Supplementary Information

A Novel Zwitterionic Ionic Liquid-based Electrolyte for More Efficient and Safer Lithium-Sulfur Battery

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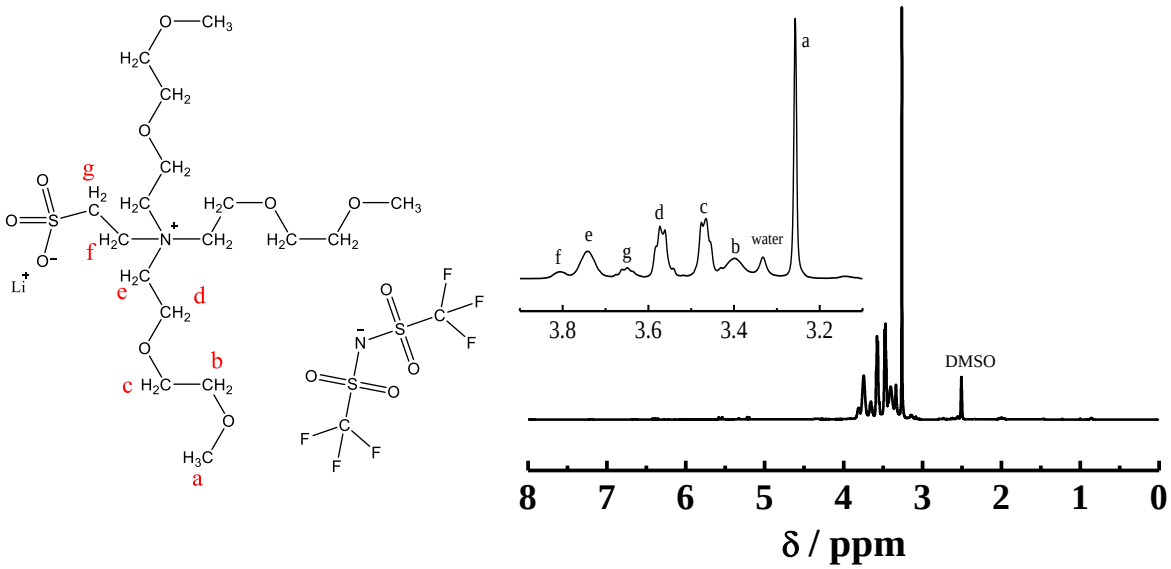


Figure S1. ^{1}H-NMR spectrum of zwitterionic ionic liquid TLTFSI.

