Supporting information

Self-degradation functional unit introduction for anti-oxidation ability enhancement of Poly(vinyl ethylene carbonate) electrolyte

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Supplementary Figures

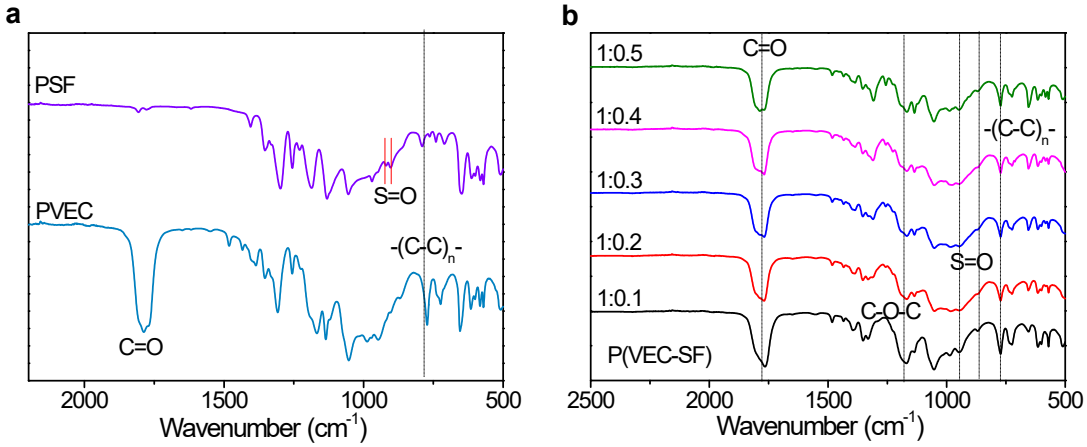

Figure S1. a, The FT-IR spectra of PVEC-PE and PSF-PE. **b,** The comparisons of FT-IR spectra of P(VEC-SF)-PE with different content of PSF-PE.

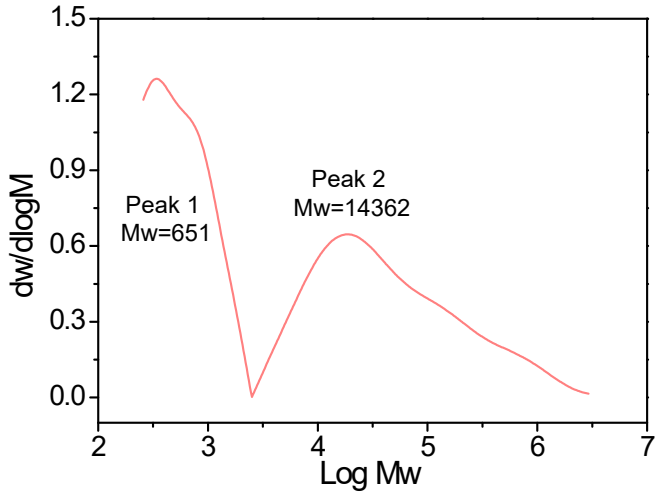

Figure S2. GPC test results of P(VEC-SF)-PE.

Figure S3. The photograph of flexible P(VEC-SF)-PE film with tunable size.

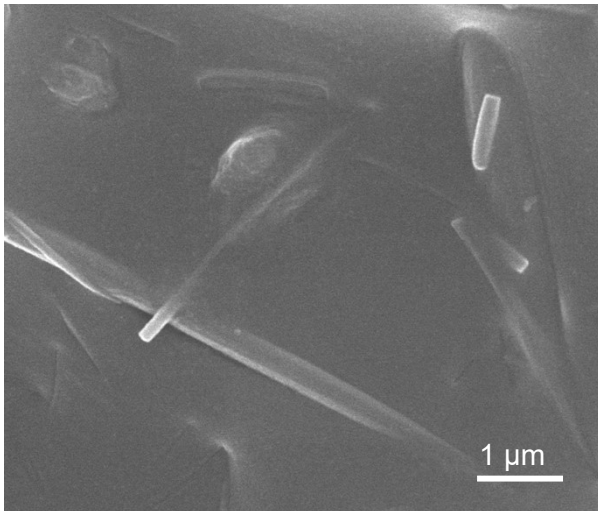

Figure S4. SEM of the P(VEC-SF)-PE.

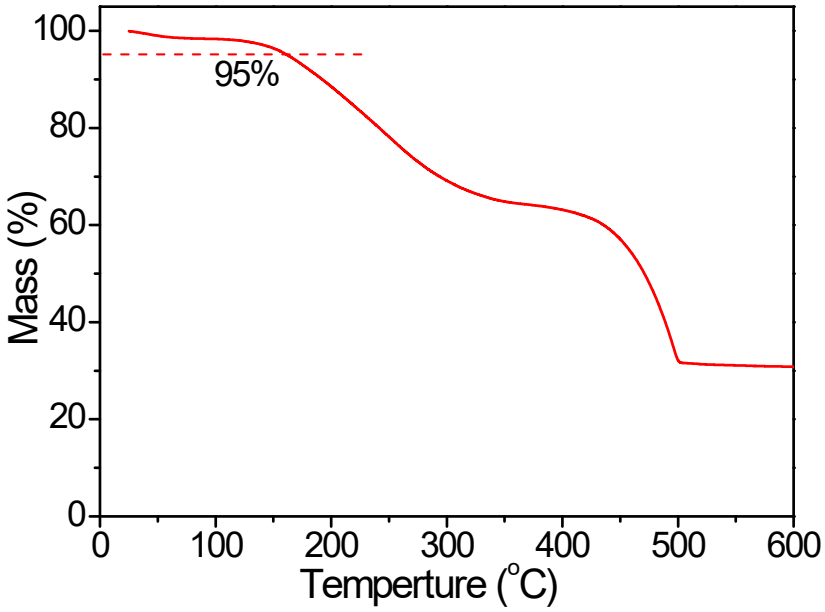

Figure S5. The TG curves of P(VEC-SF)-PE.

