Supporting information

Regulating Weak Solvation Structure in Electrolyte for High-Rate Li-Metal Batteries at Low Temperature

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Table S1. Summary of the ionic conductivity at low temperature with different electrolytes

No	Electrolyte formula	-20 ℃	-40 ℃	-60 ℃ (mS/cm)
1	1M $LiPF_6$ EC/EMC/DEC/MA(1:1:1:1)	5.5	3.4	0.26
2	1M $LiPF_6$ EC/EMC/TFENH(1:4:1)	3.2	0.53	
3	1M LiTFSI DOL/DME(8:2)	5.6	3.2	0.92
4	2M LiFSI/BFE	2.8	1.87	0.95
5	0.75 M $LiPF_6$ EC/EMC/MTFA(1:4:2)	2.2	0.43	
6	1M $LiPF_6$ MP/FEC(9:1)	6.3	4.1	2.1
7	0.7M $LiPF_6$+0.3M $LiBF_4$ EC/DMC/EMC/BA	0.828	0.726	
8	1M $LiPF_6$ MTFP/FEC(9:1)		3.2	1.68
This work	0.5M LiDFOB+0.5M $LiBF_4$ IZ/EMC/FEC(5:2:3)	6.9	3.87	1.86

Table S2. Summary of the Li^+ transference number with different electrolytes

No	Electrolyte formula	t_{Li+}(25℃)
9	LiFSA/SL/HFE(1:2.5:2)	0.38
10	0.9 M LiFSI+0.1MLiDFOB IZ/FEC(7:3)	0.53
11	1M LiTFSI MP/FEC(9:1)+HFE+LiDFOB	0.61
12	1 M LiTFSI in [EMIM][TFSI] with 20 wt.% of PIL	0.41
13	1M LiFSI-DTDL	0.75
This work	0.5M LiDFOB+0.5M $LiBF_4$ IZ/EMC/FEC(5:2:3)	0.56

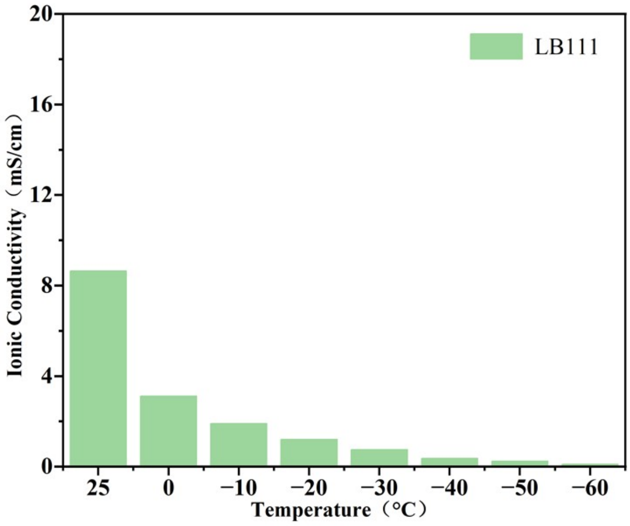

Figure S1. Ionic conductivities of LB111 electrolyte from 25 to −60 °C.

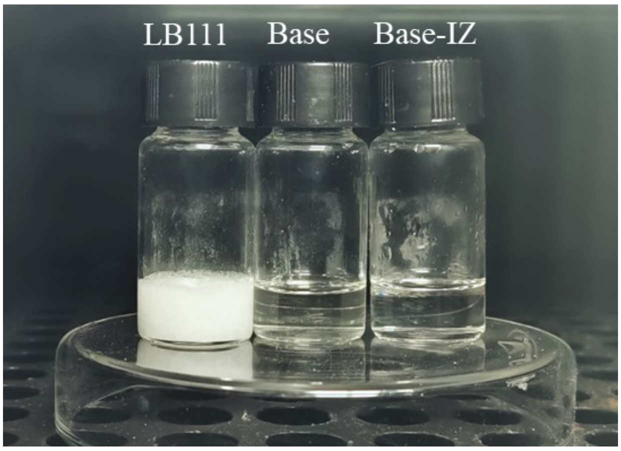

Figure S2. The photographs of different electrolytes at −60 °C.