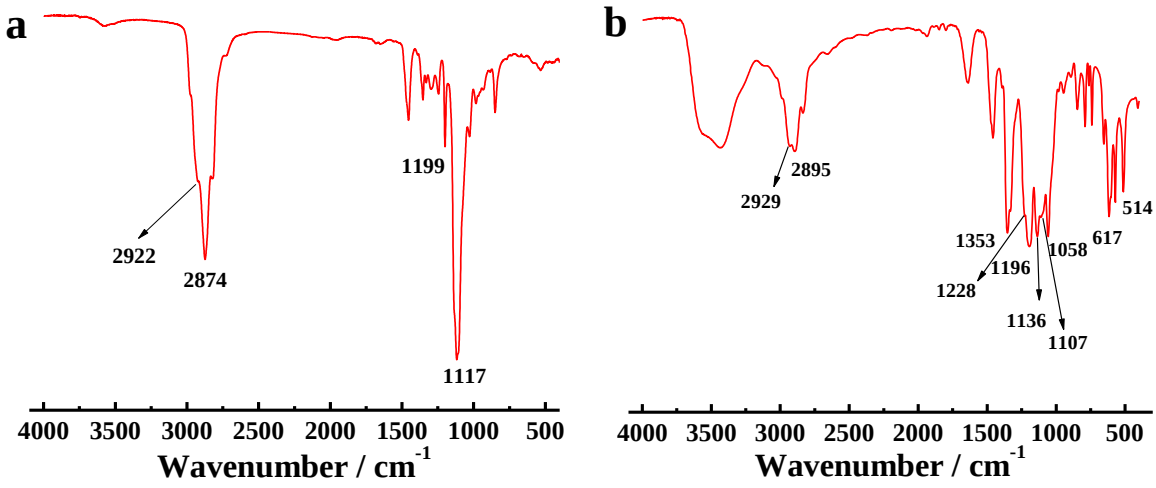


Figure S2. The FTIR spectra of (a) TDA and (b) TLTFSI.

The characteristic absorption peaks in **Figure S2a** represent for: ν_{CH} of CH_3&CH_2: 2922 cm^{-1}, 2874 cm^{-1}; ν_{C-N}: 1199 cm^{-1}; ν_{C-O-C}: 1117 cm^{-1}.

The characteristic absorption peaks in **Figure S2b** represent for: ν_{CH} of CH_3&CH_2: 2929 cm^{-1}, 2895 cm^{-1}; $\nu_{S=O}$ of the SO_2 in $TFSI^-$: 1353 cm^{-1}; ν_{CF_3} of the SO_2 in $TFSI^-$: 1228 cm^{-1}; $\nu_{S=O}$ of the SO_3^-: 1196 cm^{-1}, 1058 cm^{-1}; ν_{S-O} of the SO_3^-: 617 cm^{-1}, 514 cm^{-1}; ν_{C-N}: 1136 cm^{-1}; ν_{C-O-C}: 1107 cm^{-1}.

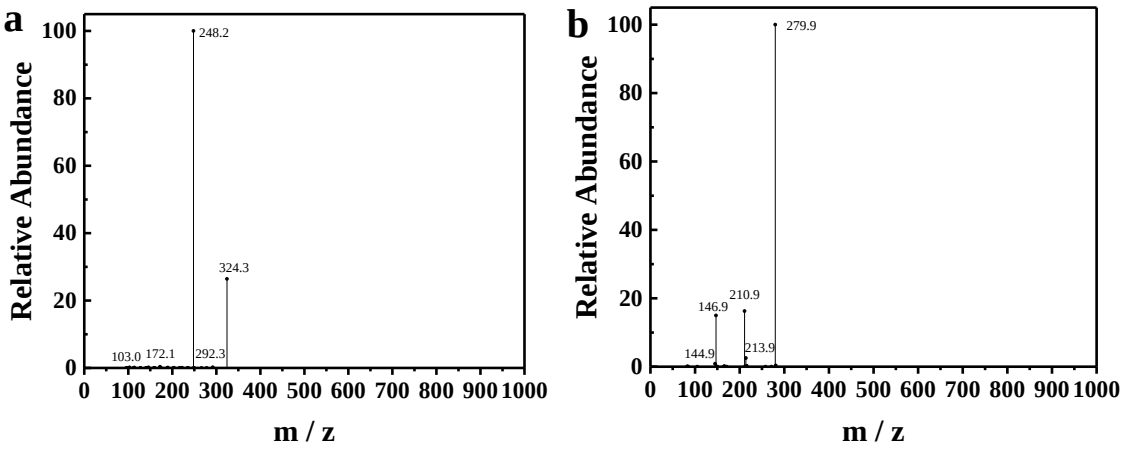


Figure S3. The mass spectra of TLTFSI, (a) positive mode and (b) negative mode.

