# *High voltage cathode-based lithium-metal batteries for all-climate application with polymerized DOL electrolyte*

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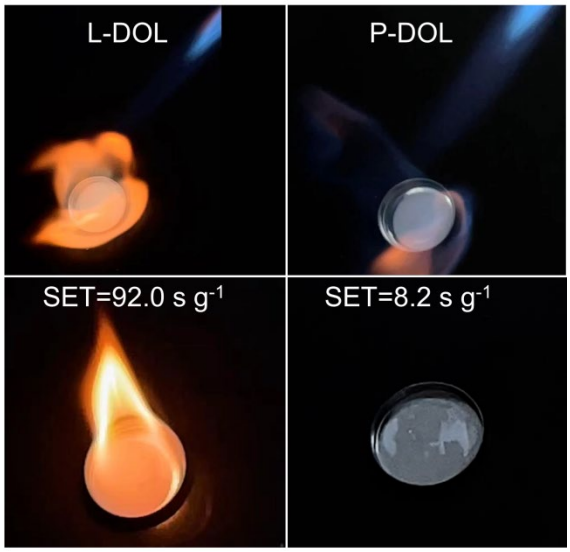



**Figure S1.** The Fire tests for P-DOL and L-DOL.

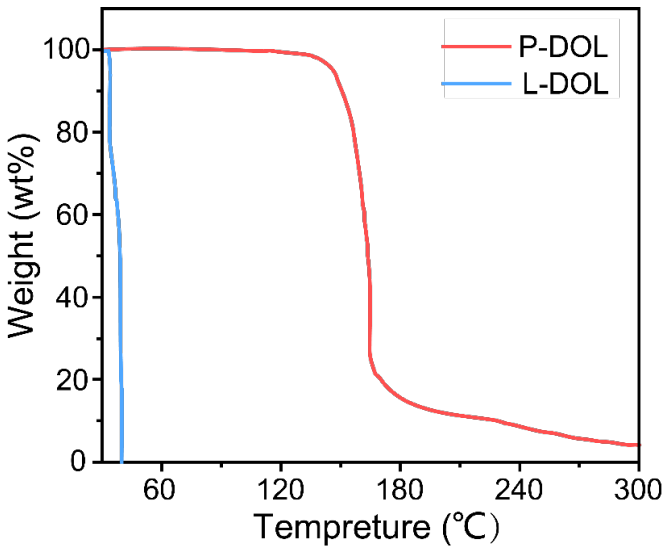



**Figure. S2.** Thermogravimetry curves of P-DOL and L-DOL

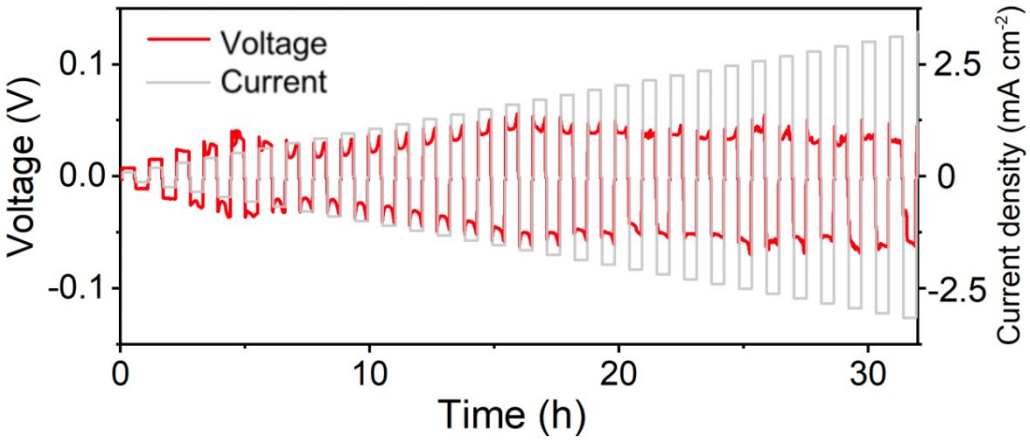



