Supporting Information for

Flexible and Stable PEO-Based Polymer Composite Solid Electrolyte Membranes Incorporating NASICON-Type $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$ for High - Performance All-Solid-State Lithium Batteries

Sumit Khatua,[1,2] Sasikumar K,[1,2] K. Ramakrushna Achary,[3] Gajjala Sindhu,[1] Tausif Alam,[1] L. N. Patro[1,2*]

[1]Solid State Ionics Lab, Department of Physics, SRM University AP, Amaravati, 522240, Andhra Pradesh, India

[2]SRM-Amara Raja Center for Energy Storage Devices, SRM University AP, Amaravati, 522240, Andhra Pradesh, India

[3]Department of Chemistry, SRM University AP, Amaravati, 522240, Andhra Pradesh, India

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[*]**Corresponding author:** laxminarayana.p@srmap.edu.in; patrolng@gmail.com (L. N. Patro)

Tel: 0863-2343000

Fax: 0863-2343111

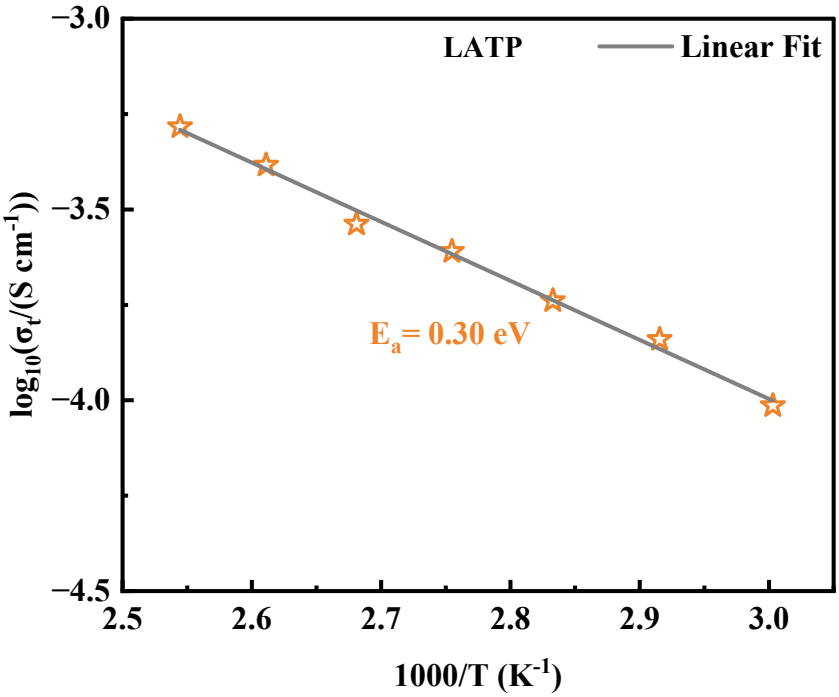

Fig. S1. Temperature dependent conductivity plot of LATP pellet.