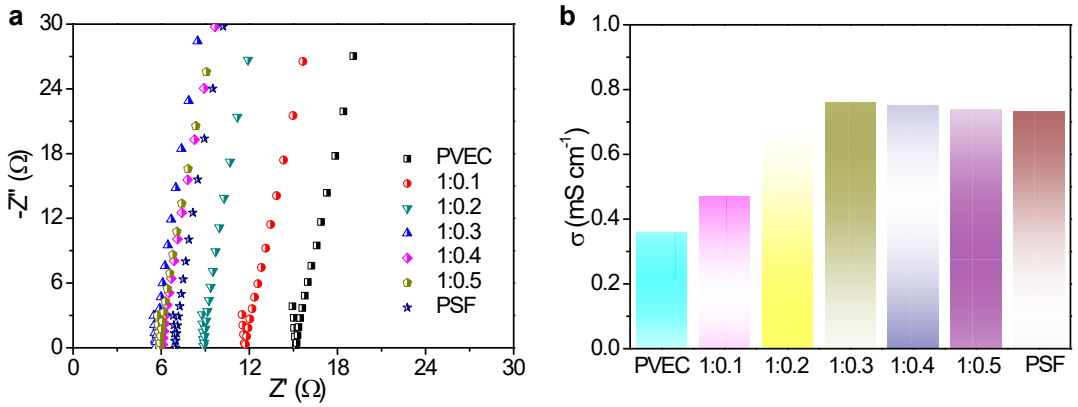

Figure S6. a, EIS of SS/PVEC-PE /SS battery, SS/PSF/SS battery and SS/P(VEC-SF)-PE /SS battery that P(VEC-SF)-PE with different content of PSF. **b,** ionic conductivity of P(VEC-SF)-PE with different content of PSF at room temperatures.

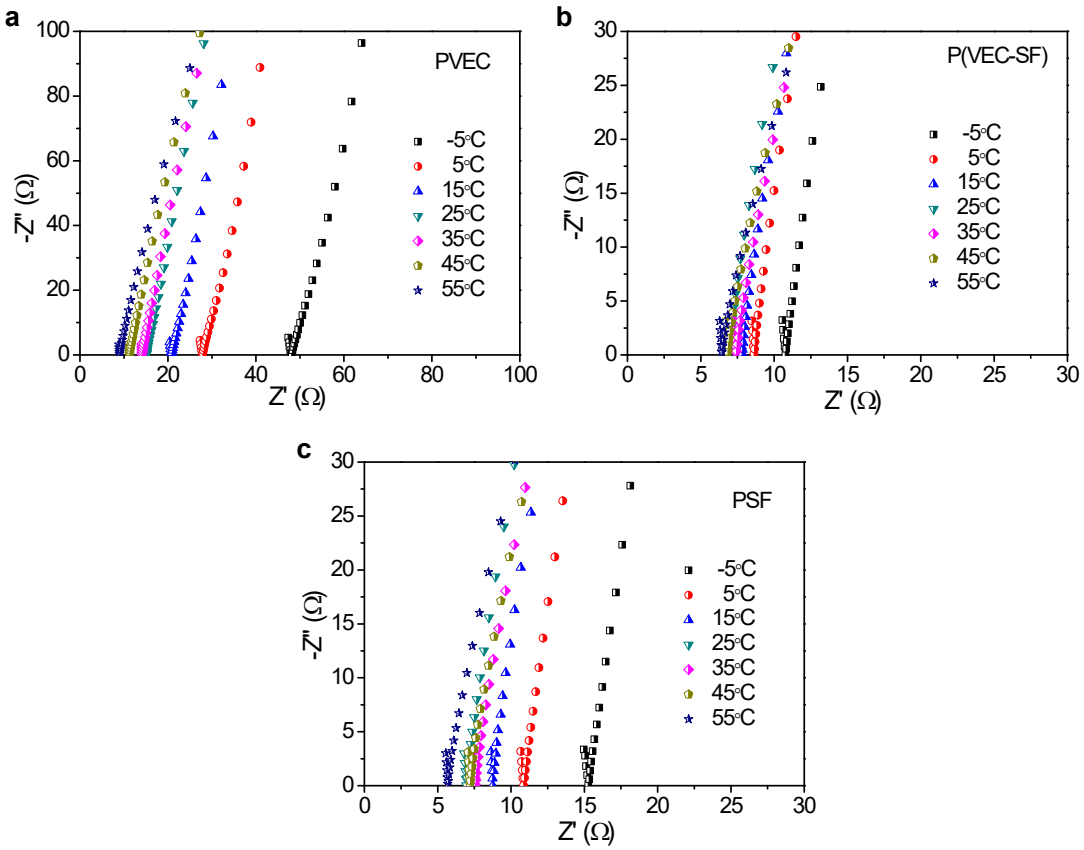

Figure S7. EIS of **a,** SS/PVEC-PE/SS battery, **b,** SS/P(VEC-SF)-PE/SS battery and **c,** SS/PSF-PE/SS battery at different temperatures.