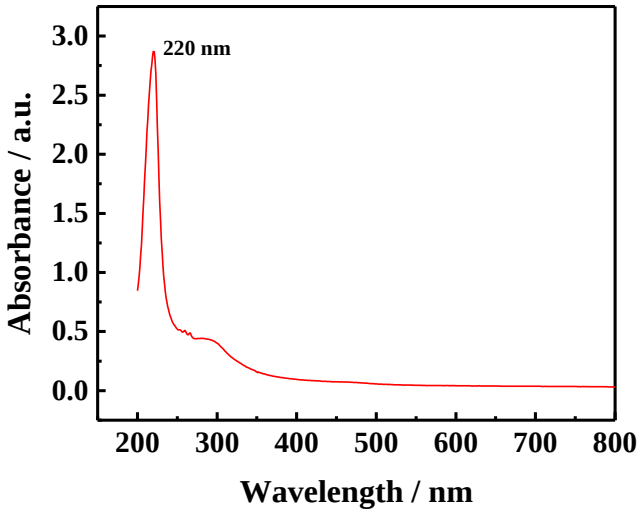


Figure S4. The UV-vis spectrum of TLTFSI.

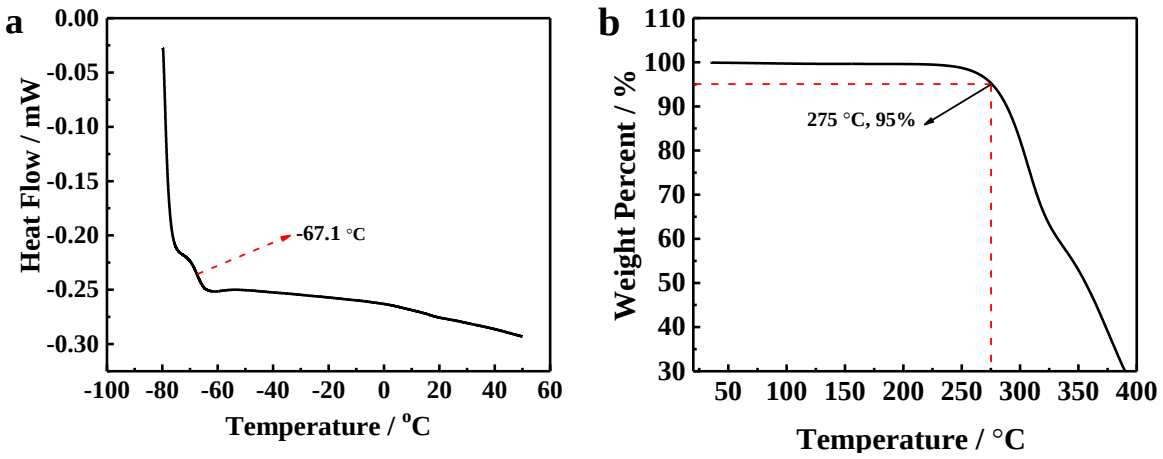


Figure S5. (a) DSC and (b) TGA curves of zwitterionic ionic liquid TLTFSI

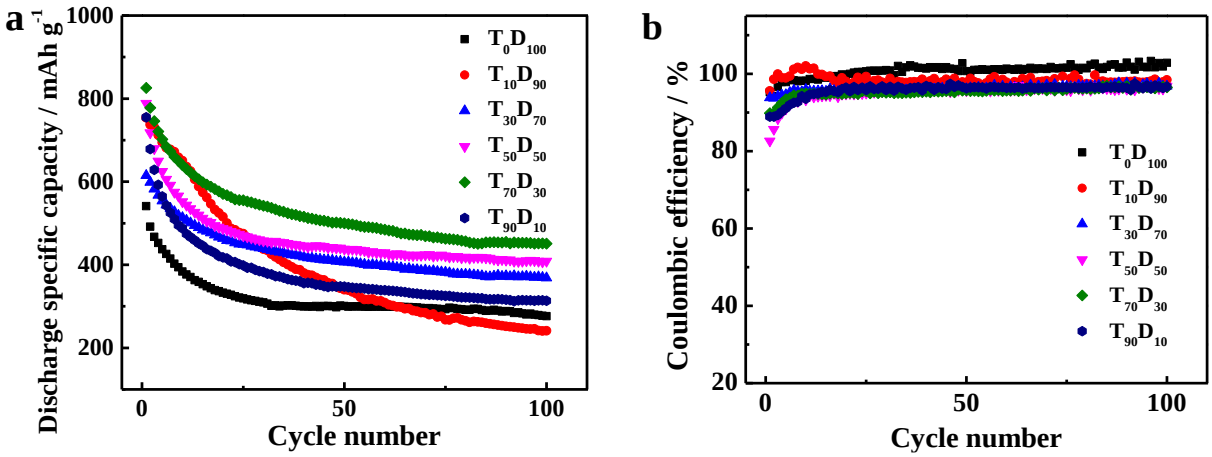


Figure S6. The cycle performances of LSBs with T_nD_m as the electrolytes recorded with a 0.5 C current density at 25 ℃.

