroproanesulfonyl(trifluoromethanesulfonylimide) (LiCPSI)

Trifluoromethanesulfonamide (14.9 g, 0.1 mol) and lithium hydroxide (4.8g, 0.2 mol) were added to anhydrous acetonitrile (150 ml). Then 3-chloropropanesulfonyl chloride (17.7 g, 0.1 mol) dispersed in anhydrous acetonitrile (100 ml) was added dropwise to the above mixture under argon protection at 0 ℃. After completion of the dropwise addition, the reaction was allowed to continue for 24 h at room temperature. When the reaction was complete, the mixtures were filtered and the filtrates were concentrated by rotary evaporation. The concentrated filtrates were recrystallized three times in dichloromethane to obtain a pure white solid powder. The solid powder obtained was dried in a vacuum oven at 60 ℃ for 24 h.

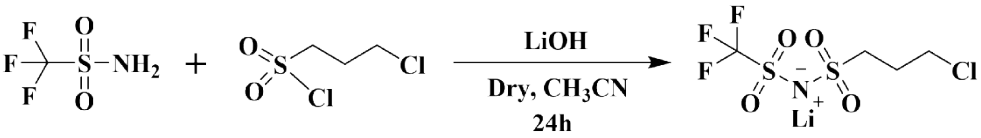

Fig. S1. The synthetic route of LiCPSI.

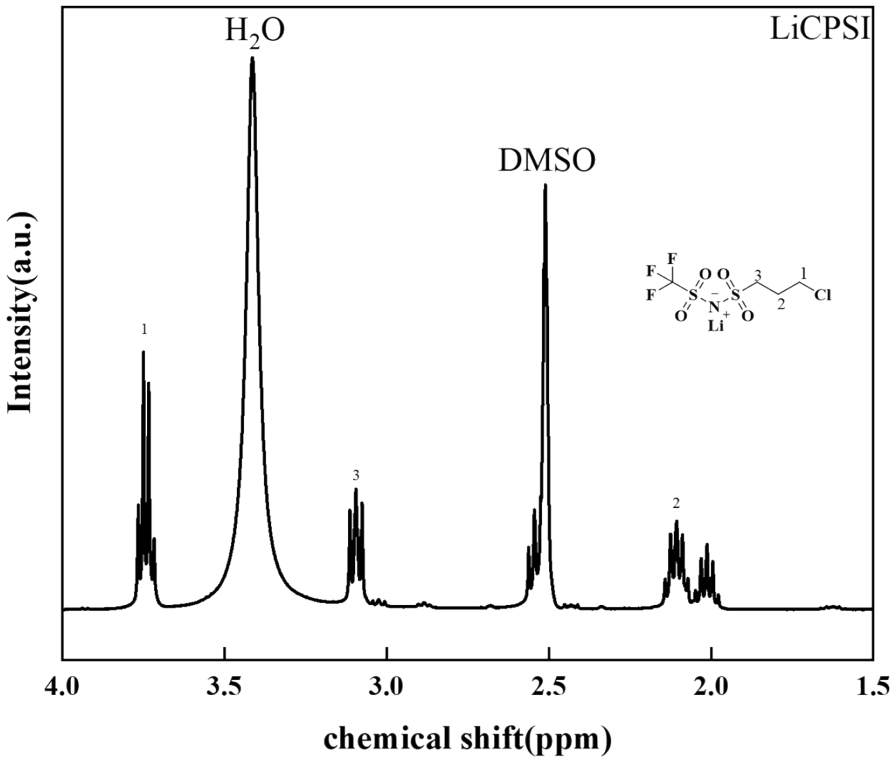

Fig. S2. 1H NMR spectrum of LiCPSI (400 MHz, DMSO-d6) δ 3.74 (d, J = 6.5 Hz, 1H), 3.12 – 3.06 (m, 1H), 2.11 (dt, J = 14.0, 6.7 Hz, 1H).

