Supporting Information

Tough and single lithium-ion conductive nanocomposite electrolytes based on PAES-g-PEG and POSS-PEG for lithium-sulfur battery

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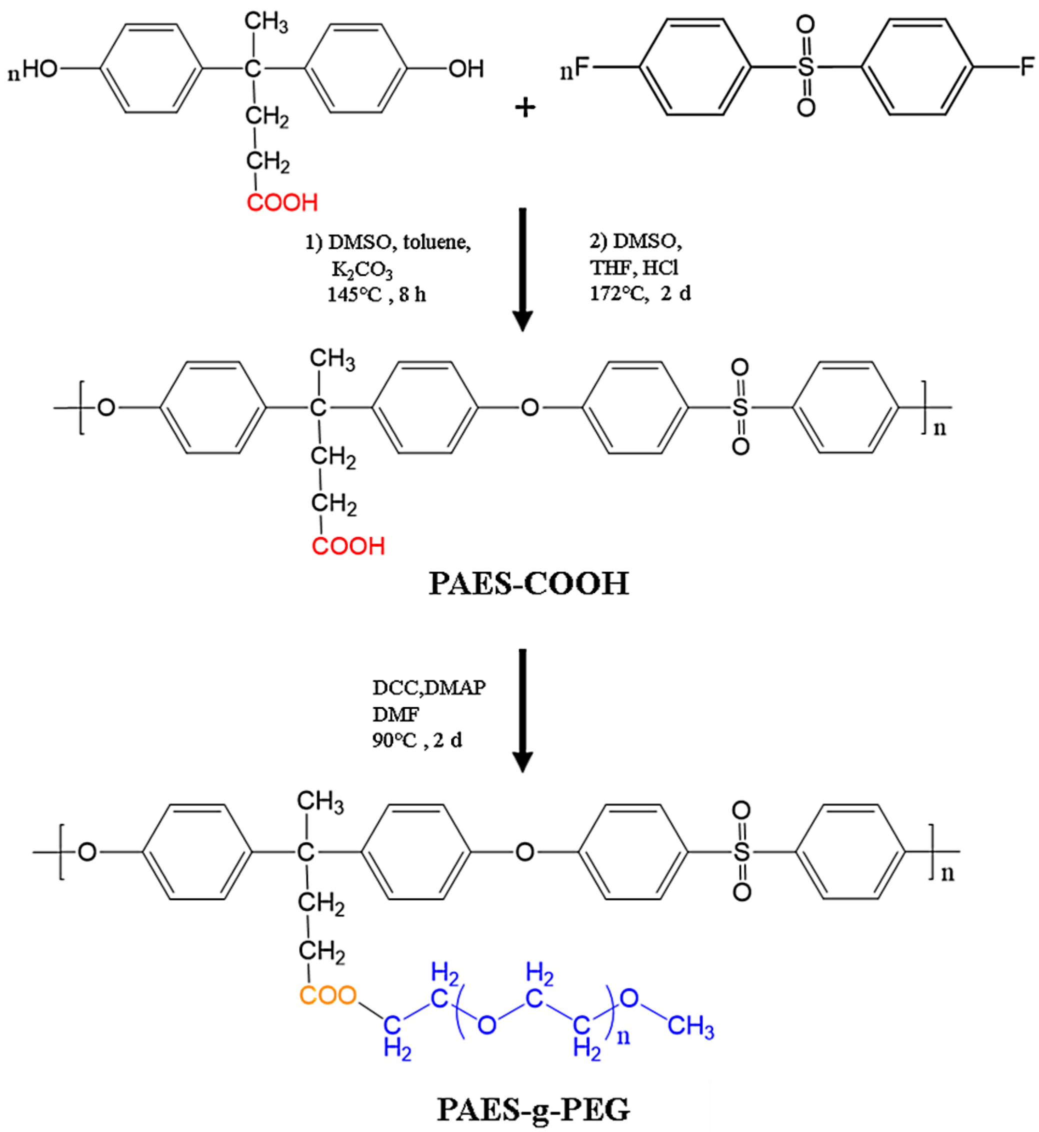


Figure S1. Synthetic scheme of PAES-COOH and PAES-g-PEG.