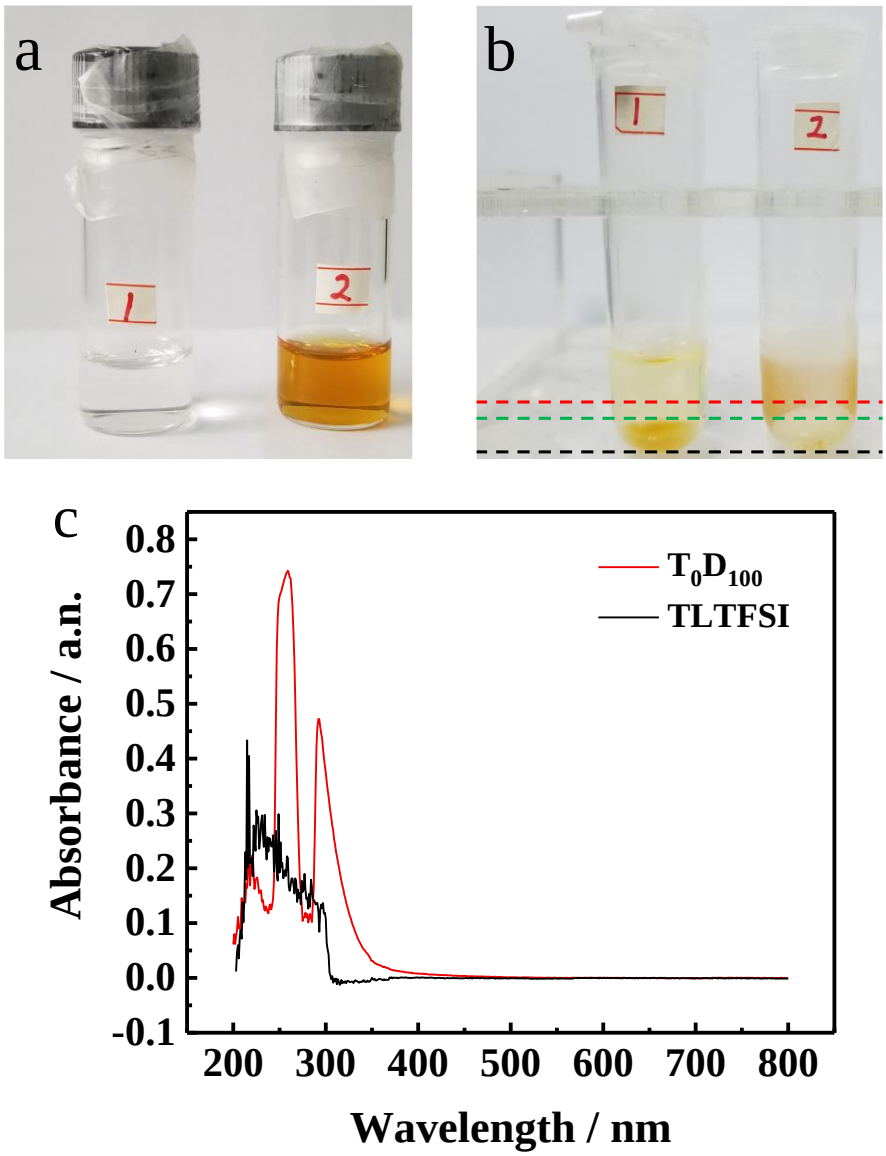


Figure S7. (a) The photo of T_0D_{100} and TLTFSI. The labels 1 and 2 represent for T_0D_{100} and TLTFSI, respectively. (b) the photo of T_0D_{100} and TLTFSI with Li_2S and sulfur powder mixtures. The labels 1 and 2 represent for T_0D_{100} and TLTFSI with Li_2S and sulfur powder mixtures, respectively. (c) the UV-vis spectra of T_0D_{100} and TLTFSI electrolytes with dissolved Li_2S_x.