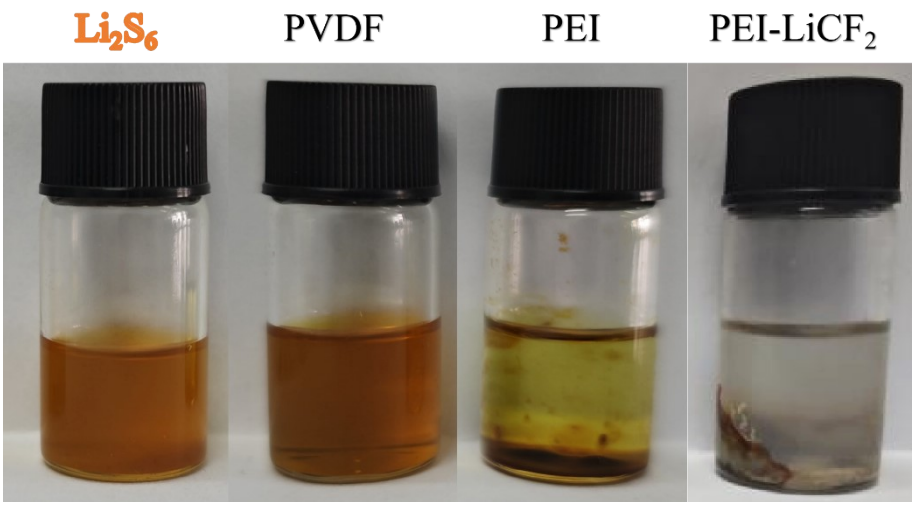

Fig. S3. Static adsorption experiment of Li_2S_6 by PVDF, PEI, and PEI-$LiCF_2$ binders.

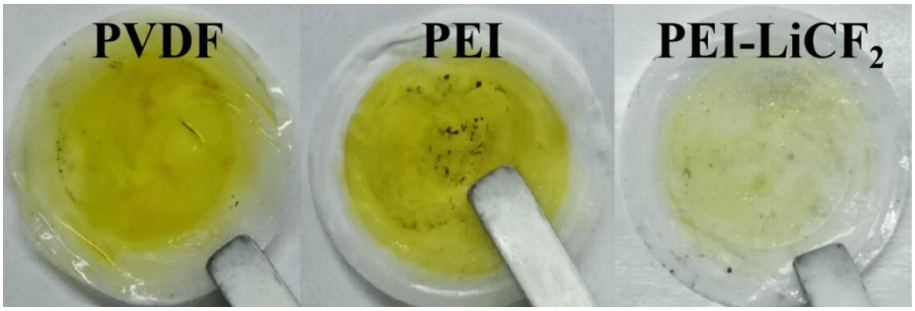

Fig. S4. The pictures of separators of PVDF, PEI and PEI-$LiCF_2$ after 0.1C cycling.

