Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

All-Solid-State Interpenetrating Network Polymer Electrolytes for Long Cycle Life of Lithium Metal Batteries

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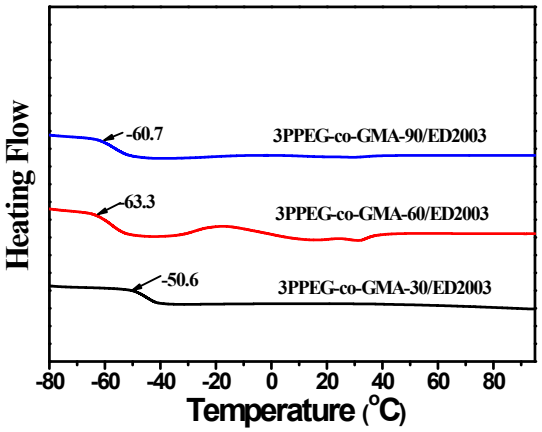

Fig. S1 DSC thermograms of cross-linking solid state polymer based on 3PPEG-co-GMA-x and ED2003 recorded under nitrogen during the second heating scans at a scan rate of 10 °C min^{-1}, the molar ratio of the epoxy and amino is fixed 2:1.

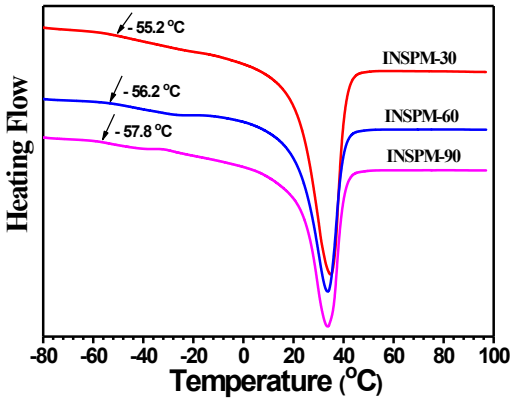

Fig. S2 DSC thermograms of interpenetrating network solid state polymer membrane (INSPM-x) recorded under nitrogen during the second heating scans at a scan rate of 10 °C min^{-1}.

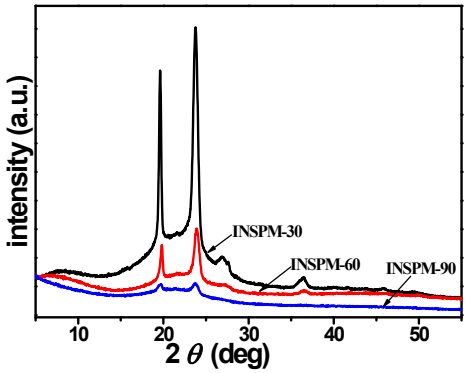

Fig. S3 XRD spectra of interpenetrating network solid polymer membrane (INSPM-x).

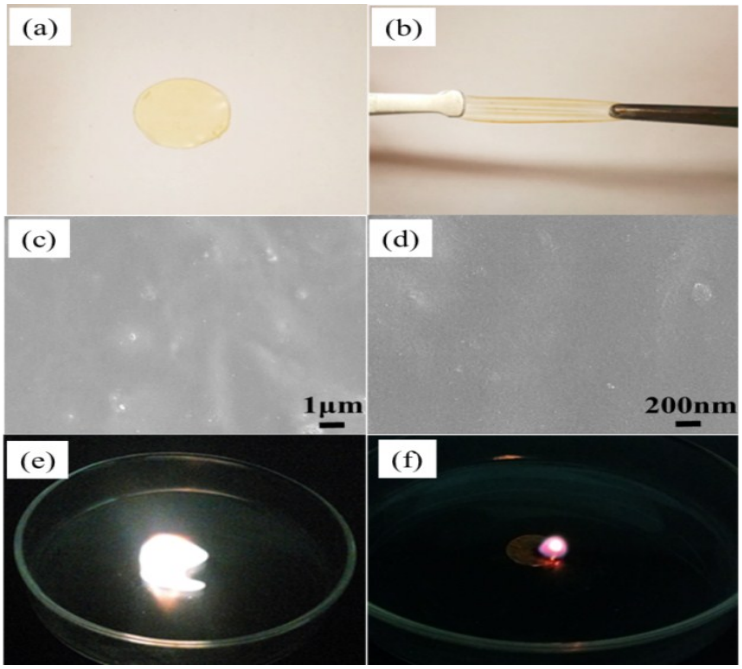

Fig. S4 Photographs (a) and (b), SEM images (c) and (d) of INSPM-60-LiTFSI, photographs demonstrating flammable behavior of liquid electrolyte (e) and INSPM-60-LiTFSI (f).