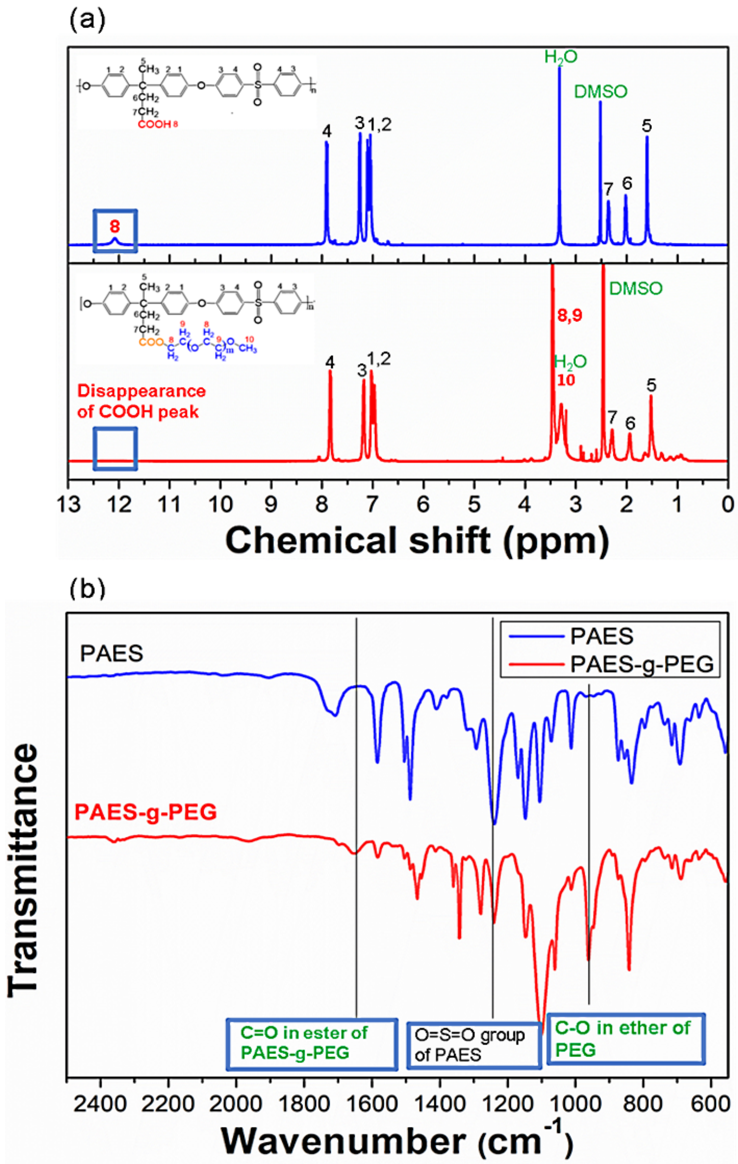
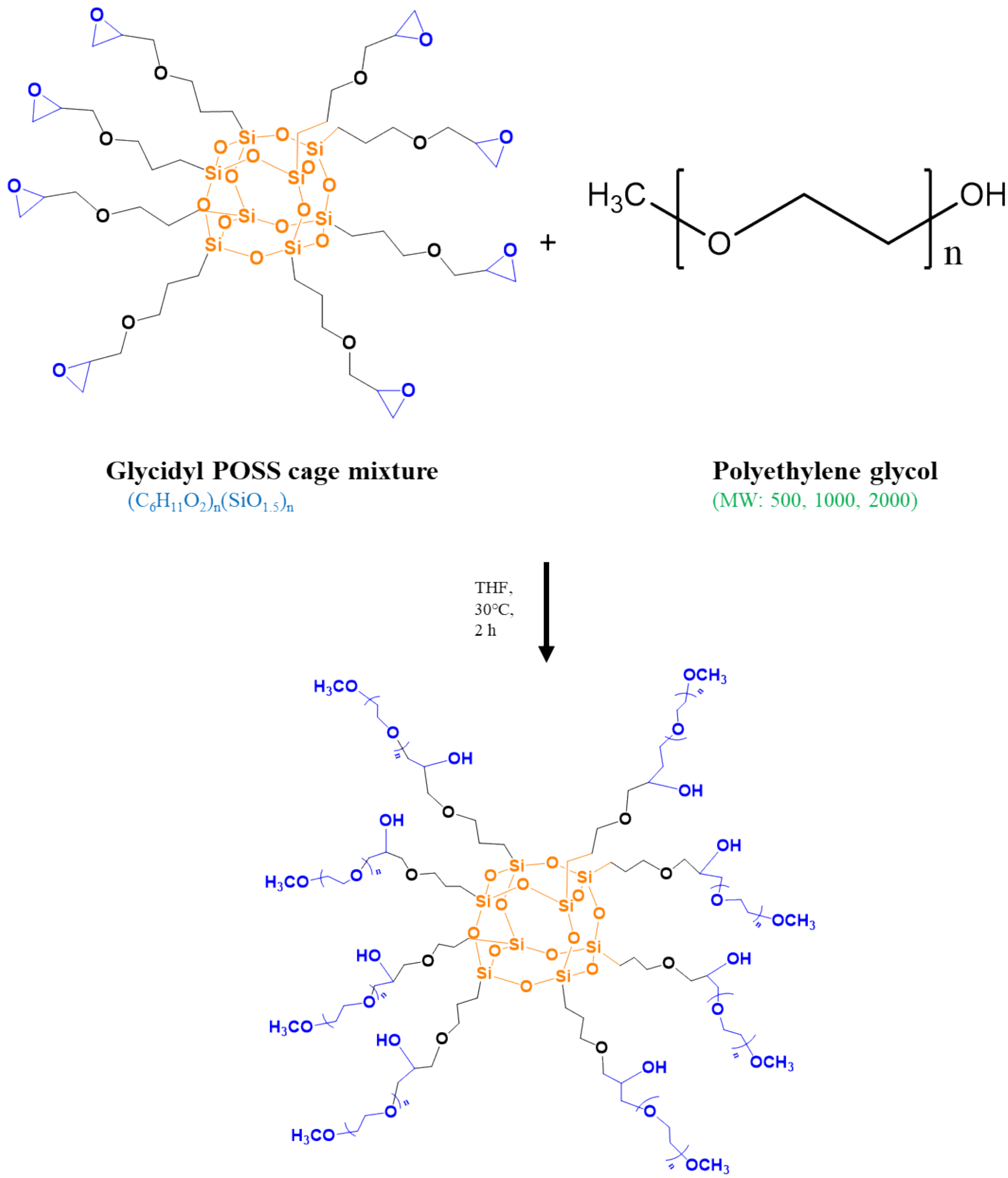


Figure S2. (a) ^{1}H-NMR; and (b) FTIR spectra of PAES-COOH and PAES-g-PEG.



POSS-PEG

Figure S3. Synthetic scheme of POSS-PEG.

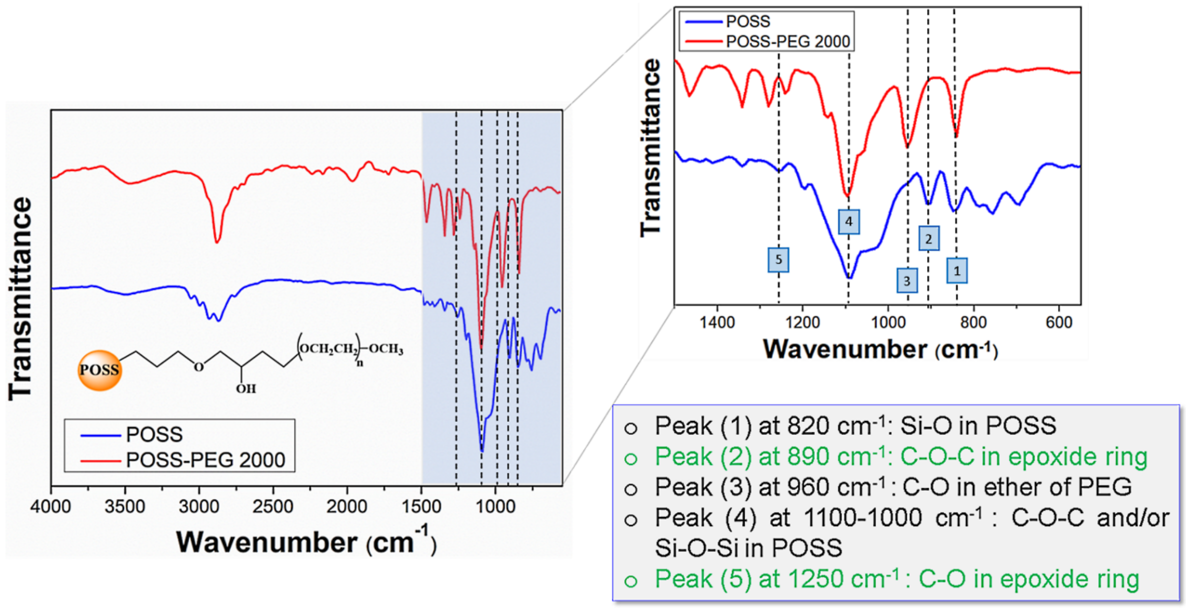


Figure S4. FTIR spectra of POSS and POSS-PEG 2000 nanoparticles.