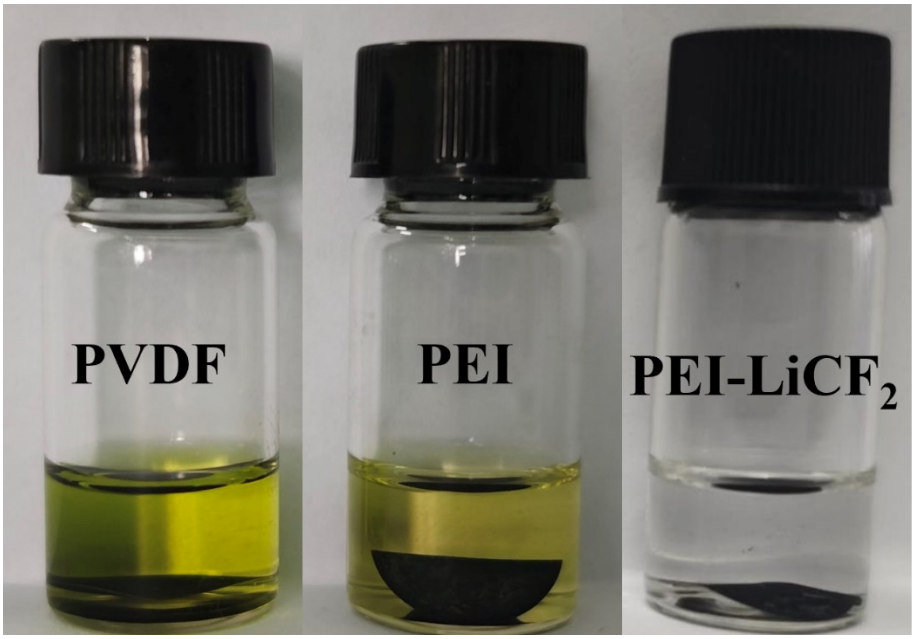

Fig. S5. The Pictures of PVDF, PEI and PEI-$LiCF_2$ cathodes immersed in electrolyte after 0.1C cycling.