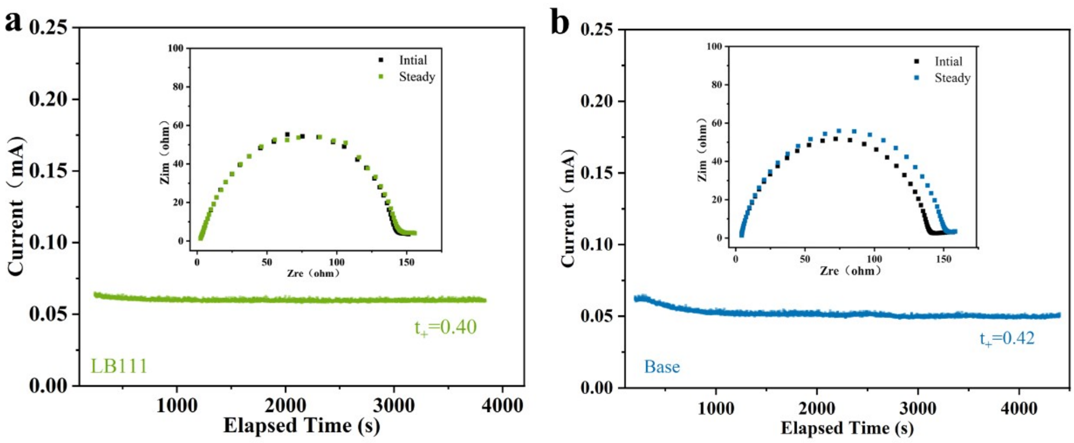

Figure S3. t_{Li+} of LB111 and Base electrolytes.

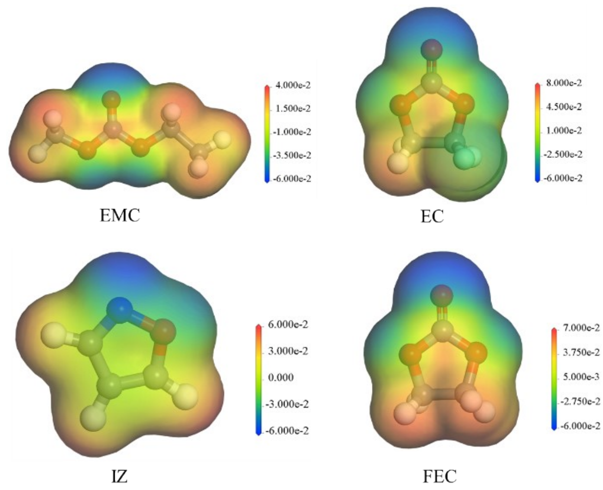

Figure S4. ESP of different solvents.

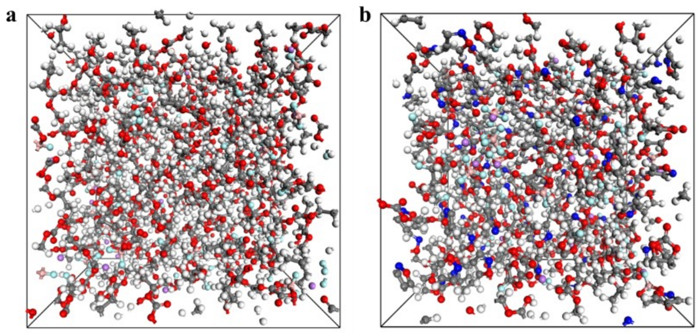

Figure S5. Snapshots of MD simulation for a) Base and b) Base-IZ.

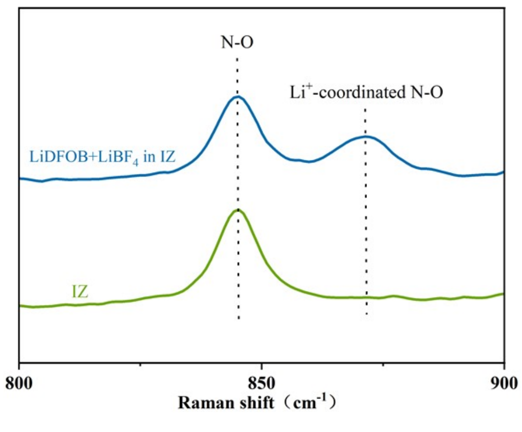

Figure S6. Raman spectra of electrolytes with IZ.