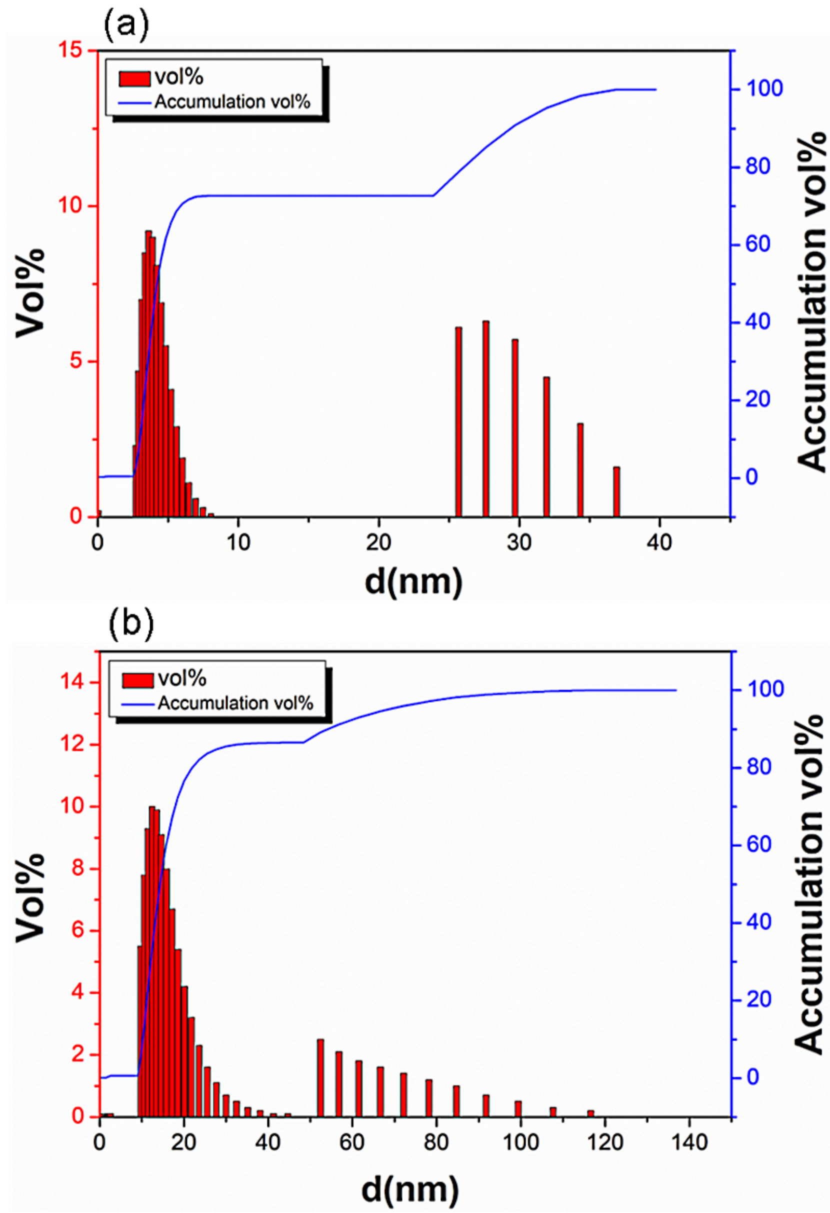


Figure S5. Nanoparticle size of (a) POSS and (b) POSS-PEG 2000 using DLS analysis.

