Supporting Information

Low temperature polymer electrolyte based solid-state lithium batteries

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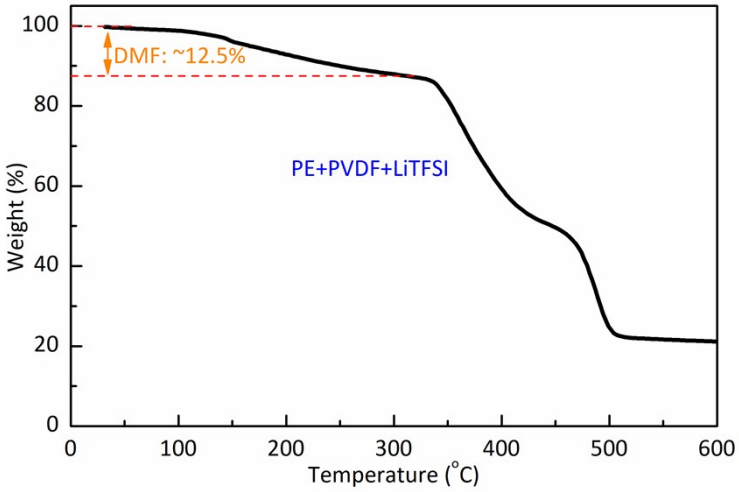

Figure S1. TG curve of PPLD electrolyte.

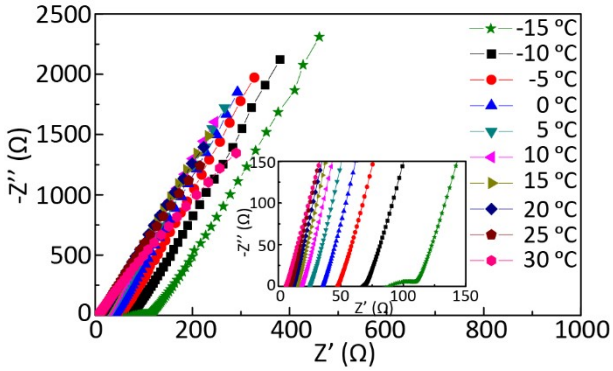

Figure S2. Alternate current impedance plots of PPLD electrolyte at different temperatures (-15-30 ^{o}C).

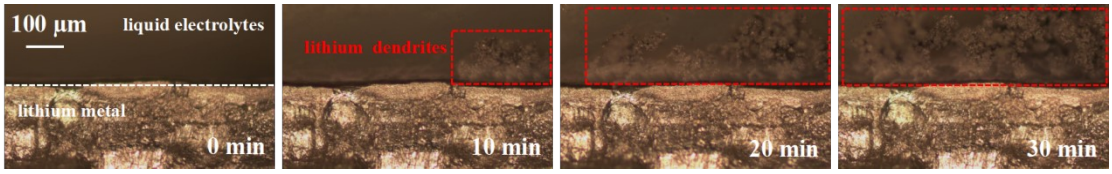

Figure S3. Optical images of the *in-situ* Li deposition on Li/liquid electrolytes (LE)/Li cell at a deposition current density of 1 mA cm^{-2}.

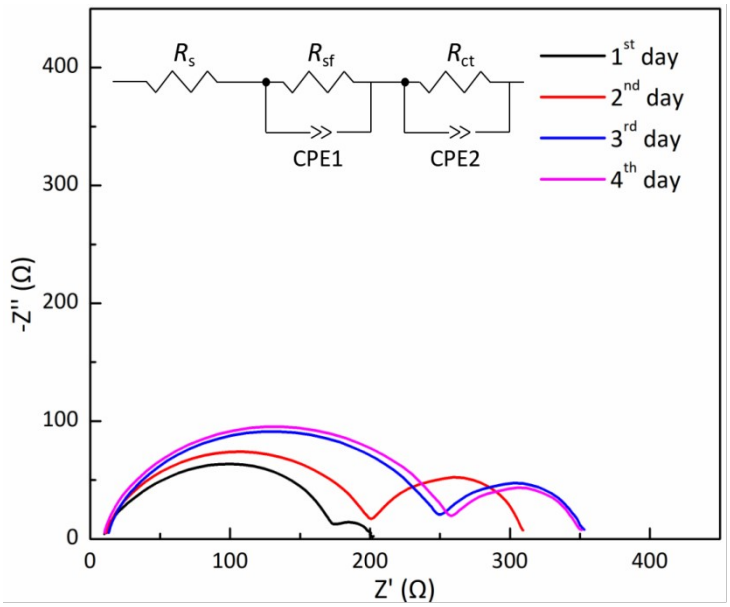

Figure S4. Nyquist plots of symmetric Li/PPLD/Li cell at various aging times and the inset is the equivalent circuit.