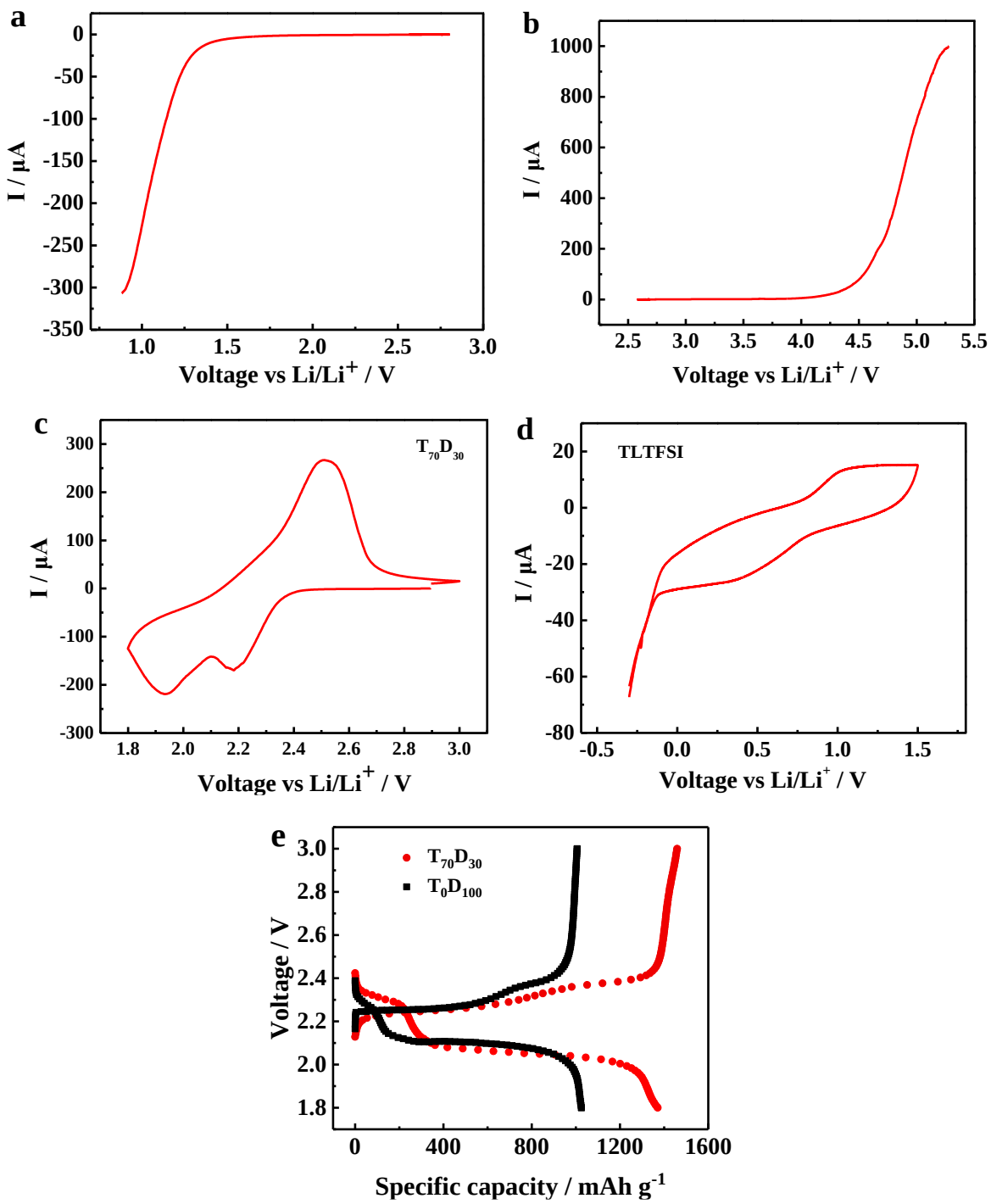


Figure S8. (a) LSV curve of $T_{70}D_{30}$ from 2.75 V to 0.75 V. (b) LSV curve of $T_{70}D_{30}$ from 2.60 V to 5.25 V. (c) The CV curve of LSB with $T_{70}D_{30}$ as electrolyte. (d) the CV curve of TLTFSI from -0.3 to 1.5 V. (e) the charge-discharge curves of LSBs with $T_{70}D_{30}$ and T_0D_{100} as electrolyte, respectively. The scanning speed for CV is 0.1 mV s^{-1} and the current density for charge-discharge test is 0.2 C.