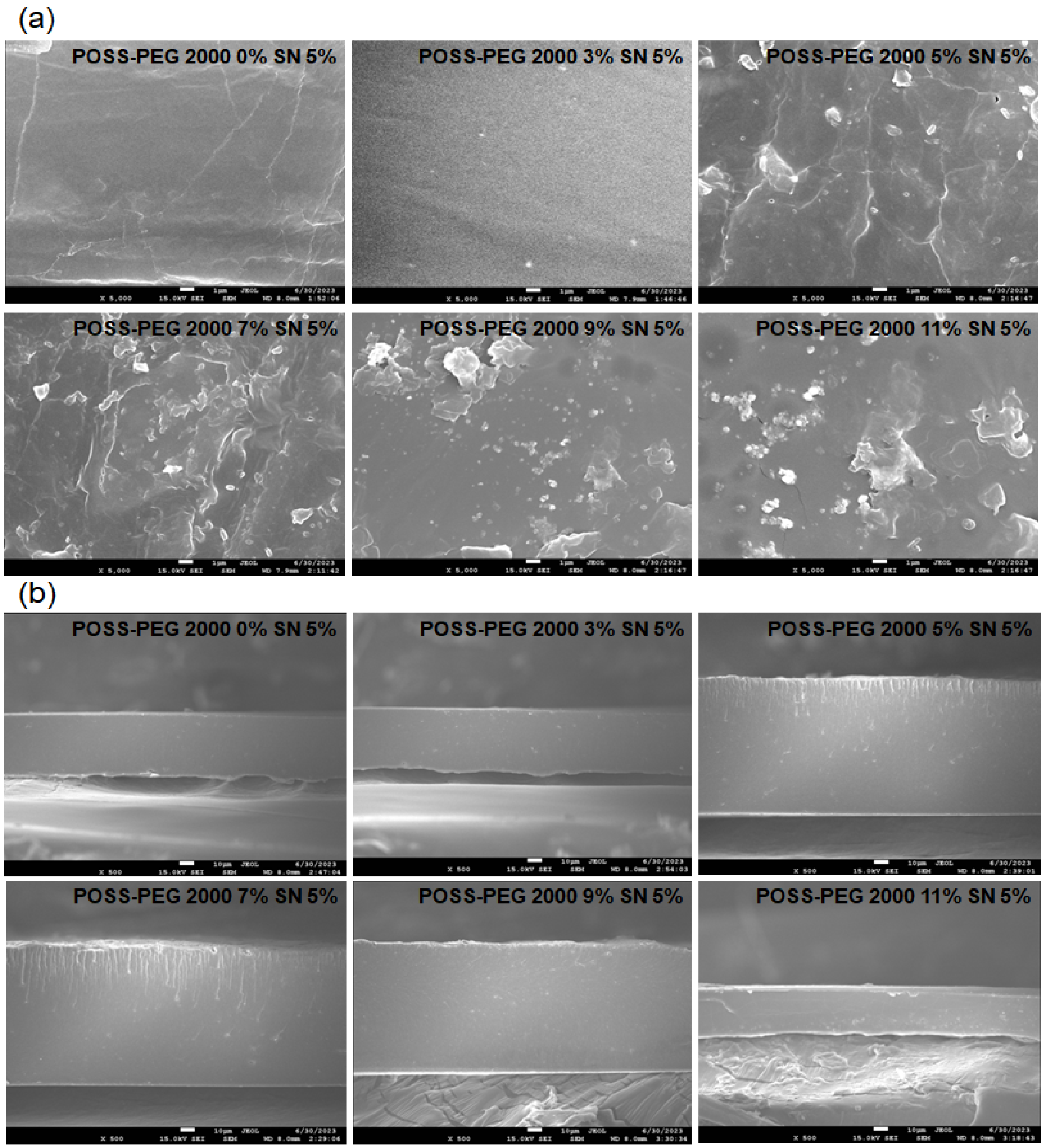


Figure S6. FESEM images of PAES-g-PEG membranes containing different amounts of POSS-PEG 2000 at (a) surface; and (b) cross-section.

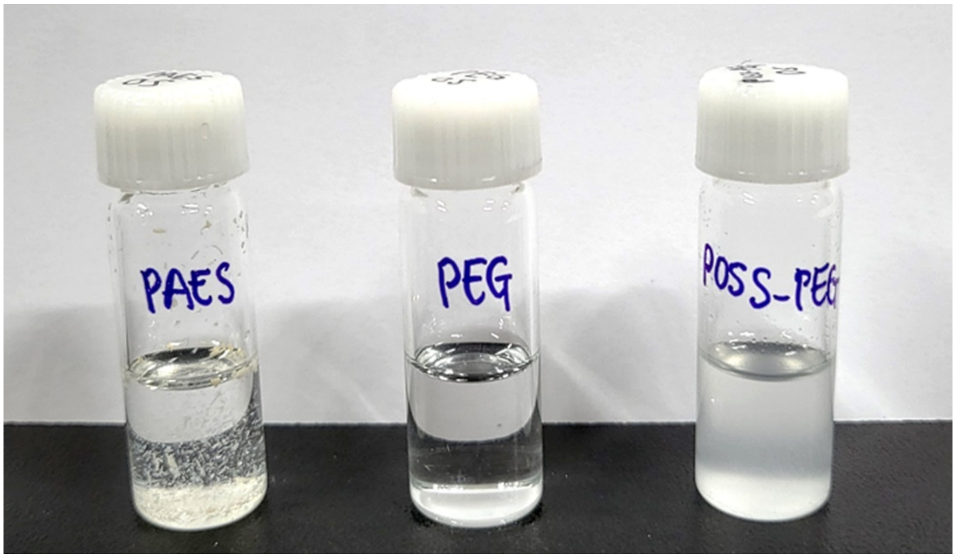


Figure S7. Miscibility of PAES, PEG, and POSS-PEG in OS.

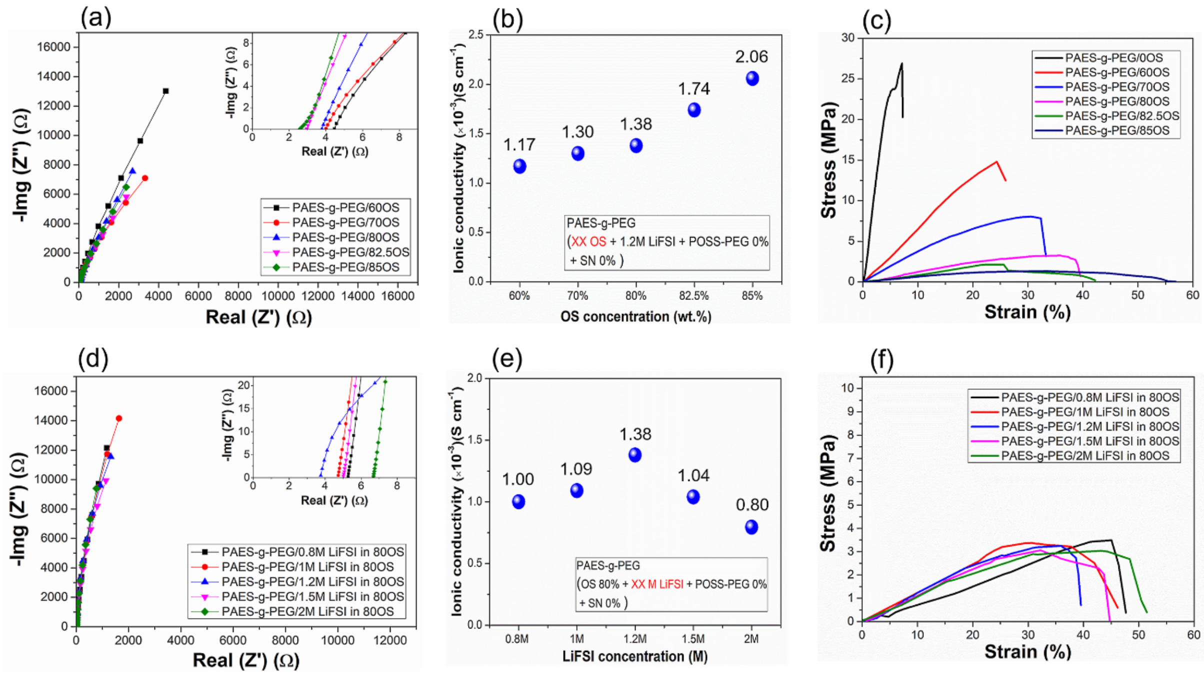


Figure S8. Effect of (a-c) OS concentration; and (d-f) LiFSI concentration on ionic conductivity and mechanical property of PAES-g-PEG membrane.