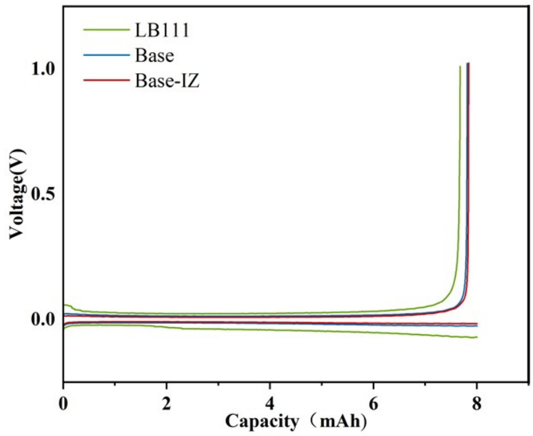

Figure S7. The corresponding deposition/stripping curves in different electrolytes.

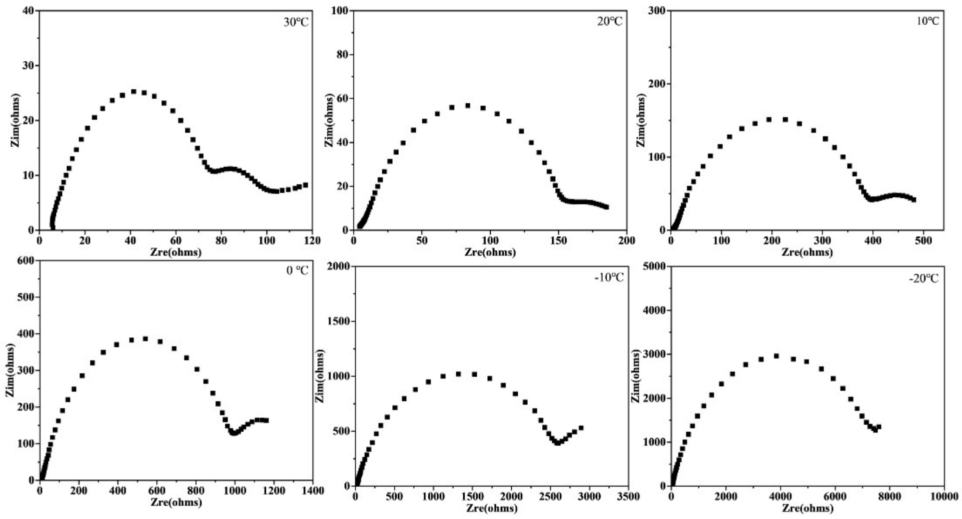

Figure S8. EIS measurements of Li||Li symmetric cells at varies temperatures from −20 to 30 ºC in LB111.