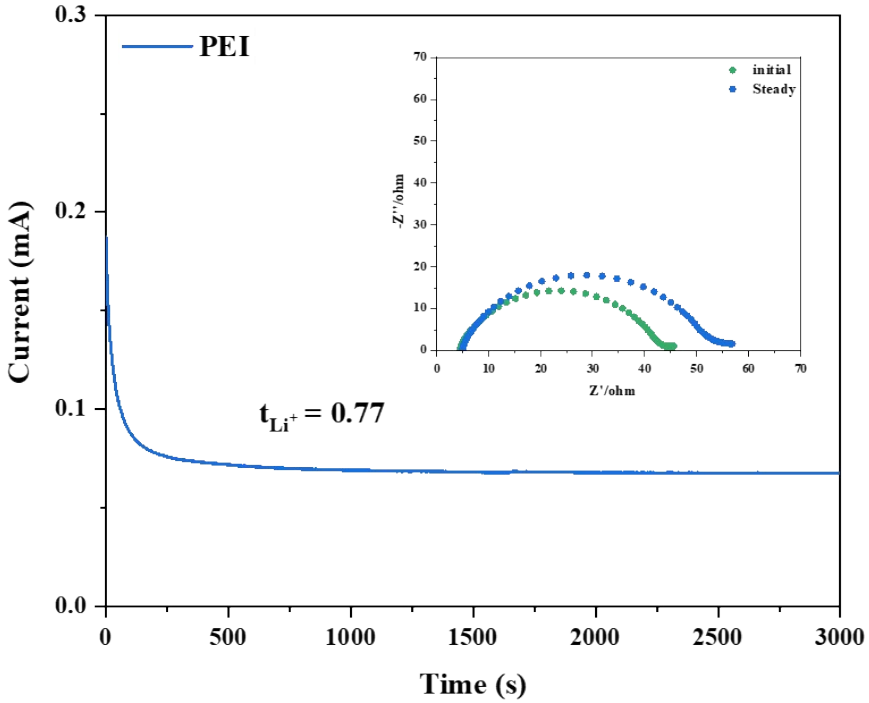

Fig. S6. Current-time profiles and EIS curves of Li|| PEI-$LiCF_2$||Li

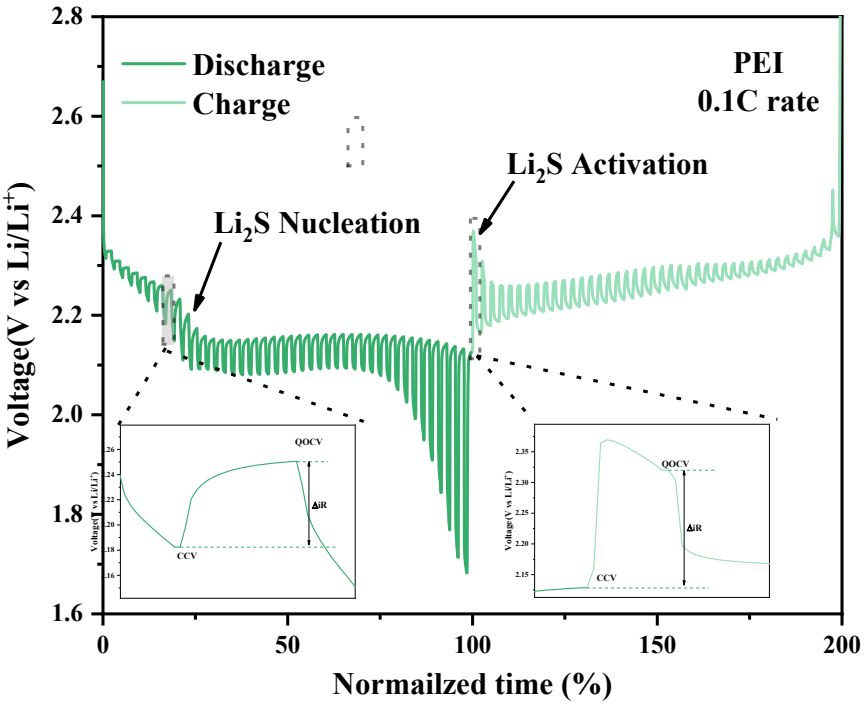

Fig. S7. GITT curve of PEI

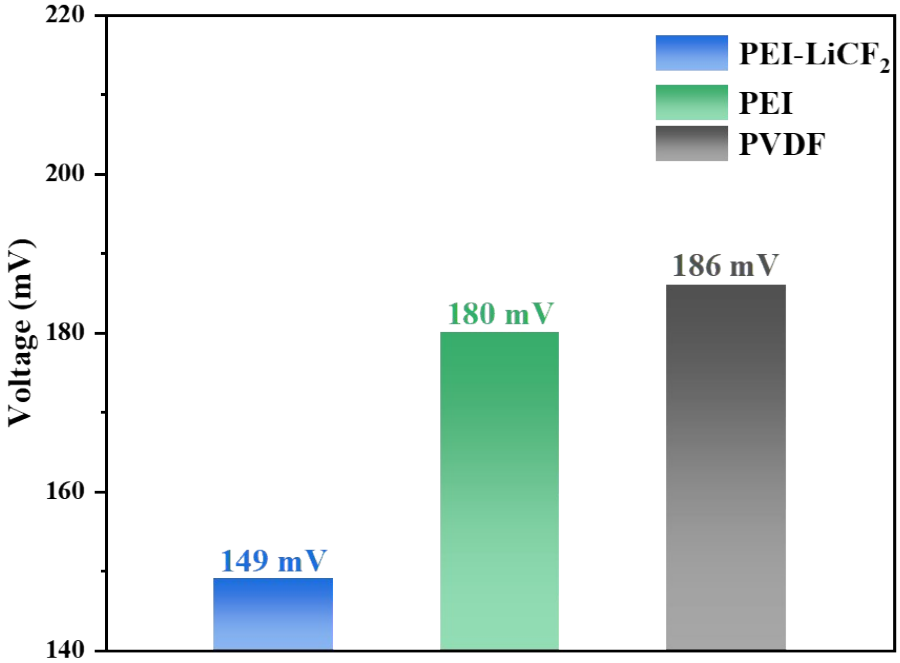

Fig. S8. ΔE value of PEI-$LiCF_2$; PEI and PVDF.