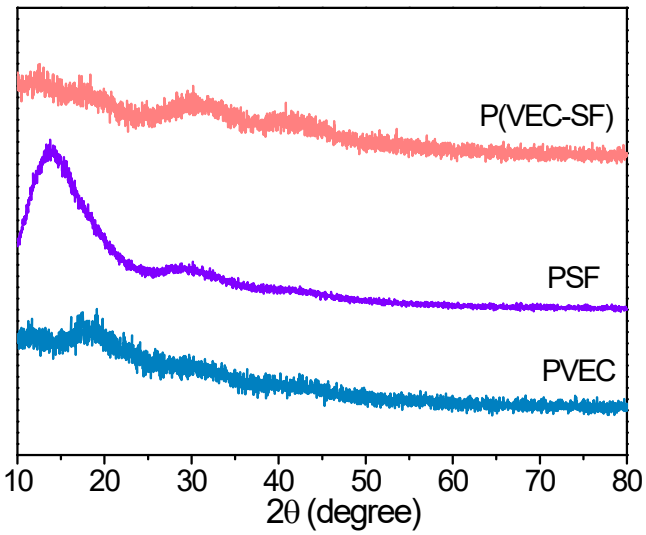

Figure S8. XRD pattern of PVEC-PE, PSF-PE and P(VEC-SF)-PE.

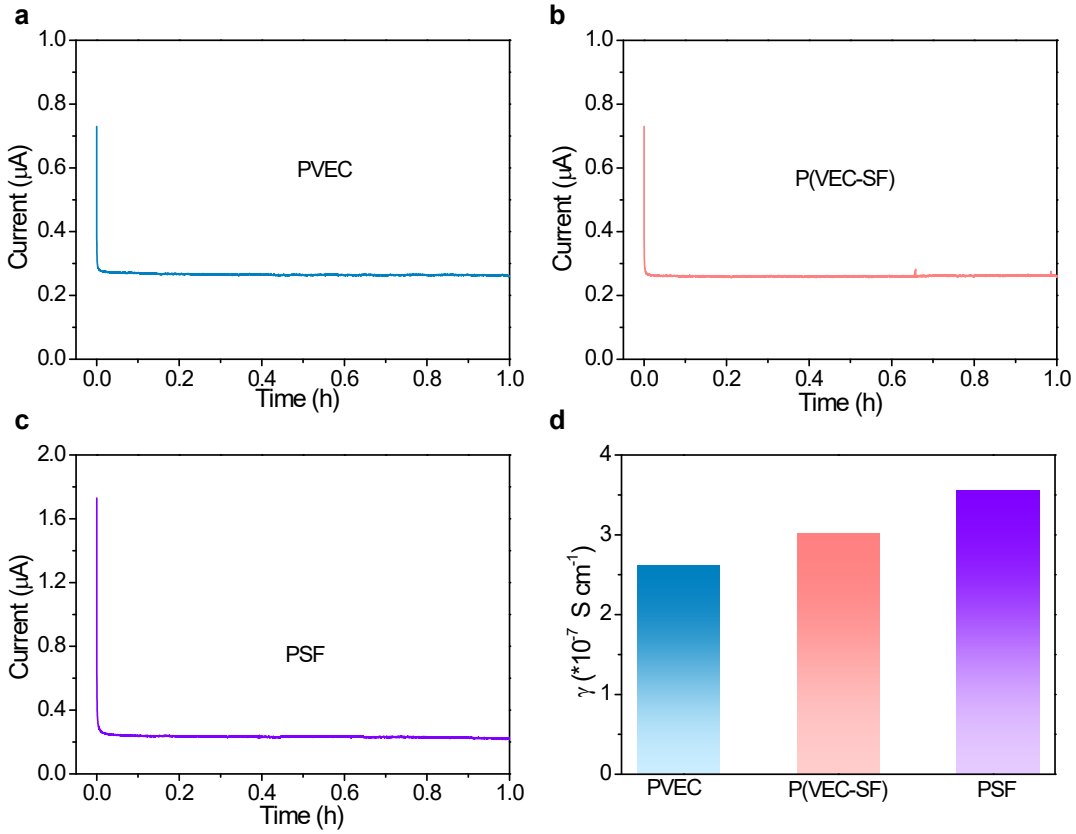

Figure S9. Potentiostatic coulometry measurement of **a,** SS/PVEC-PE/SS battery, **b,** SS/P(VEC-SF)-PE/SS battery and **c,** SS/PSF-PE/SS battery. **d,** electronic conductivity of PVEC-PE, PSF-PE and P(VEC-SF)-PE.

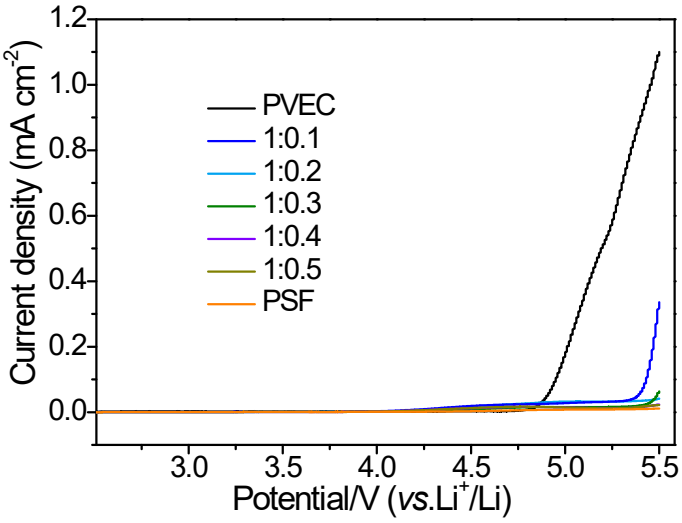

Figure S10. LSV profile of Li/PVEC-PE/SS battery, Li/PSF-PE/SS battery and Li/P(VEC-SF)-PE/SS battery that P(VEC-SF)-PE with different content of PSF-PE.