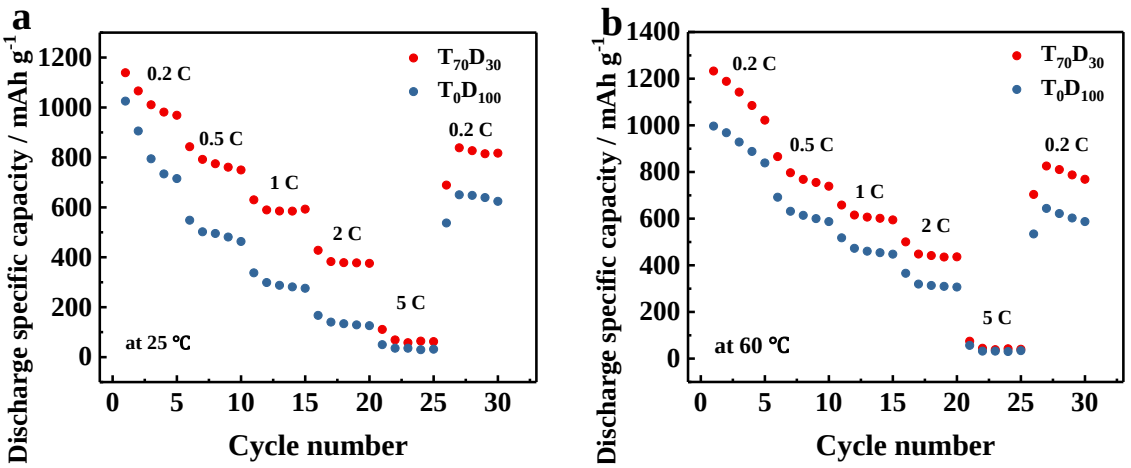
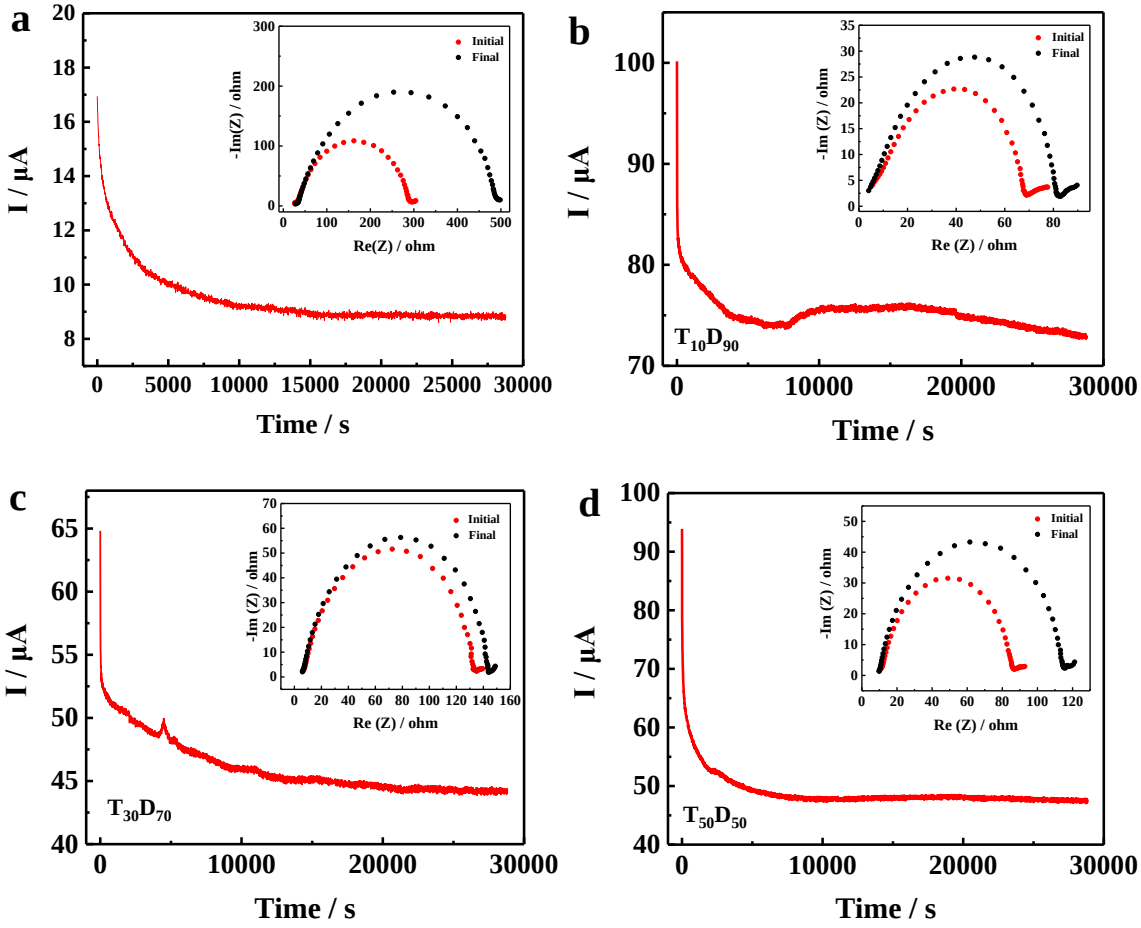


Figure S9. The rate performances of LSBs with $T_{70}D_{30}$ and T_0D_{100} electrolyte, respectively, measured under various current densities at (a) 25 °C, (b) 60 °C.