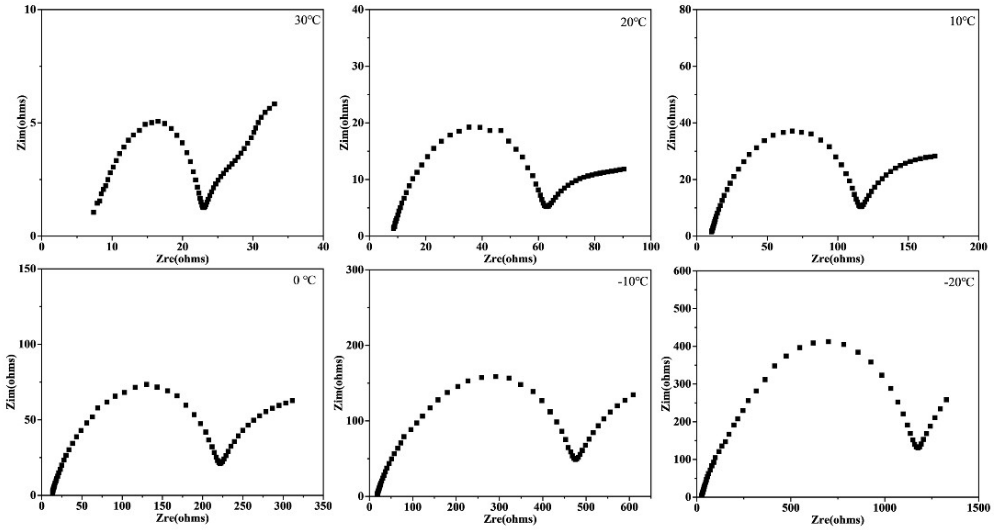

Figure S9. EIS measurements of Li||Li symmetric cells at varies temperatures from −20 to 30 ºC in Base.

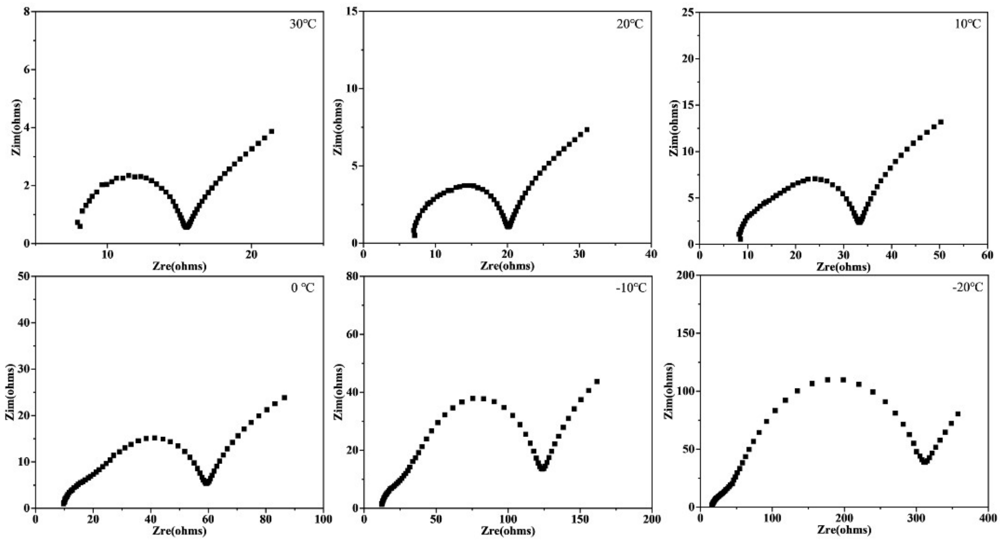

Figure S10. EIS measurements of Li||Li symmetric cells at varies temperatures from −20 to 30 ºC in Base-IZ.

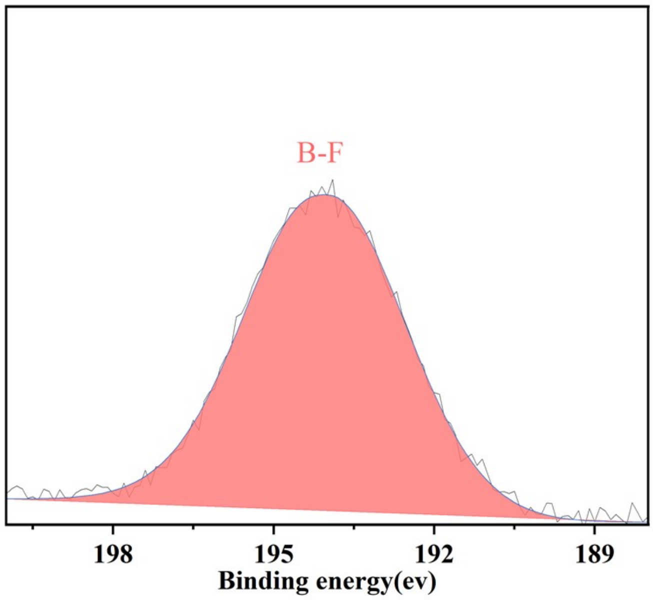

Figure S11. XPS spectrum of B 1s in Li metal anodes after 20 cycles with Base-IZ.