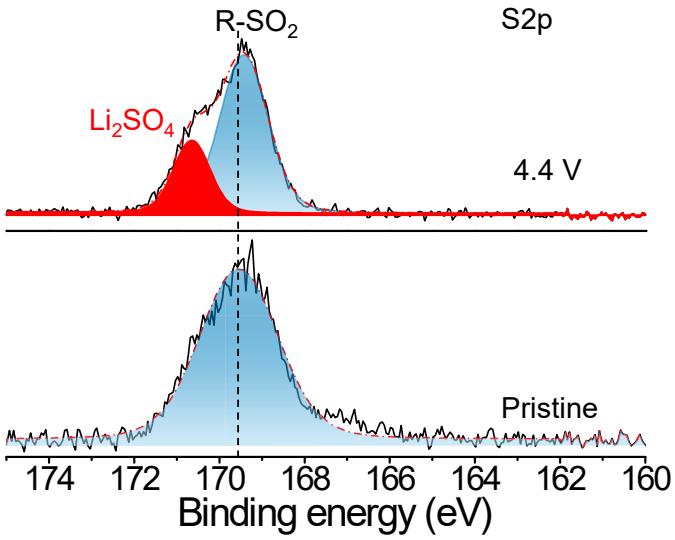

Figure S11. The S2p XPS spectra of PSF-PE after different constant current-current voltage charging tests.

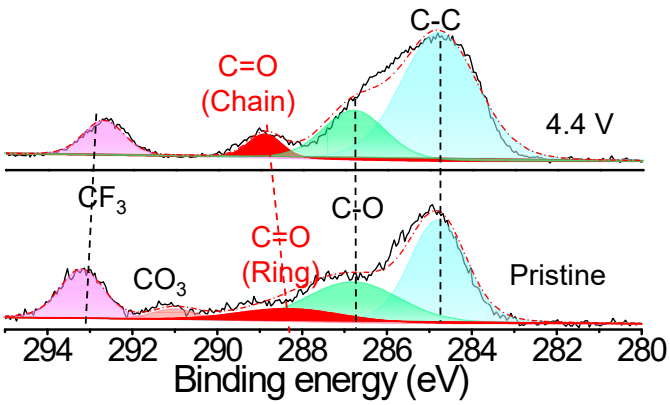

Figure S12. The C1s XPS spectra of PVEC-PE after different constant current-current voltage charging tests.

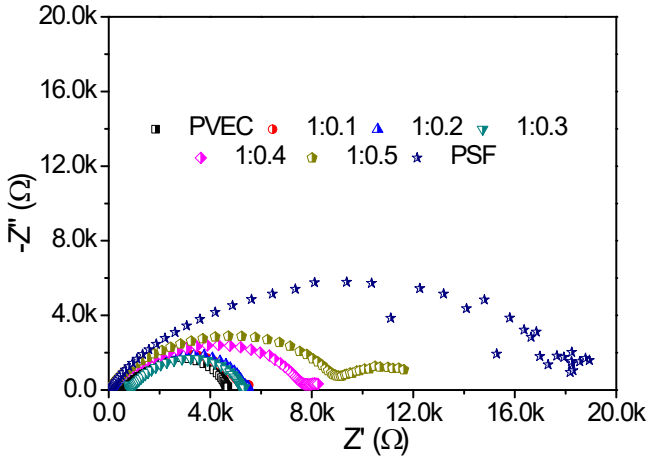

Figure S13. The EIS of Li/PVEC-PE/Li battery, Li/PSF-PE/Li battery and Li/P(VEC-SF)-PE/Li battery that P(VEC-SF)-PE with different content of PSF.

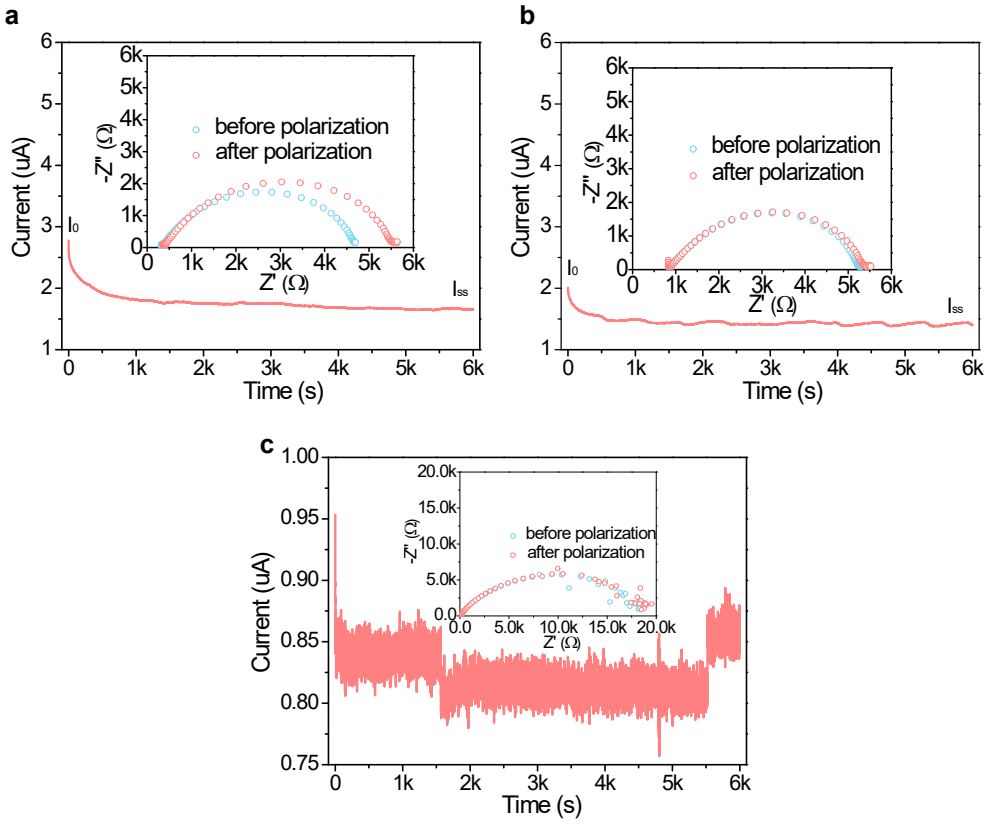

Figure S14. Chronoamperometry profile of the **a,** Li/PVEC-PE/Li battery, **b,** Li/P(VEC-SF)-PE/Li battery and **c,** Li/PSF-PE/Li battery under a polarization potential of 10 mV, and the EIS before and after the polarization (insert).