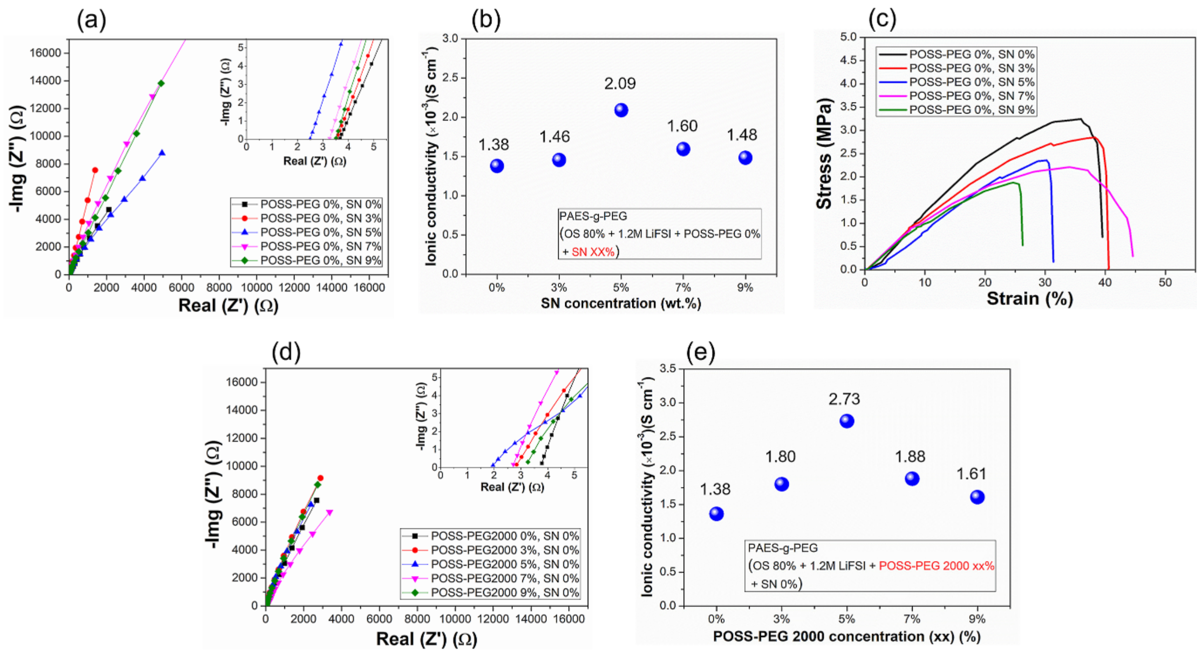


Figure S9. Effect of (a-c) SN concentration on ionic conductivity and mechanical property of PAES-g-PEG membrane; and (d, e) POSS-PEG 2000 concentration on ionic conductivity of PAES-g-PEG membrane without SN additive.

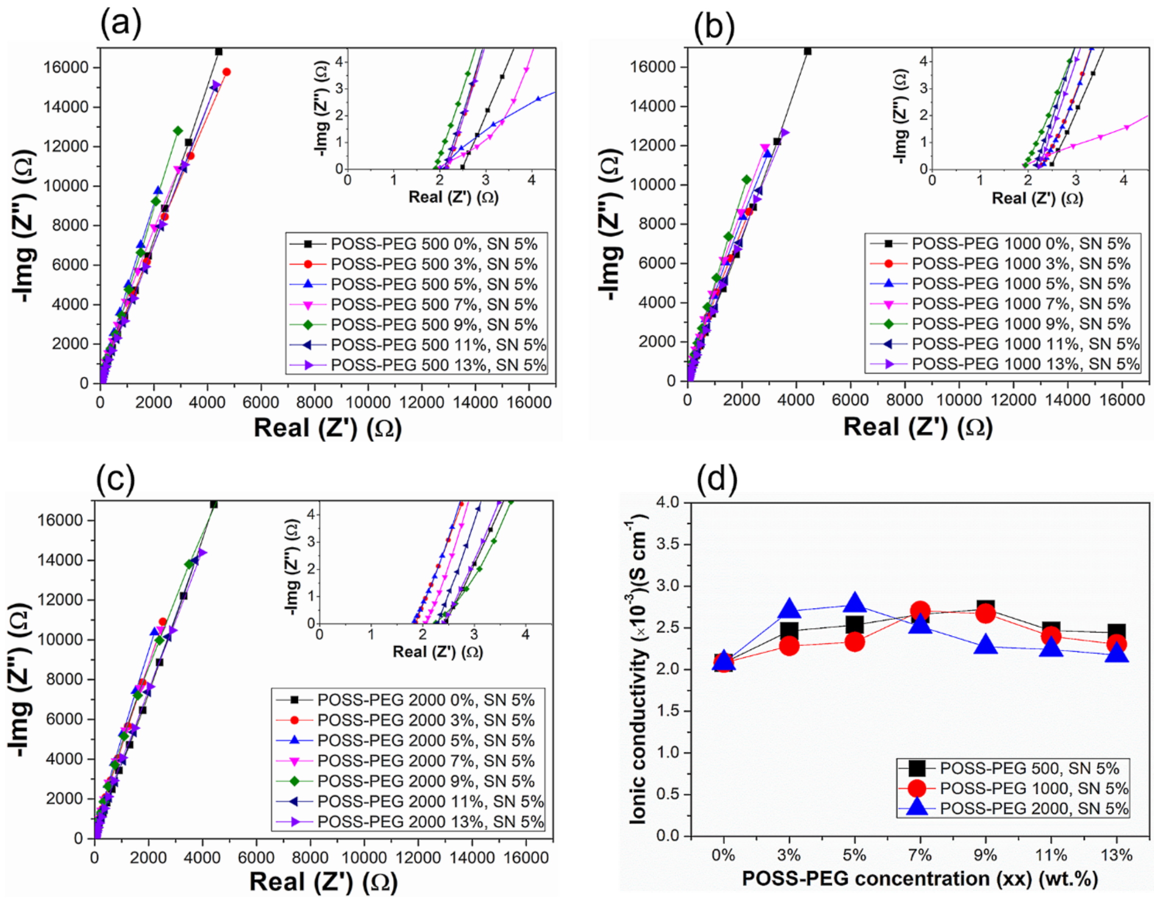


Figure S10. (a-c) Nyquist plot; and (d) ionic conductivity of PAES-g-PEG membranes containing POSS-functionalized with various PEG side chain lengths.