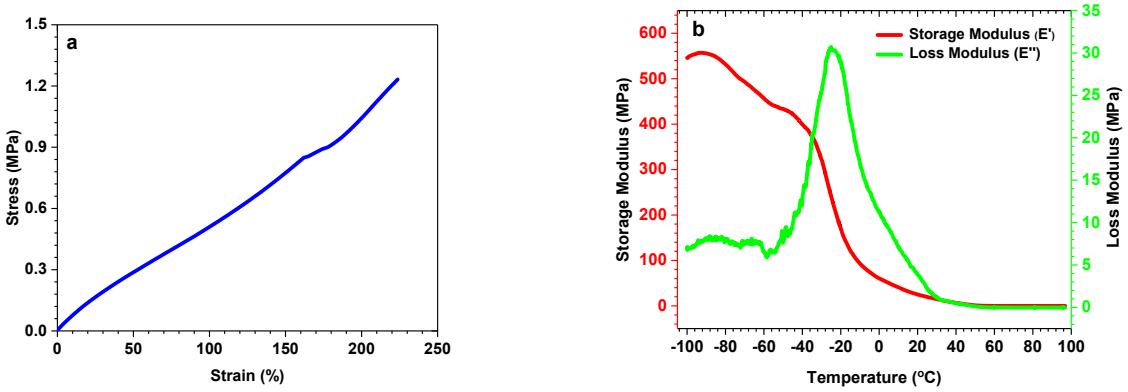

Fig. S5 (a) Stress-strain measurement of INSPM-60 at 25 °C with force ramp rate of 0.2 N/min and (b) storage and loss modulus measurement of INSPM-60 at a heating rate of 3 K/min.

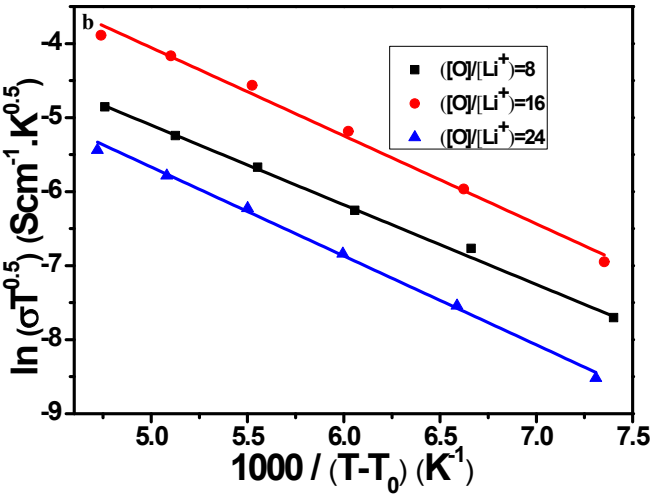

Fig. S6 VTF fitting curves of INSPM-60-LiTFSI with various [O]/ [Li^+].