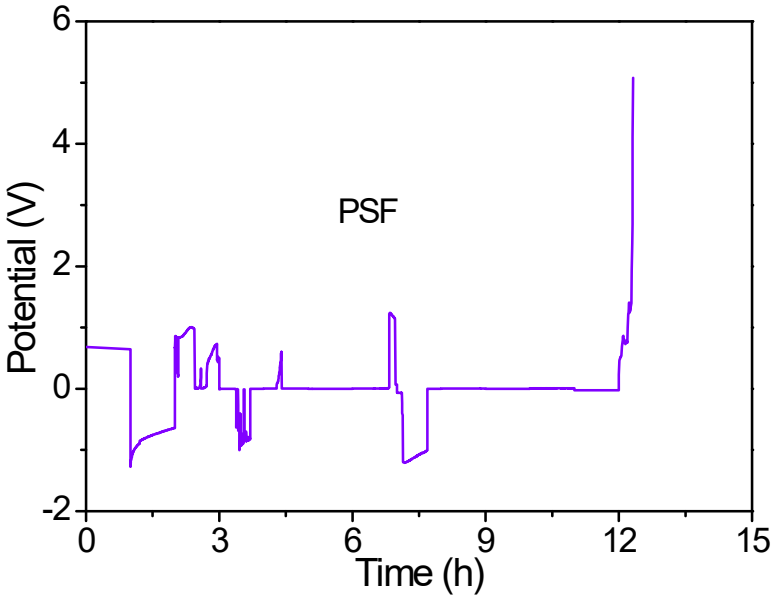

Figure S15. The potential profiles of repeated Li plating/striping in Li/PSF-PE/Li battery with current density of 0.5 mA cm^{-2}.

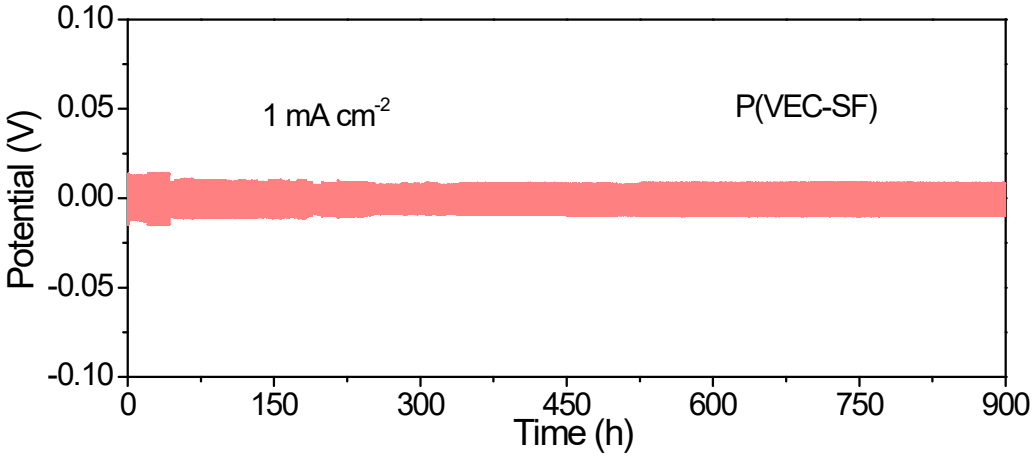

Figure S16. The potential profiles of repeated Li plating/striping in Li/P(VEC-SF)-PE/Li battery with current density of 1 mA cm^{-2}.

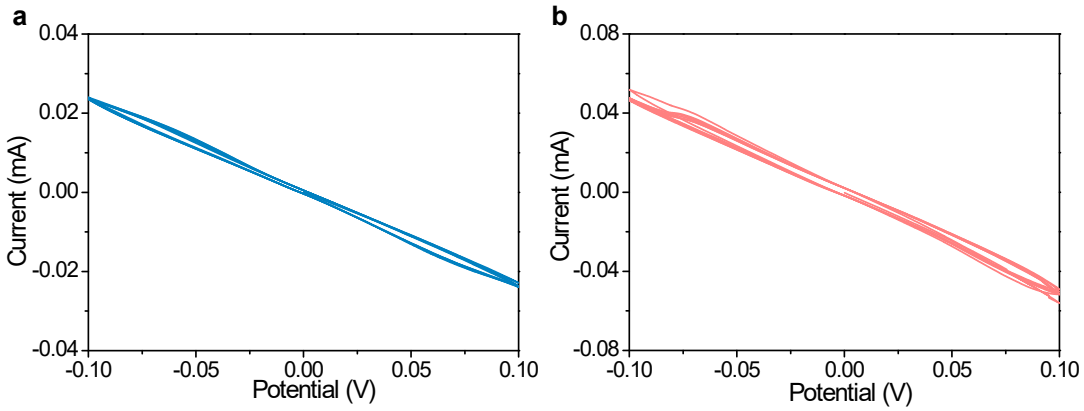

Figure S17. CV curve of **a,** Li/PVEC-PE/Li battery and **b,** Li/P(VEC-SF)-PE/Li battery in a voltage range of -0.1-0.1 V over 5 cycles.