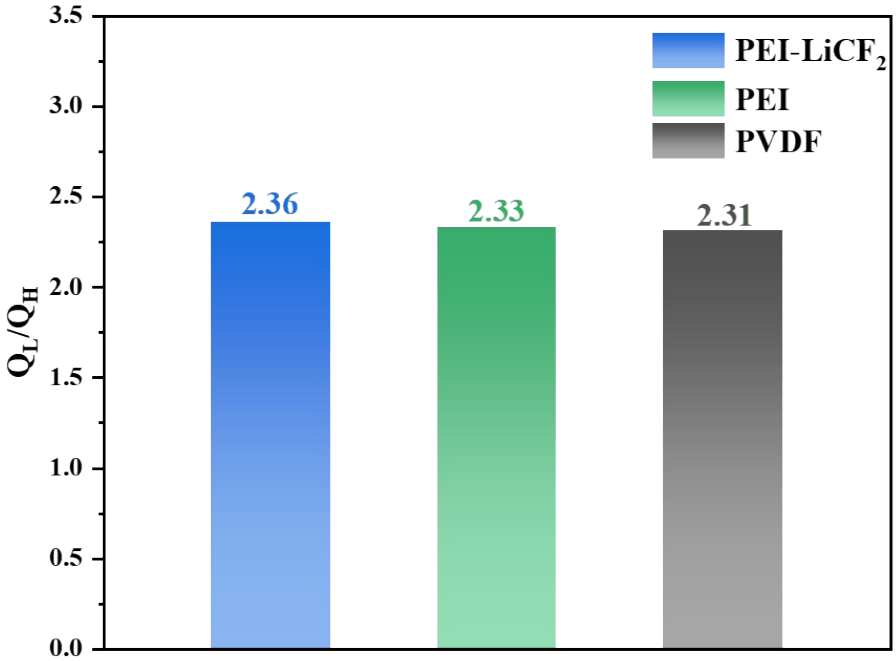

Fig. S9. Q_L/Q_H values of PEI-$LiCF_2$, PEI and PVDF

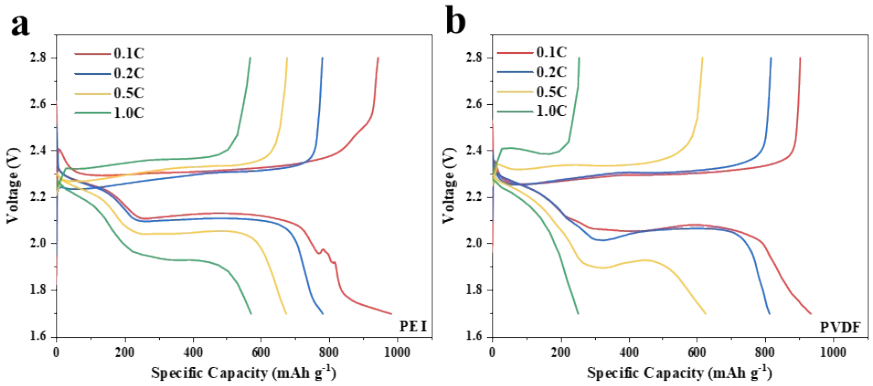

Fig. S10 Galvanostatic charge-discharge curves of (a) PEI and (b) PVDF electrode at different rates

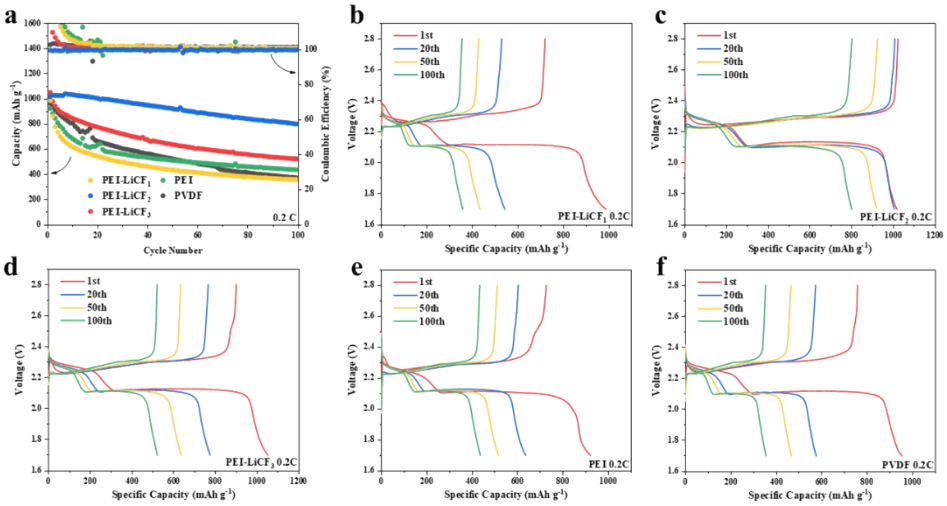

Fig. S11 (a) Cycling performance of different binders at 0.2 C; Galvanostatic charge-discharge curves of (b) PEI-LiCF$_1$; (c) PEI-LiCF$_2$;(d) PEI-LiCF$_3$;(e) PEI and (f) PVDF with different number of turns.