**Figure. S3.** Critical current density of Li‖PDOL‖Li cells.

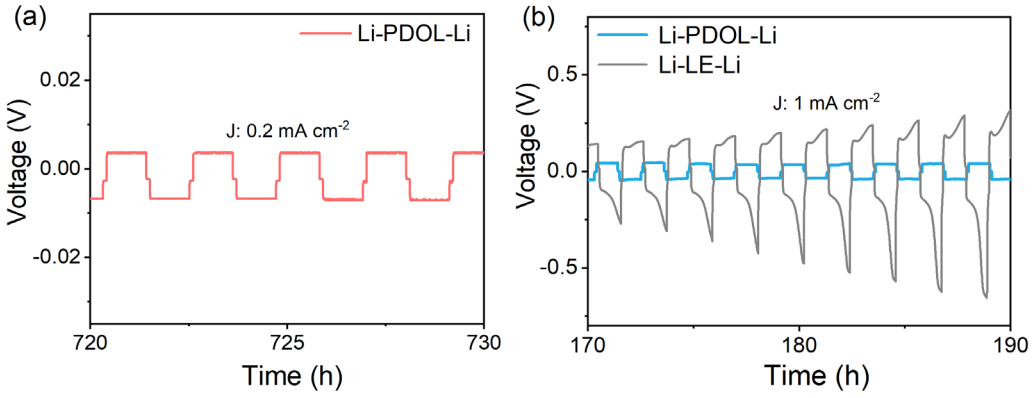



**Figure. S4.** The enlarged Charge-discharge curve of Li‖Li at 0.2 mA cm$^{-2}$and 1 mA cm$^{-2}$.

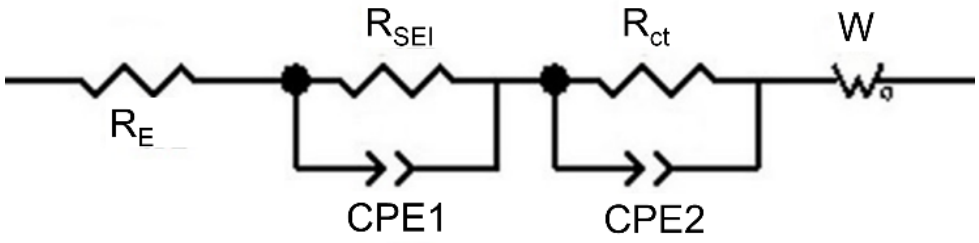



**Figure. S5.** The equivalent circuit of EIS

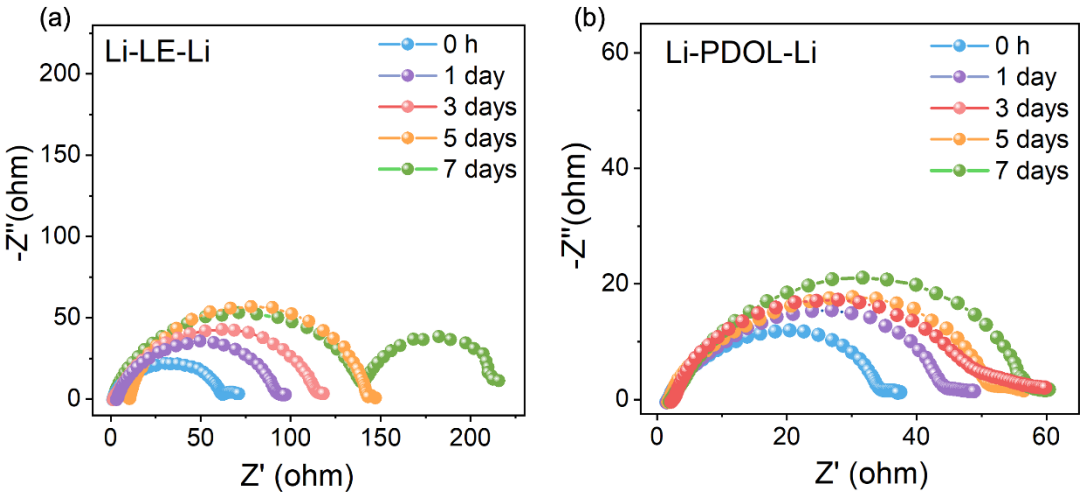



**Figure. S6.** Nyquist impedance plots of Li‖PDOL‖Li and Li‖LE‖Li batteries after 1 day, 3 days, 5 days and 7 days placement, respectively.

