Electronic Supplementary Material (ESI) for RSC Advances.


**Supplementary Information for**

# Solvate ionic liquid electrolyte with 1,1,2,2-tetrafluoroethyl 2,2,2-trifluoroethyl ether as a support solvent for advanced lithium-sulfur batteries

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**Fig. S1** The solubility pictures of polysulfide in various electrolytes after standing for 3 days. The dissolution quantity of polysulfide decreases gradually as TFTFE content in the electrolyte increases.

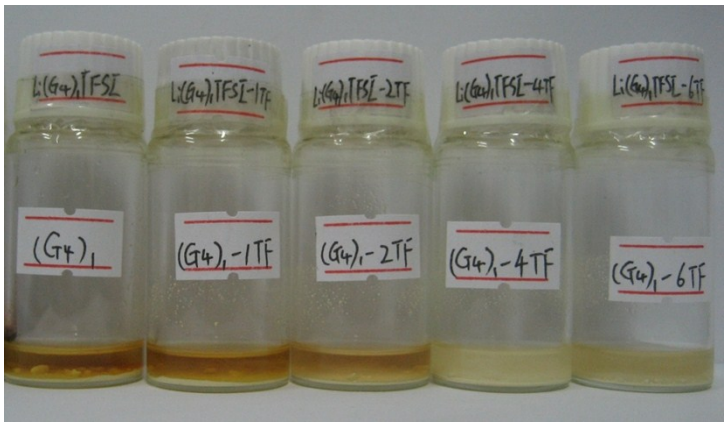


**Fig. S2** The separators extracted from the cells cycled in (a) $Li(G4)_1TFSI$, (b) $Li(G4)_1TFSI$-2TF and (c) $Li(G4)_1TFSI$-4TF. As the separator can absorb certain amount of electrolyte, its color can also characterize the solubility of polysulfides in the electrolyte. The pictures below further reveal that the fluorinated ether is beneficial to reduce polysulfide dissolution.

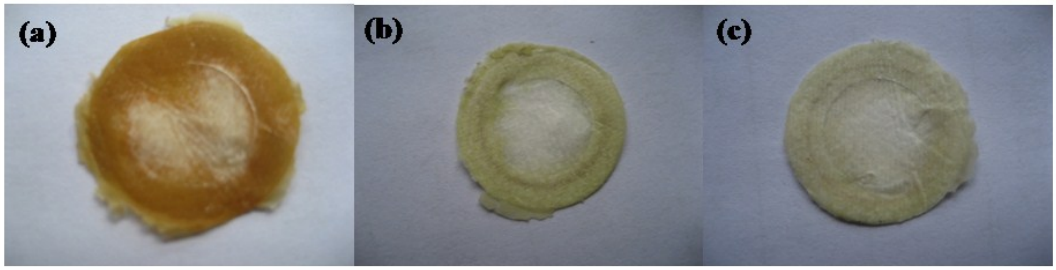

**Fig. S3** TGA curve of the sulfur-carbon composite employed in the study. It shows that the sulfur content in the composite reaches 79.1%.

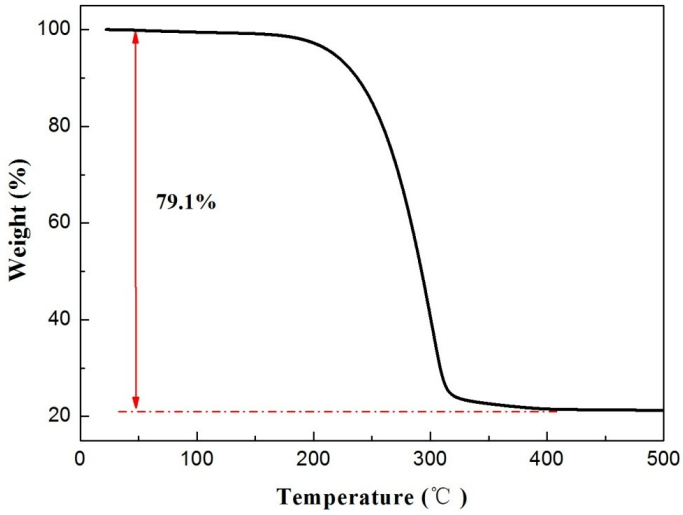


**Fig. S4** (a) Discharge capacity and (b) coulombic efficiency of the cell in different electrolytes at 0.1 C. The relatively lower TFTFE contents contribute to better cycle stability. The coulombic efficiencies of these cells are all close to 100%.

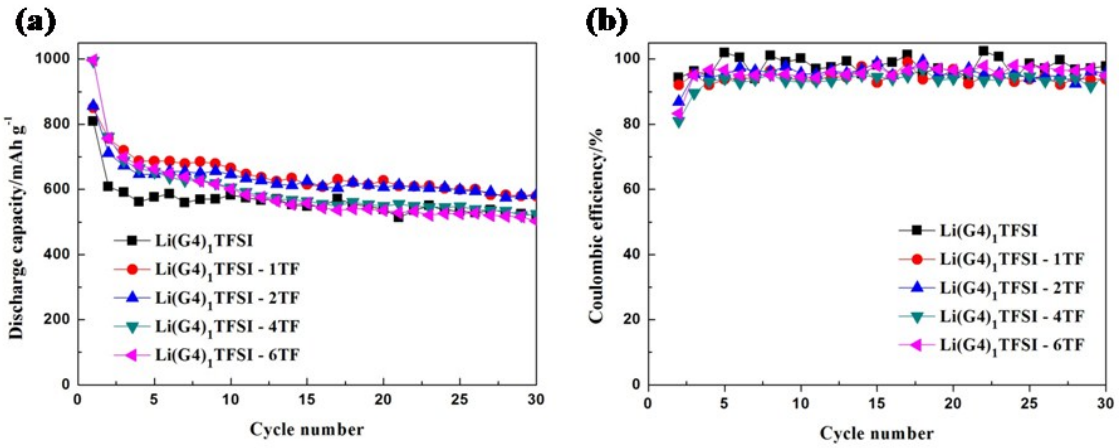

**Fig. S5** Initial charge-discharge curves of the cells in two electrolytes at a rate of 0.3 C. It suggests that the polarization of the cell with $Li(G4)_1TFSI$-4TF is smaller than that with $Li(G4)_1TFSI$.