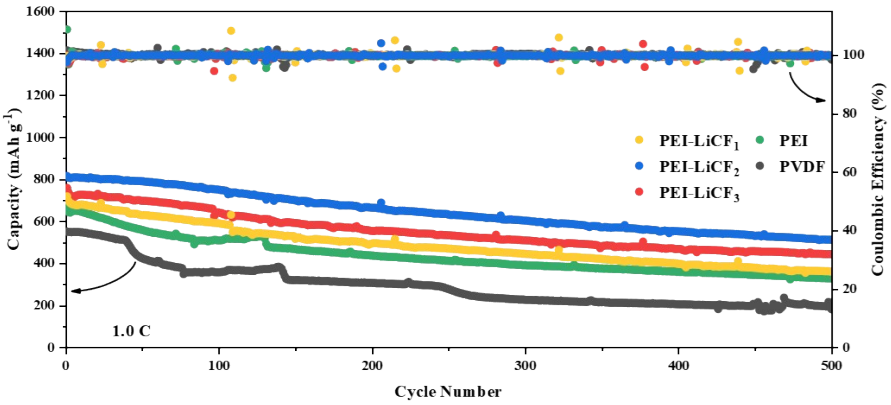

Fig. S12 Long-term cycling stability at 1 C

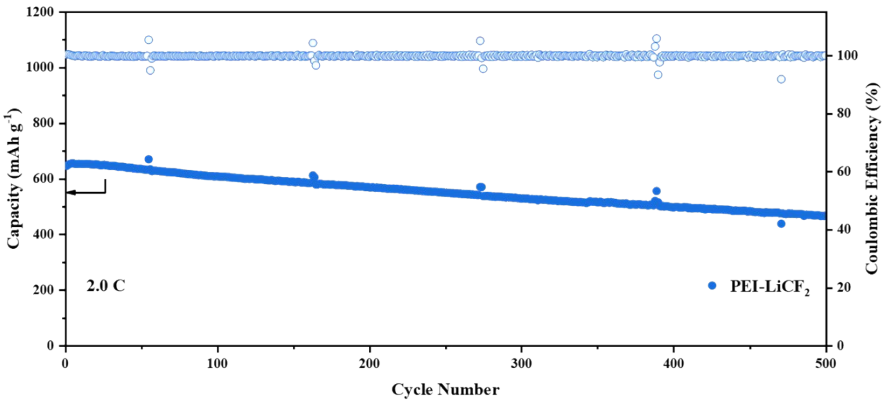

Fig. S13. Long-term cycling stability at 2 C

Table. S1. Representative work of for Li-S electrodes using different binders in recent years.

Binders	Initial capacity (Current density)	Final capacity (Cycle number)	Capacity retention (%)
PEI-$LiCF_2$	**1017.8 mAh g^{-1} (0.2C)**	**800.5 mAh g^{-1} (100)**	**78.6%**
(This work)	**816 mAh g^{-1} (1C)**	**512 mAh g^{-1} (500)**	**63%**
ChMSA25[1]	417 mAh g^{-1} (1C)	296 mAh g^{-1} (500)	71%
CAB[2]	981 mAh g^{-1} (0.5C)	678 mAh g^{-1} (200)	69%
C-PF[3]	979.5 mAh g^{-1} (0.1C)	670 mAh g^{-1} (100)	68.4%
PTTG[4]	980.28 mAh g^{-1} (0.2C)	825 mAh g^{-1} (80)	84%
c-QACS[5]	944.8 mAh g^{-1} (0.2C)	700 mAh g^{-1} (100)	74%
PAM-PAA[6]	1008.1 mAh g^{-1} (0.2C)	600 mAh g^{-1} (200)	60%
FBCP[7]	730.7 mAh g^{-1} (0.2C)	518.8 mAh g^{-1} (100)	71%
SA-Co-PEDOT[8]	877.8 mAh g^{-1} (0.5C)	395 mAh g^{-1} (500)	45%
CCS-MWCNTs[9]	1016 mAh g^{-1} (0.2C)	690 mAh g^{-1} (100)	68%

References

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