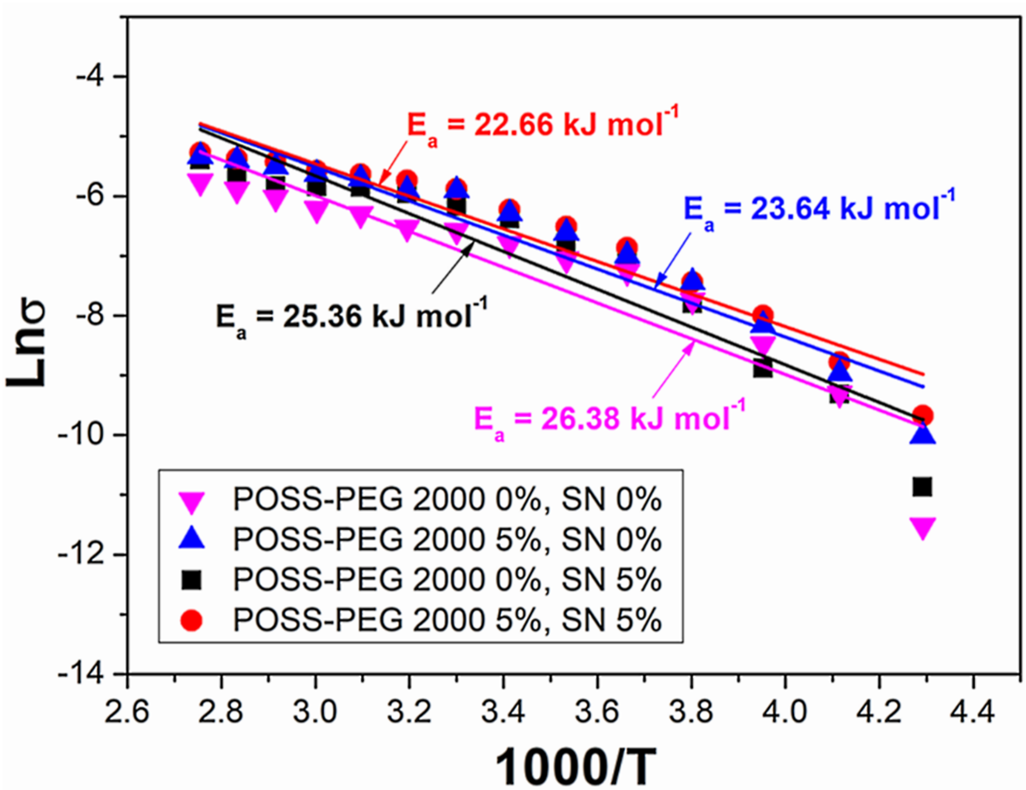


Figure S11. Thermal activation energy of PAES-g-PEG membranes containing different amounts of POSS-PEG 2000 and SN.

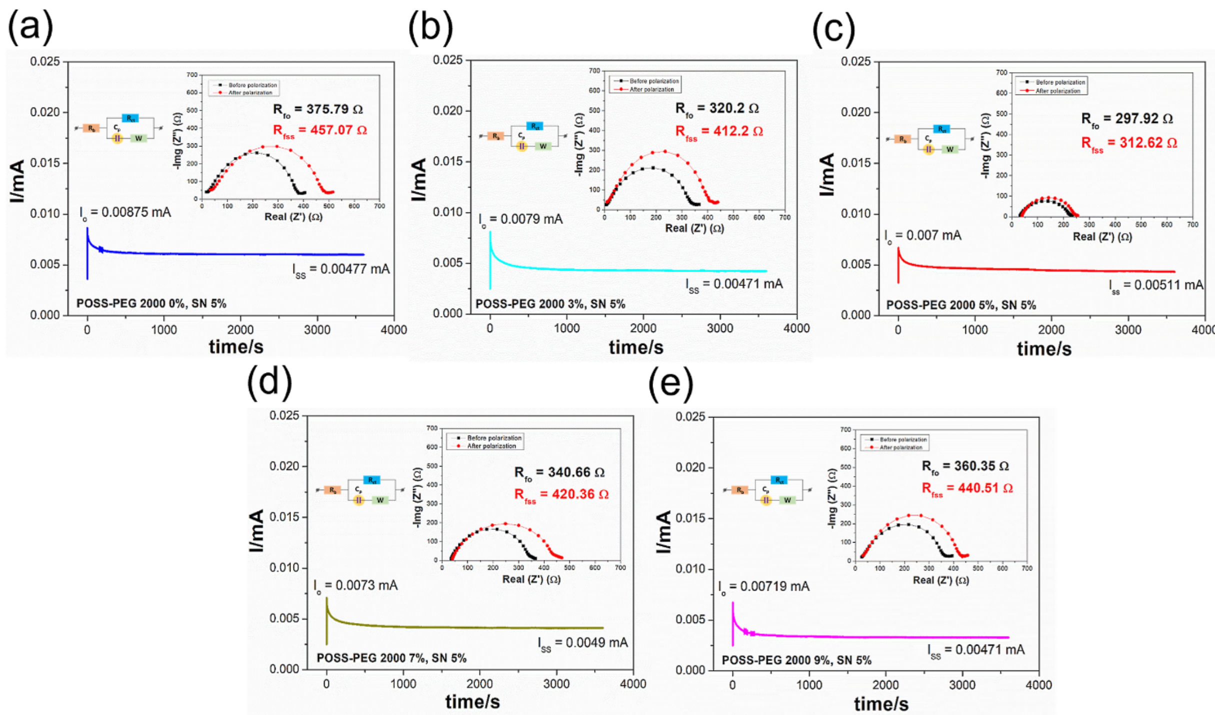


Figure S12. Chronoamperometry curves and interfacial resistance before and after polarization of PAES-g-PEG membranes containing various POSS-PEG 2000 contents at 5 wt.% SN.