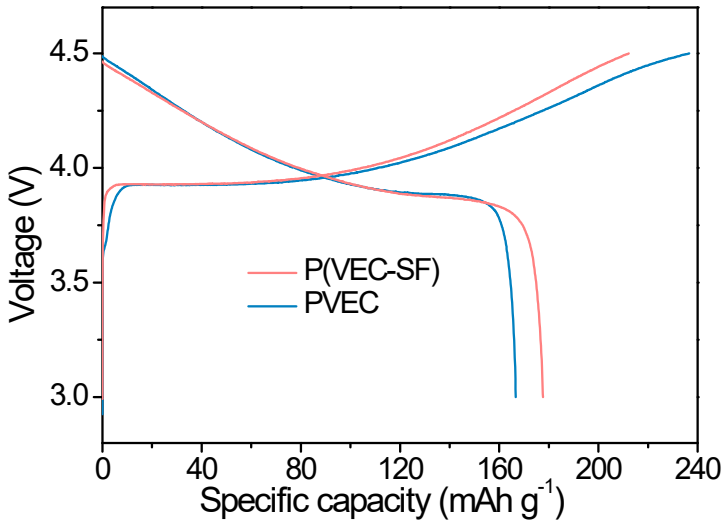

Figure S18. Typical charge-discharge curves of LCO/PVEC-PE/Li and LCO/P(VEC-SF)-PE/Li batteries in the voltage range of 3.0-4.5 V at current density of 0.1 C.

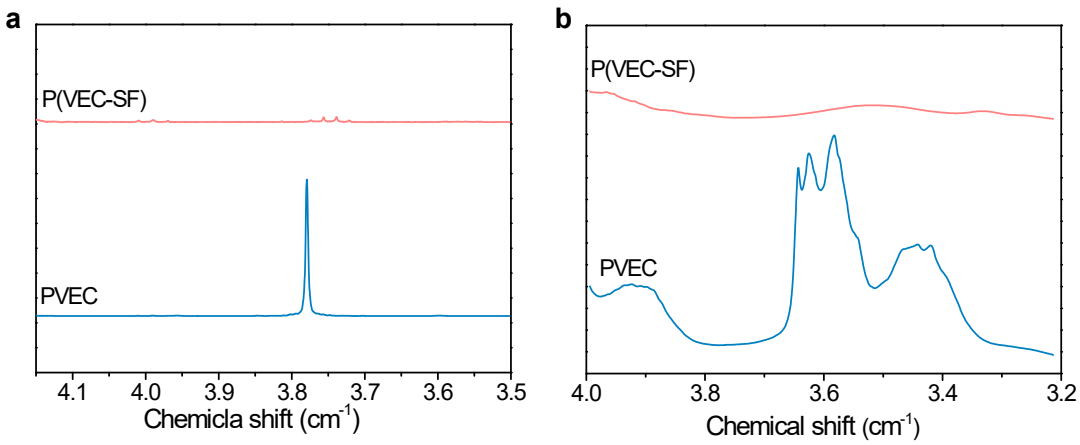

Figure S19. The **a,** liquid ^{1}H NMR spectra and **b,** solid state ^{1}H MAS-NMR spectra of PVEC-PE and P(VEC-SF)-PE after test.

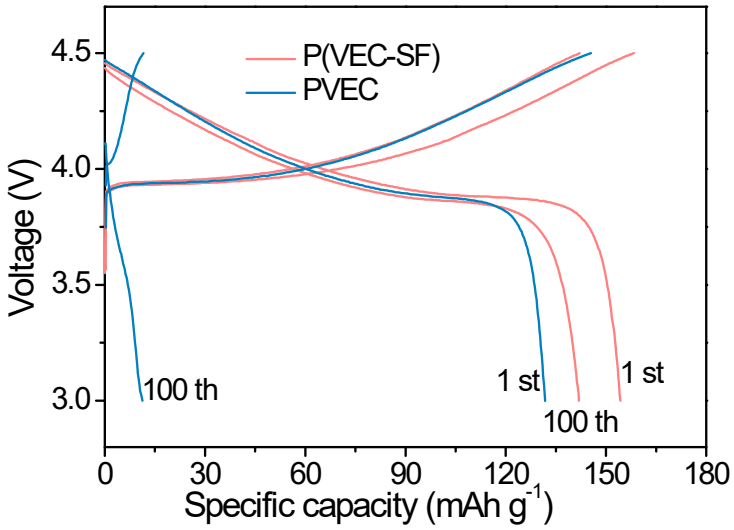

Figure S20. Comparisons of charge-discharge curves of the LCO/PVEC-PE/Li and LCO/ P(VEC-SF)-PE/Li batteries at current density of 0.5 C.

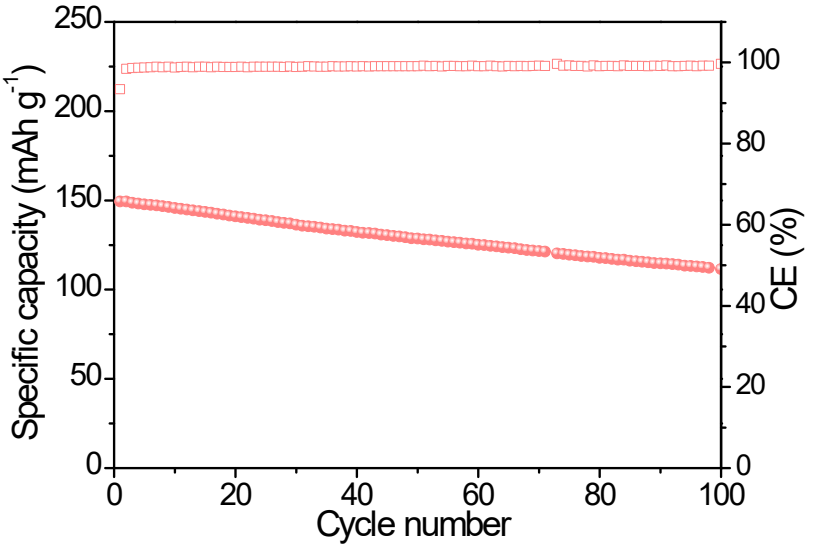

Figure S21. The cycling stabilities of LCO/P(VEC-SF)-PE/Li batteries at current density of 1 C.