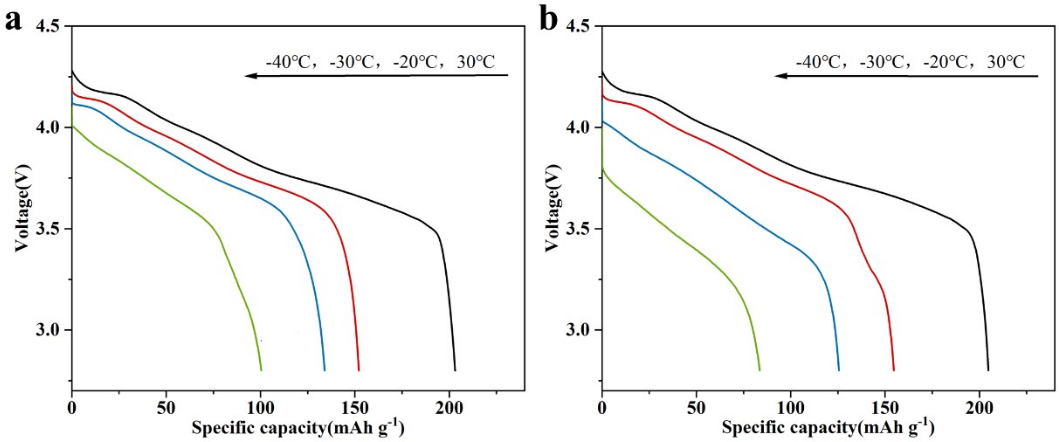

Figure S12. Discharge curves of NCM811 cell with a) 0.5M LiDFOB +0.5M $LiBF_4$ in IZ/EMC/FEC=3:5:2; and b) 1M $LiPF_6$ in IZ/EMC/FEC=5:2:3 under various temperatures.