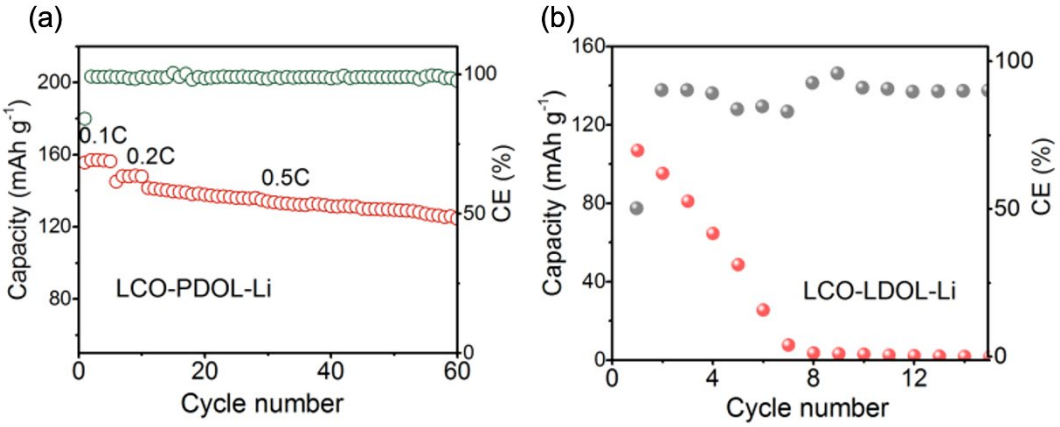



**Figure. S7.** Capacity-efficiency plots of (a) Li‖P-DOL‖LCO and (b) Li‖L-DOL‖LCO cells.

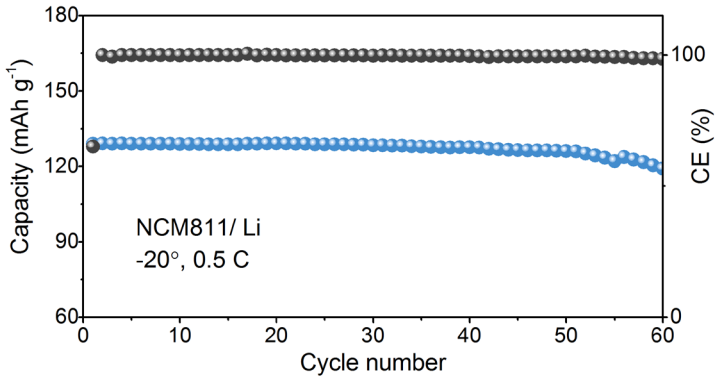



**Figure S8.** The Capacity-efficiency plot of the Li‖NCM811 cell at 0.5 C and -20 ºC.

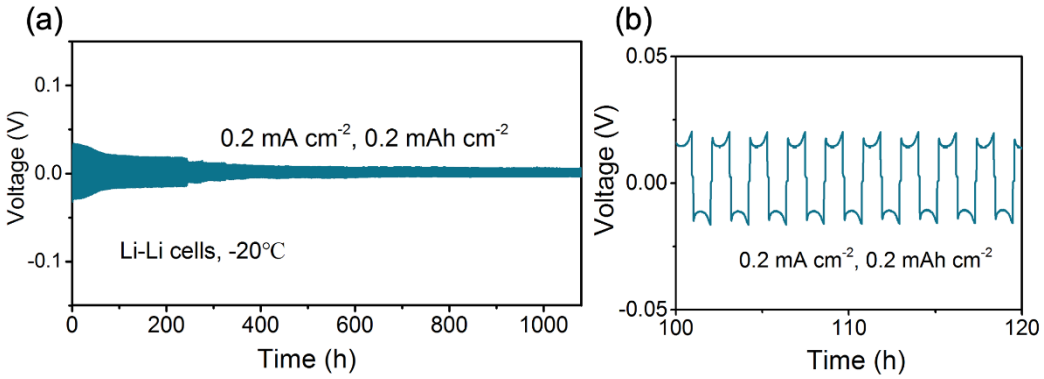



**Figure. S9.** (a) Charge-discharge curve of Li‖Li at 0.2 mA cm$^{-2}$ and (b) zoomed-in figure

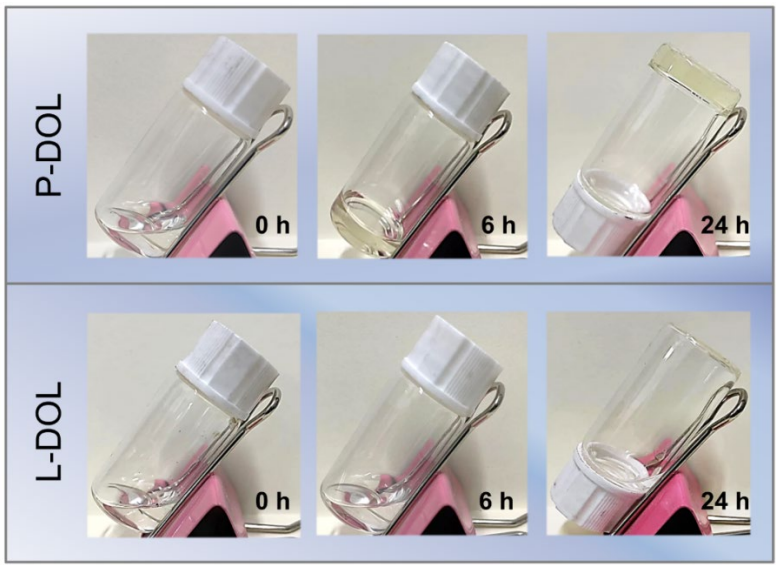



**Figure. S10.** Optical photographs of P-DOL and L-DOL at 0 h, standing for 6 h and 24 h

**Table S1.** Impedance values of Li‖Li batteries after 1, 3, 5 and 7 days of placement based on P-DOL and L-DOL.

| $R_i$（Ω） | 0 h | 1 day | 3 days | 5 days | 7 days |
|---|---|---|---|---|---|
| PDOL | 33.4 | 42.6 | 48.3 | 51.1 | 53.6 |
| LE | 61.1 | 91.4 | 113.8 | 144.5 | 212.3 |

**Table S2.** Comparisons of the electrochemical performance in the previous literature.

| **Cathode** | **electrolyte** | **Voltage range (V)** | **Capacity retention** | **Terperature** | **Ref** |
|---|---|---|---|---|---|
| NCM811 | PDOL | 2.8-4.3 | 0.2 C, 109 mAh $g^{-1}$, 100 cycles | -20 ºC | [51] |
| $LiFePO_4$ | PEG-PISA | 2.5-4.1 | 0.2 C, 62.5 mAh $g^{-1}$, 20 cycles | 0ºC | [52] |
| NCM622 | PDOL | 2.8-4.3 | 0.1 C, 153 mAh $g^{-1}$, 60 cycles | 25 ºC | [39] |
| NCM811 | PDOL | 2.8-4.3 | 0.2 C, 125.2 mAh $g^{-1}$, 120 cycles | -20 ºC | this work |

**Equations S1**.

$$\delta = \frac{L}{R \times S} \qquad (S1)$$

where δ, L, R and S are the ionic conductivity, the thickness between the steel sheets, the electrochemical impedance and the contact area between the electrolyte and the blocking electrode, respectively.

**Equations S2**.

$$\sigma = AT^{-\frac{1}{2}} e^{-\frac{Ea}{R(T-T_0)}} \quad (S2)$$

where A, $E_a$, R and $T_0$ are the prefactor, apparent activation energy, ideal gas coefficient and ideal glass transition temperature, respectively.