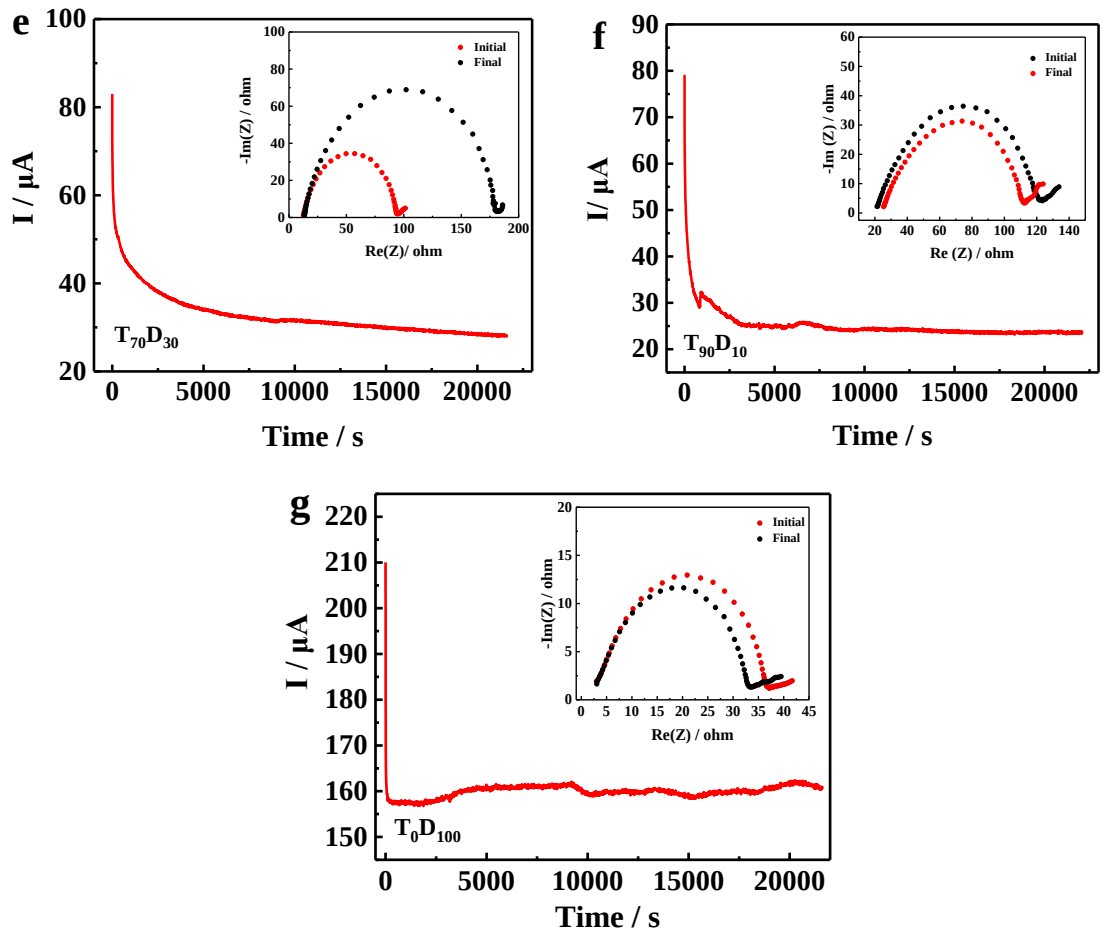


Figure S10. The current of a [Li metal anode | TLTFSI-based electrolyte | Li metal cathode] cell under a polarization voltage of 10 mV at 25 °C as a function of time. The inset shows the AC impedance spectra of the symmetrical cell before and after polarization. (a) TLTFSI, (b) $T_{10}D_{90}$, (c) $T_{30}D_{70}$, (d) $T_{50}D_{50}$, (e) $T_{70}D_{30}$, (f) $T_{90}D_{10}$ and (g) T_0D_{100}.

The lithium-ion transference number (t_{Li}^+) can be calculated by the following equation:

$$t_{Li}^+ = I_{ss}R_e^{ss}(\Delta V - I_0R_0) / I_0R_e^0(\Delta V - I_{ss}R_f)$$

where I_0, R_e^0, and R_0 are the initial current, electrolyte resistance and lithium interfacial resistance, respectively. I_{ss}, R_e^{ss}, and R_f are the steady current, electrolyte resistance and lithium interfacial resistance, respectively. ΔV is the polarization voltage.

Video S1. The degreased cotton after dipping into the $T_{70}D_{30}$ electrolyte can hardly be lighted by a lighter.

Video S2. The degreased cotton after dipping into the T_0D_{100} electrolyte can be easily lighted by a lighter and burned to ashes.