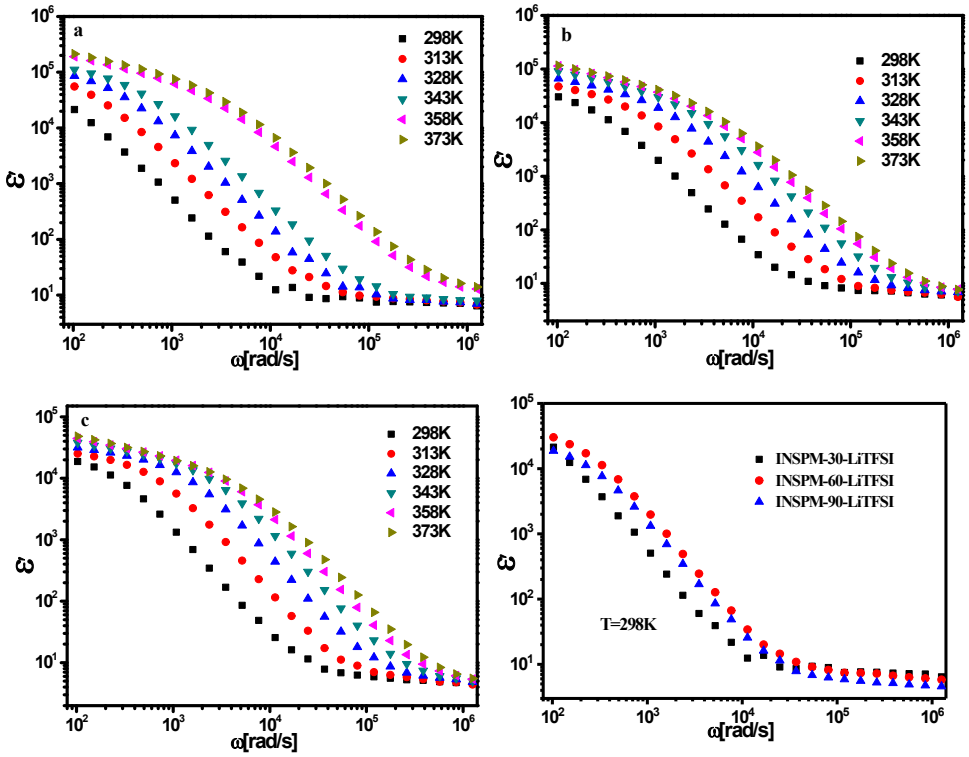

Fig. S7 Dielectric permittivity (ε′) spectra as functions of angular frequency ω of (a) INSPM-30-LiTFSI, (b) INSPM-60-LiTFSI, (c) INSPM-90-LiTFSI at different temperature and (d) a comparison of the three samples at 298 K.

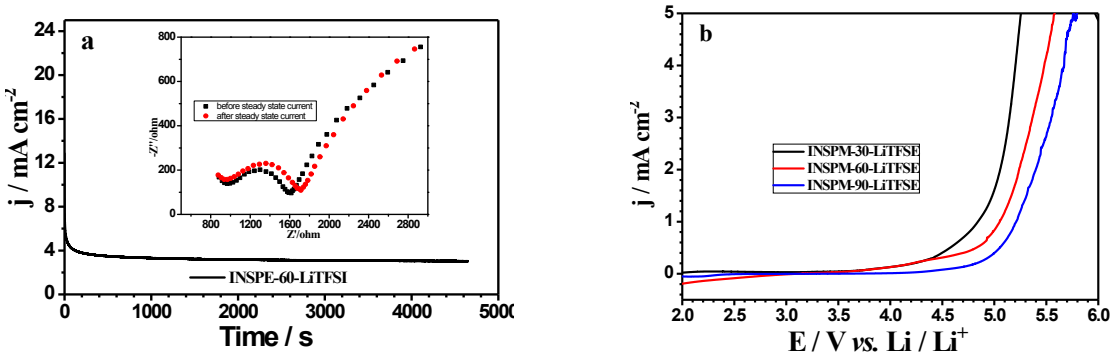

Fig. S8 (a) Chronoamperometry profile of INSPM-60-LiTFSI; (b) linear sweep voltammetry curves of the cell based on INSPM-x-LiTFSI electrolyte at 60 °C, [O]/ [Li] = 16.