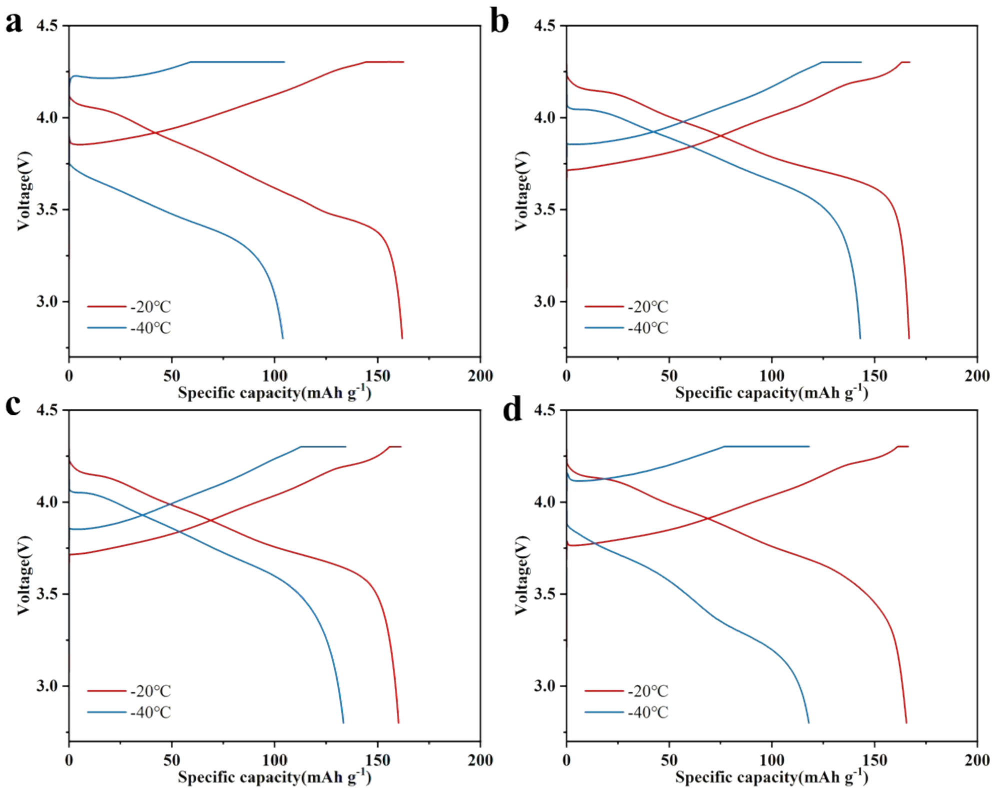

Figure S13. Charge and discharge curves of NCM811 cells with a)1M $LiBF_4$ in IZ/EMC/FEC=5:2:3; b) 1M LiDFOB in IZ/EMC/FEC=5:2:3; c) 0.5M LiDFOB +0.5M $LiBF_4$ in IZ; d) 0.5M LiDFOB +0.5M $LiBF_4$ in IZ/DME/FEC=5:2:3 under various temperatures.

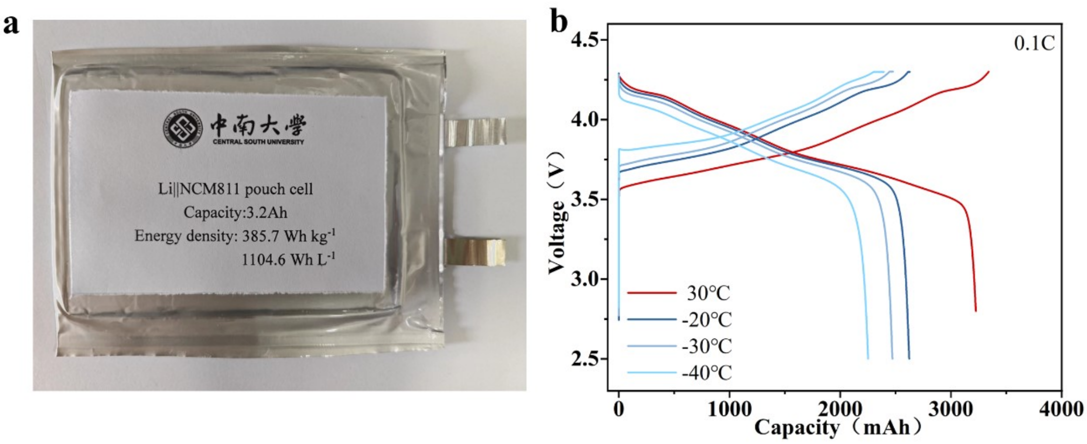

Figure S14. a) Digital photograph and b) the charge/discharge curves at 0.1 C under various temperatures of the NCM811||Li pouch battery (3.2 Ah).

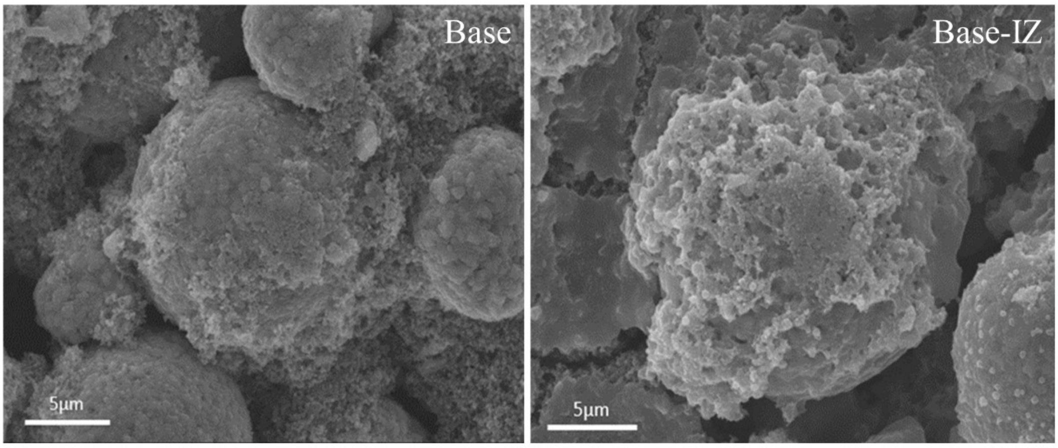

Figure S15. SEM images of the positive electrodes from cells with different electrolytes after cycling at −40 ºC.

Reference

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