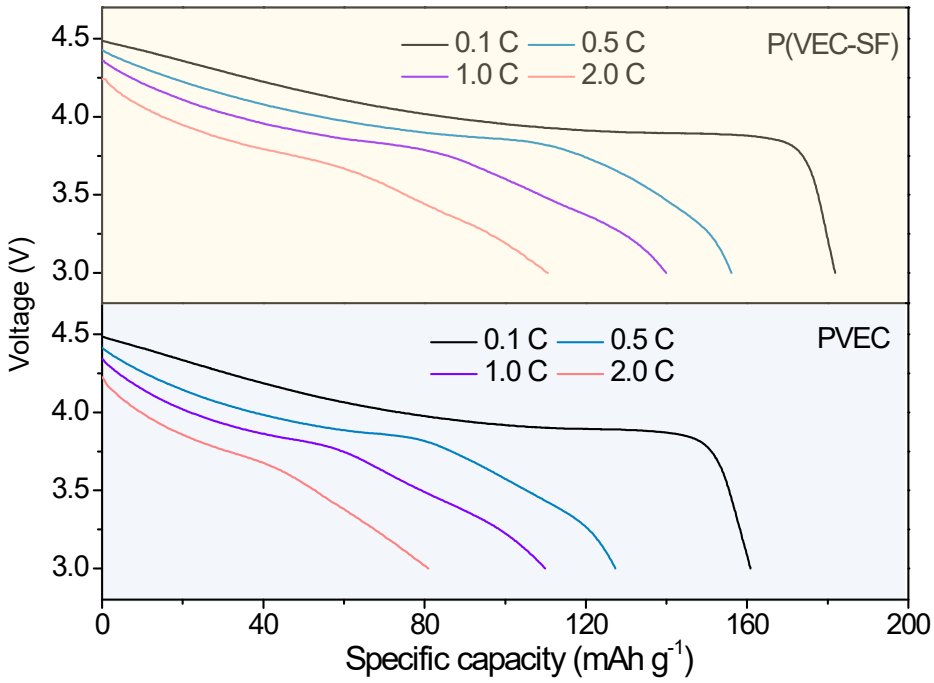

Figure S22. Discharge curves of LCO/PVEC-PE/Li and LCO/P(VEC-SF)-PE/Li battery at different density under cut-off voltage of 4.5 V.

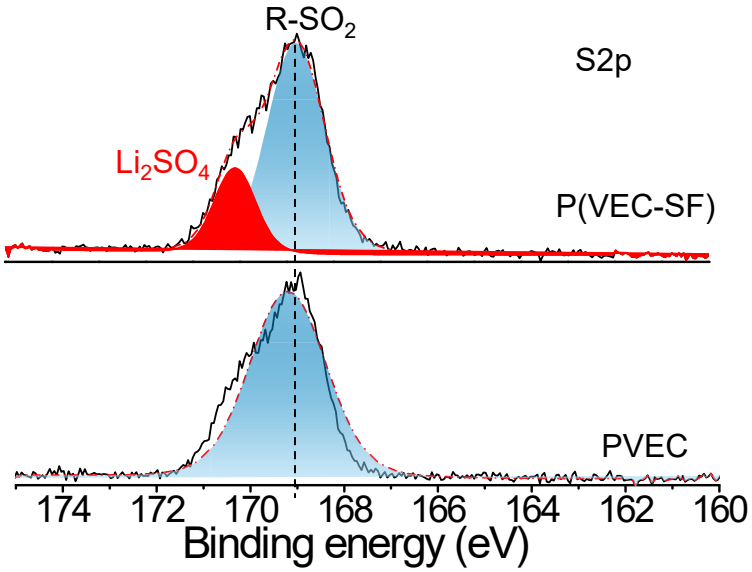

Figure S23. The S2p XPS spectra of PVEC and P(VEC-SF)-PE after tests.

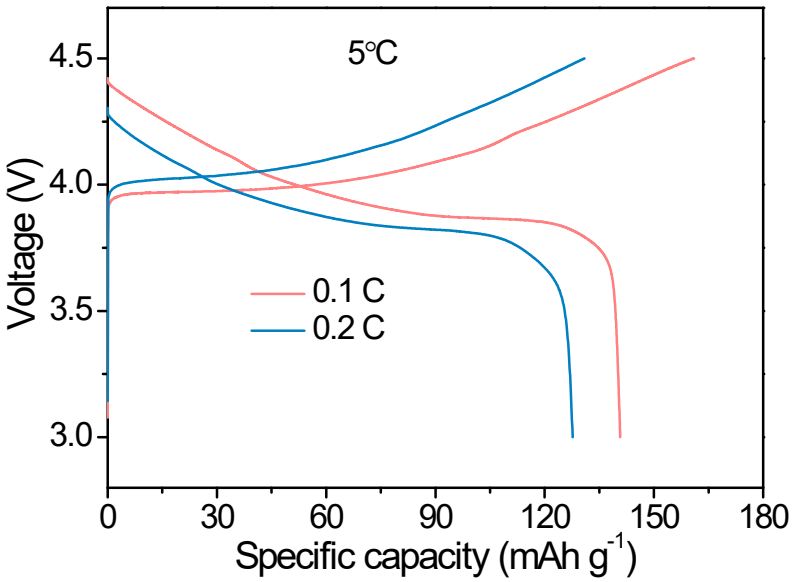

Figure S24. Charge-discharge curves of the LCO/P(VEC-SF)-PE/Li battery under different current densities at 5 ℃.