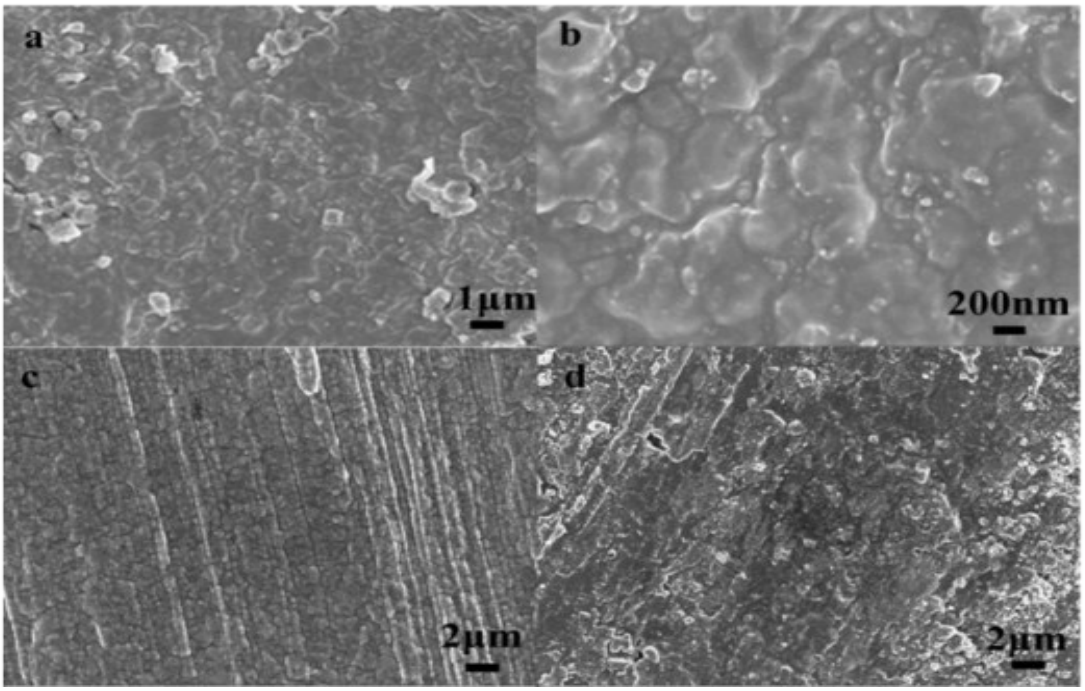

Fig. S9 SEM images of the INSPM-60-LiTFSI membrane (a, b) and Li electrode (c, d) in a Li || INSPM-60-LiTFSI || Li cell before (a, c) and after (b, d) 2200 cycles.

Table S1 Thermal property, ionic conductivity, and VTF fitting parameters of the INSPM-60/LiTFSI electrolytes

[O]/ [Li^+]	T_g,°C	T_m (°C)	ΔH_m (J/g)	*E*a (kJ/mol)	*A* (Scm^{-1}K$^{0.5}$)	t_+	σ/S cm^{-1}	
							25°C	100°C
8	-54.9	23.3	-40.4	8.95	0.28	-	2.1×10^{-5}	3.3×10^{-4}
16	-55.4	26.4	-50.5	9.89	1.89	0.37	5.6×10^{-5}	1.1×10^{-3}
24	-56.9	27.7	-67.9	9.99	0.34	-	9.5×10^{-6}	1.8×10^{-4}

A is a pre-factor that is often related to the number and mobility of charge carriers, E_a is the activation energy

Table S2 Comparison of the electrochemical performance based on solid-sate electrolytes.

Reference	Ionic conductivity (S cm $^{-1}$)	The initial discharge capacity (mAh g $^{-1}$)	Test condition	Electrolyte
1	2.5×10^{-5}	120-130/ 0.05C	30 °C	PEC-LiFSI
2	2.2×10^{-4}	141/0.5C	25 °C	ipn-PEA/$LiPF_6$
3	～1.4×10^{-3}	～140 /0.2C	25 °C	PEM/SCN/LiTFSI
4	～10^{-5}	160/0.1C	70 °C	TBP-3/LiTFSI
5	1.1×10^{-4}	137.1/0.5C	25 °C	SPEM/LiTFSI
6	4.0×10^{-4}	/	25 °C	PTL-3/LiTFSI
This work	5.6×10^{-5}	156.2/0.1C	60 °C	INSPM-60/LiTFSI

All the batteries were assembled with lithium metal as anode and $LiFePO_4$ as cathode.

Supplementary References

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