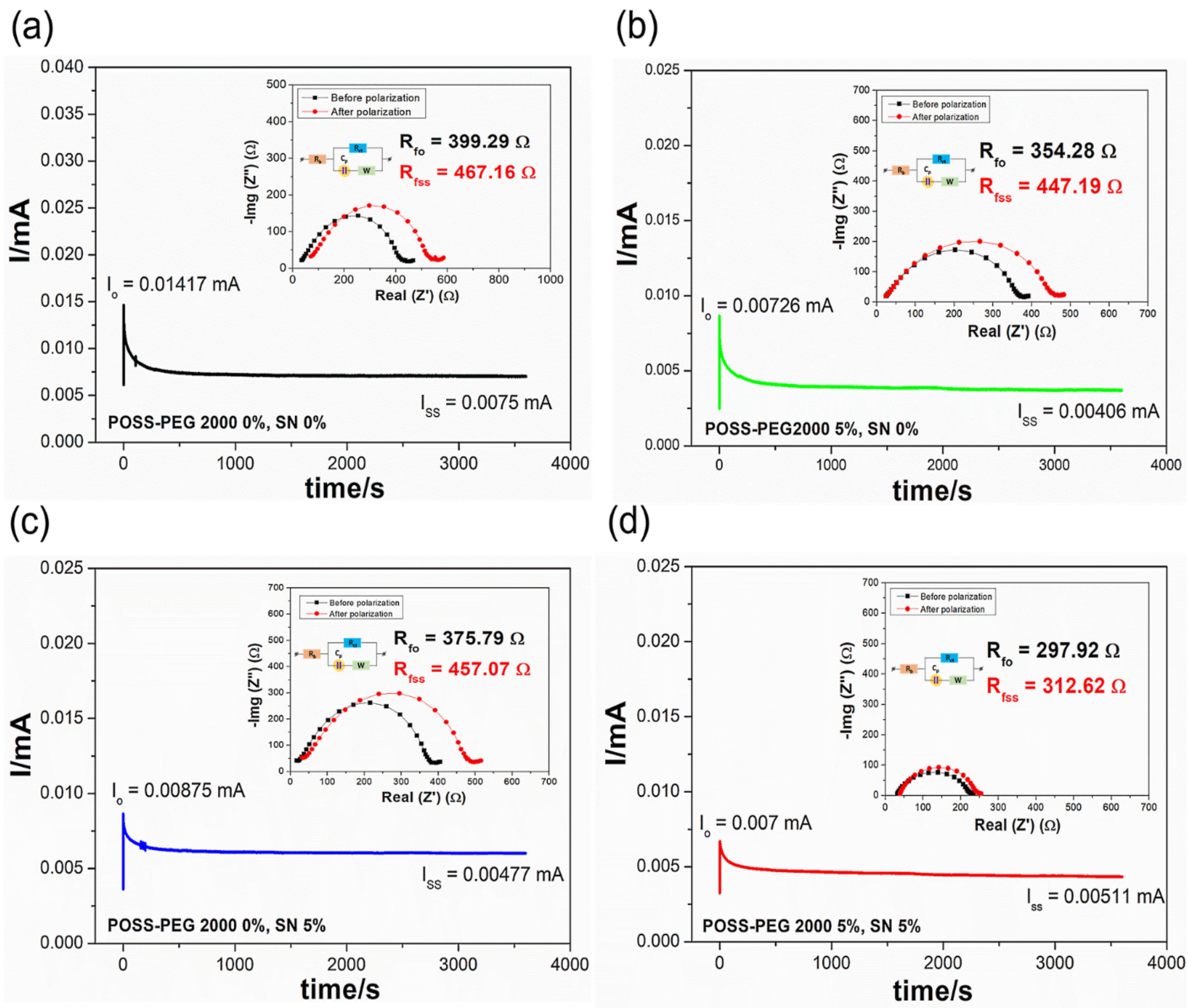


Figure S13. Chronoamperometry curves and interfacial resistance before and after polarization of PAES-g-PEG membranes containing different concentrations of POSS-PEG 2000 and SN.