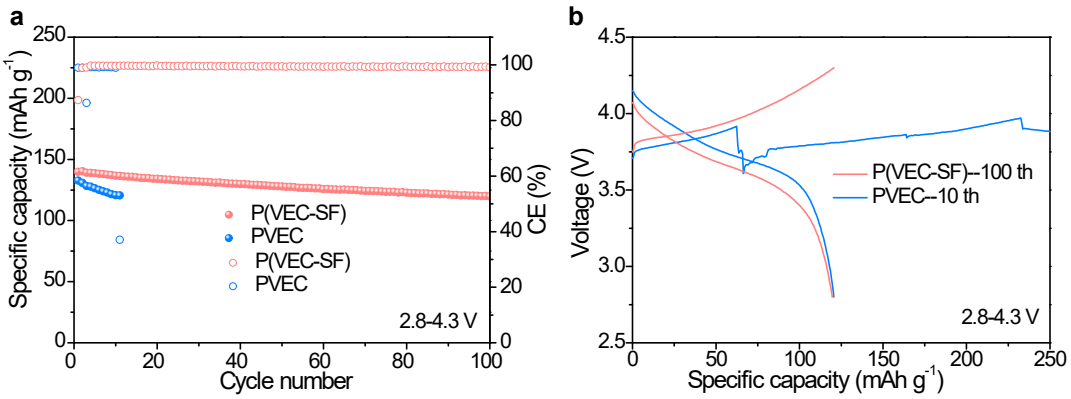

Figure S25. a, the cycling stabilities performances of NCM/PVEC-PE/Li batteries and NCM /P(VEC-SF)-PE/Li batteries with current densities of 1 C at constant voltage of 4.3 V. b, The charge/discharge curves of the NCM/PVEC-PE/Li batteries and NCM /P(VEC-SF)-PE/Li with current densities of 1 C at constant voltage of 4.3 V.

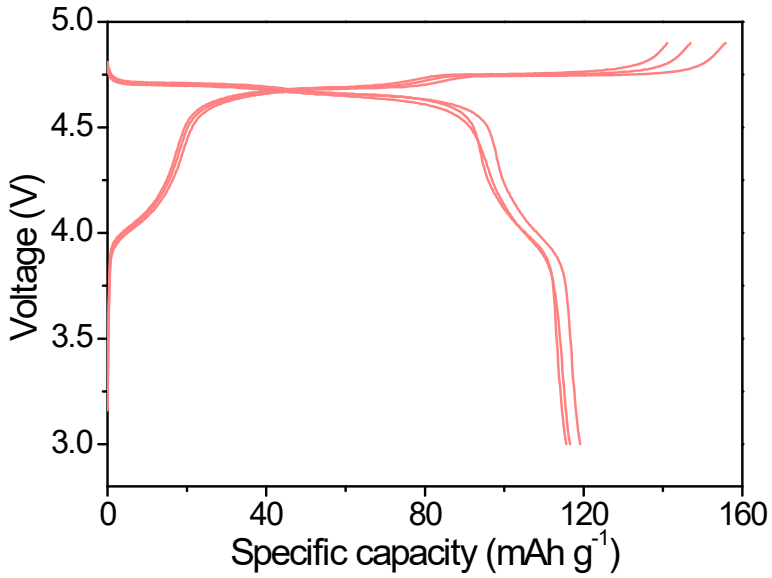

Figure S26. Charge-discharge curves of LNMO/P(VEC-SF)-PE/Li battery.

Table S1. The comparisons of this work with the latest published paper about polymer electrolyte lithium metal batteries.

Polymer electrolyte	Solvent/ additives	Cothode materials	Cut-off voltage (V)	Rate (C)	Cycles	Capacity retention (%)	Ref
PDOX	----	NCM811	4.5	1	100	84	[1]
PDOL	----	NCM811	4.3	1	100	70.6	[2]
PETEA-HFA-TCGG	Liquid electrolyte	NCM811	4.5	2	300	84	[3]
PVDF-HFP	$Mg_2B_2O_5$/PC	LCO	4.4	0.5	50	76.8	[4]
PVEC/BTO	---	LCO	4.3	0.5	185	80	[5]
P(VEC-SF)	----	LCO	4.5	0.5	150	80	This word

References

1. Y. Liu, H. Zou, Z. Huang, Q. Wen, J. Lai, Y. Zhang, J. Li, K. Ding, J. Wang, Y.-Q. Lan and Q. Zheng, *Energy Environm. Sci.*, 2023, DOI: 10.1039/d3ee02797j.

2. A. Hu, Z. Liao, J. Huang, Y. Zhang, Q. Yang, Z. Zhang, L. Yang and S.i. Hirano, *Chemical Engineering Journal*, 2022, **448**, 137661.

3. J. Huang, Z. Shen, S. J. Robertson, Y. Lin, J. Zhu, K. Yang, Y. Wang, M. Shao and Z. Shi, *Chemical Engineering Journal*, 2023, **475**, 145802.

4. Y. Jing, Q. Lv, Y. Chen, B. Wang, B. Wu, C. Li, S. Yang, Z. He, D. Wang, H. Liu and S. Dou, *J.Energy Chem.*, 2024, DOI: 10.1016/j.jechem.2024.02.046.

5. L. Wu, H. Lv, R. Zhang, P. Ding, M. Tang, S. Liu, L. Wang, F. Liu, X. Guo and H. Yu, *ACS Nano*, 2024, **18,** 5498-5509.