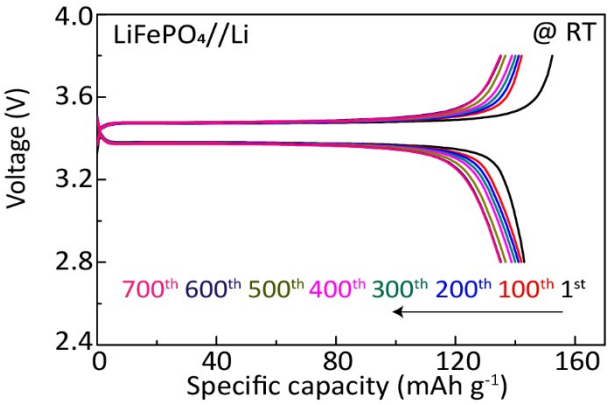

Figure S5. Voltage profiles of $LiFePO_4$/PPLD/Li pouch cell at different cycles under 0.5 C rate and room temperature.

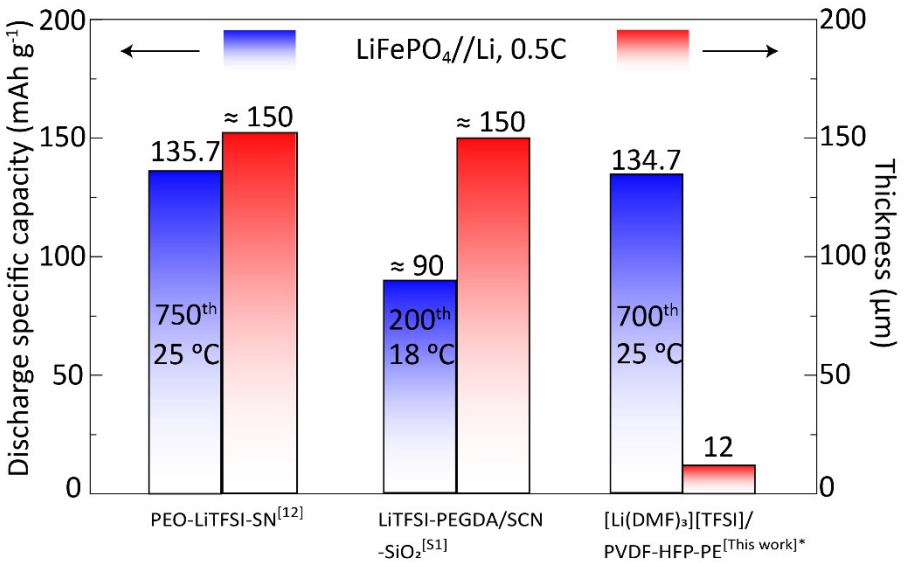

Figure S6. Thicknesses of reported solid polymer electrolytes and discharge specific capacities of their assembled $LiFePO_4$//Li cells.

Figure S7. Digital image of the flexibility of the PPLD electrolyte.

Table S1. Cyclic and rate performances of reported low-temperature $LiFePO_4$//Li batteries assembled with solid polymer electrolytes.

Polymer electrolyte	Working temperature (°C)	Current density	Reversible specific capacity (mAh g^{-1})	Capacity retention (%)	Cycle number	Rate performance	
						Discharge capacity (mAh g^{-1})	Current density
PEO-LiTFSI-SN[7]	25	0.5 C	135.7	93.2	750	152.8	0.2 C
						145.3	0.5 C
						134.3	1 C
						105.7	2 C
						61.5	5 C
	0	0.1 C	121.8	97.2	180	--	--
CPPC-LiTFSI[10]	20	0.5 C	110.2	95	1000	132	0.2 C
						116	0.5 C
						103	1 C
						80	2 C
						52	3 C
	5	--	--	--	--	138	0.05 C
						114	0.1 C
						89	0.2 C
						65	0.5 C
						40	1 C
PVEC-PE[S1]	Room temperature	1 C	~140	~100	100	~158	0.2 C
						~140	0.5 C
						~130	1 C
						~113	2 C
	5	0.1 C	146	--	1	--	--
	-5	0.1 C	136	--	1	--	--
	-15	0.1 C	104	--	1	--	--
Agarose-based SPE[S2]	25	0.5 C	97.3	80.2	500	156.7	0.1 C
						136.7	0.3 C
						123.6	0.5 C
						98.6	1 C
	0	0.1 C	87.3	71.5	150	--	--
PE-PVDF-HFP-[Li(DMF)$_3$][TFSI] [Our work]	25	0.5 C	134.7	94.2	700	155.6	0.2 C
						140	0.5 C
						121	1 C
						93.9	2 C
	0	0.1 C	128.5	~108.9	100	--	--
	-10	0.1 C	78.8	~100	100	--	--

References

S1. Lin Z, Guo X, Wang Z, et al. A wide-temperature superior ionic conductive polymer electrolyte for lithium metal battery. Nano Energy, **2020**, *73*, 104786.

S2. Liu F, Liu J. Agarose based solid electrolyte for all-solid-state lithium ion batteries working from -20 °C to 80 °C. J. Electrochem. Soc, **2020**, *8*, 080519.