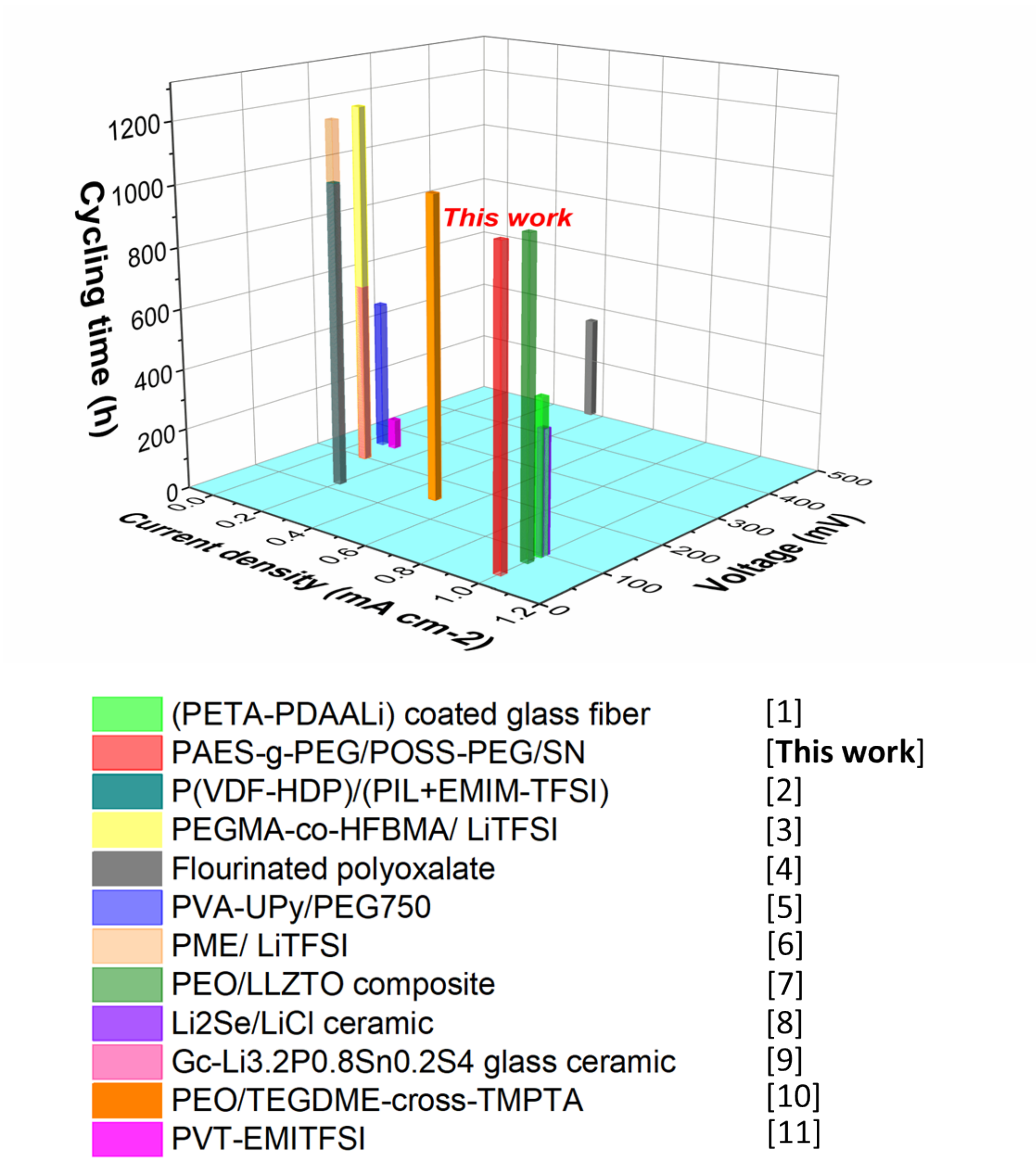


Figure S14. Comparison of interfacial stability of symmetric Li/Li cells containing PAES-g-PEG/POSS-PEG 2000/SN with that of Li/Li cells using other solid electrolytes recently published. [1–11]

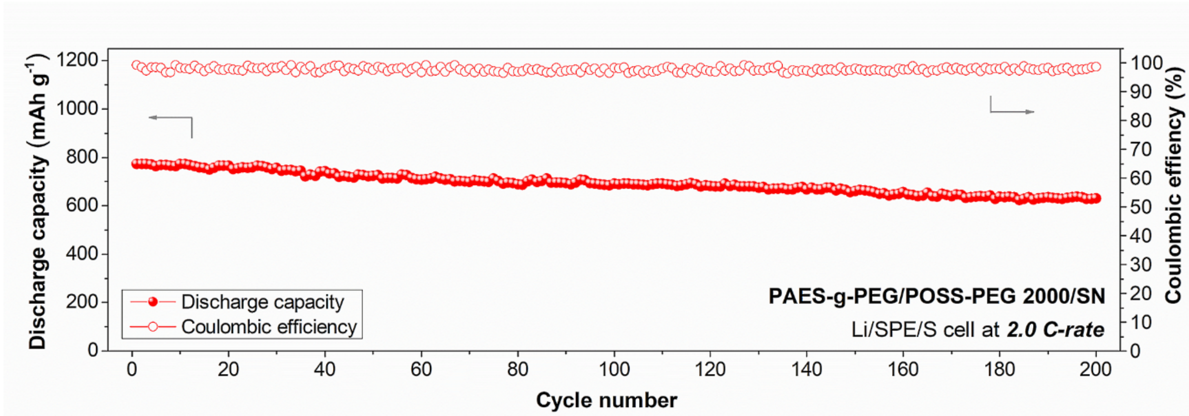


Figure S15. Cycling performance of Li/SPE/S cell assembled with PAES-g-PEG membrane containing POSS-PEG 2000 5% and SN 5% at 2.0 C-rate.

Table S1. Comparison of ionic conductivity (σ), tensile strength and electrochemical stability window of PAES-g-PEG/POSS-PEG 2000/SN membrane with those of other electrolytes recently reported.[12–24]

Electrolyte membranes	**σ (mS cm^{-1})**	**TS [a)] (MPa)**	**ESW [b)] (V)**	**[Ref]**
GPE-PI10	6.22	*	5.5	[12]
Poly(PEG-co-BTA)/zwitterion	4.79	0.05	4.5	[13]
PAES-g-PEG/POSS-PEG 2000/SN	***2.78***	***3.7***	***4.9***	**This work**
PIL-UPy/ LiTFSI (DOL+DME)	1.57	0.047	5.3	[14]
PAES-g-2PEG/IL-EC	1.15	0.9	4.95	[15]
ultrathin dual-salt PEO	0.57	2.4	4.8	[16]
PEO/LiTFSI/In2O3	0.527	5.1	4.6	[17]
PVAC/LLZTO	0.496	5.97	5.4	[18]
PI/PVDF/LiTFSI	0.41	6.1	5.1	[19]
PVDF+CA/BPSO-LiTFSI	0.4	6.8	4.7	[20]
PZEw-50%	0.275	*	4.94	[21]
F-PMIA@ZIF-8-PEO-LiTFSI	0.239	8.39	5.1	[22]
PEO/LiTFSI/ox-PIL@GO	0.101	0.43	5.28	[23]
PEO/POSS-PEG1000	0.08	0.406	5.08	[24]

[a)] Tensile strength and [b)] electrochemical stability window.

Table S2. Comparison of the S/SPE/Li cell performance based on PAES-g-PEG/POSS-PEG 2000/SN membranes with those based on some other electrolytes recently reported.[25–35]

Electrolyte membranes	Discharge capacity (mAh g^{-1})				Capacity retention (%) (C /cycle number)	[Ref]
	0.2C	0.5C	1.0C	2.0C		
PEO/ PIM-8% *solid electrolyte*	1200	1100	910	600	66.3% (0.5C/100th)	[26]
SO_3Li-*g*-UIO(MOF)/LiTFSI +IL	985	890	749	-	84% (0.2C/250th)	[27]
PEO-$Li_4(BH_4)_3I$/ SiO_2 (5%wt)	950	817	613	583	62.2% (0.1C/75th)	[25]
PAES-g-PEG/POSS-PEG/SN	***980.1***	***929.9***	***865.9***	***772.8***	***85.3% (0.2C/200th)*** ***82.0%(2.0C/200th)***	**This work**
PETT-DA/(PEO+PVDF-HFP)	910	766	624	543	87.1% (2.0C/300th)	[28]
In-situ S-DCBQ organosulfur	890	795	750	600	74% (0.2C/100th)	[29]
PEO/(LLZO+MWCNT)	873	810	500	400	72.6% (0.2C/60th)	[30]
PETEA+DVA/(DOL+TEGDM)	779	621	325	220	70% (0.5C/300th)	[31]
PEO/ (P_2S_5 + LiTFSI)	750	450	-	-	55% (0.2C/350th)	[32]
PEO/ $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$/ PEO)	692.9	428.4	362.3	-	75% (0.1C/100th)	[33]
Polydopamine-coated Li_6PS_5Cl	552.8	226.4	-	-	72% (0.2C/100th)	[34]
PEO/(TCM+ LiTFSI)	450	300	-	-	85% (0.1C/50th)	[35]

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