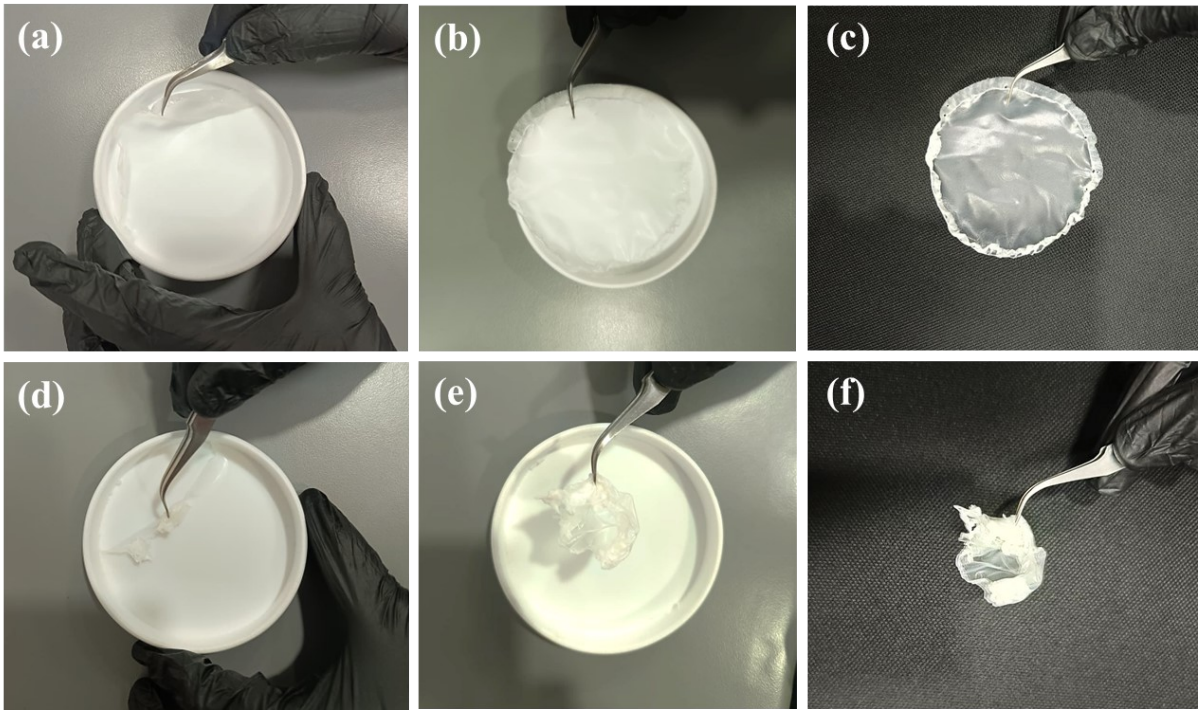

Fig. S2 (a-c). Photographs of the 20% LiTFSI and **(d-f).** 25% LiTFSI polymer membranes at RT during their development.

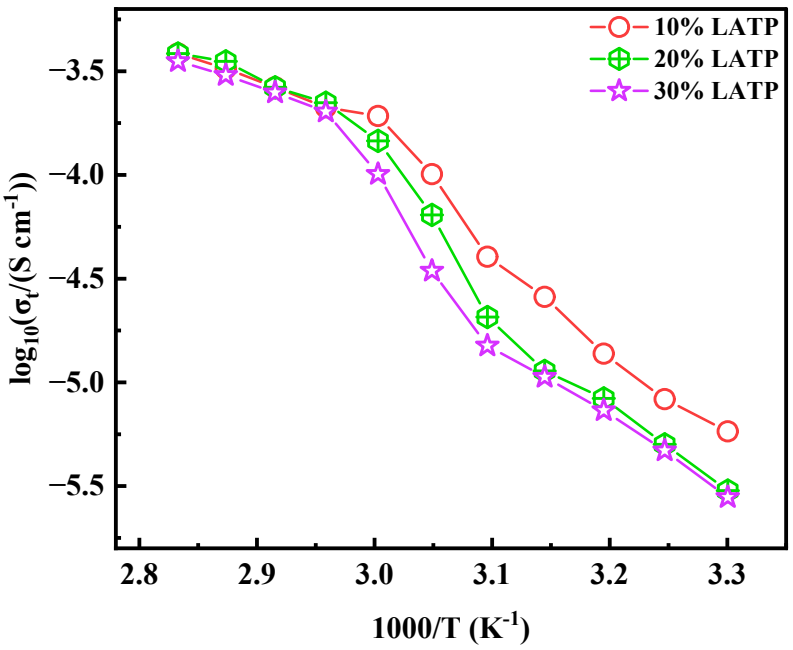

Fig S3. Temperature-dependent ionic conductivity (30-80°C) of PCSE membranes with varying LATP ceramic filler concentrations.

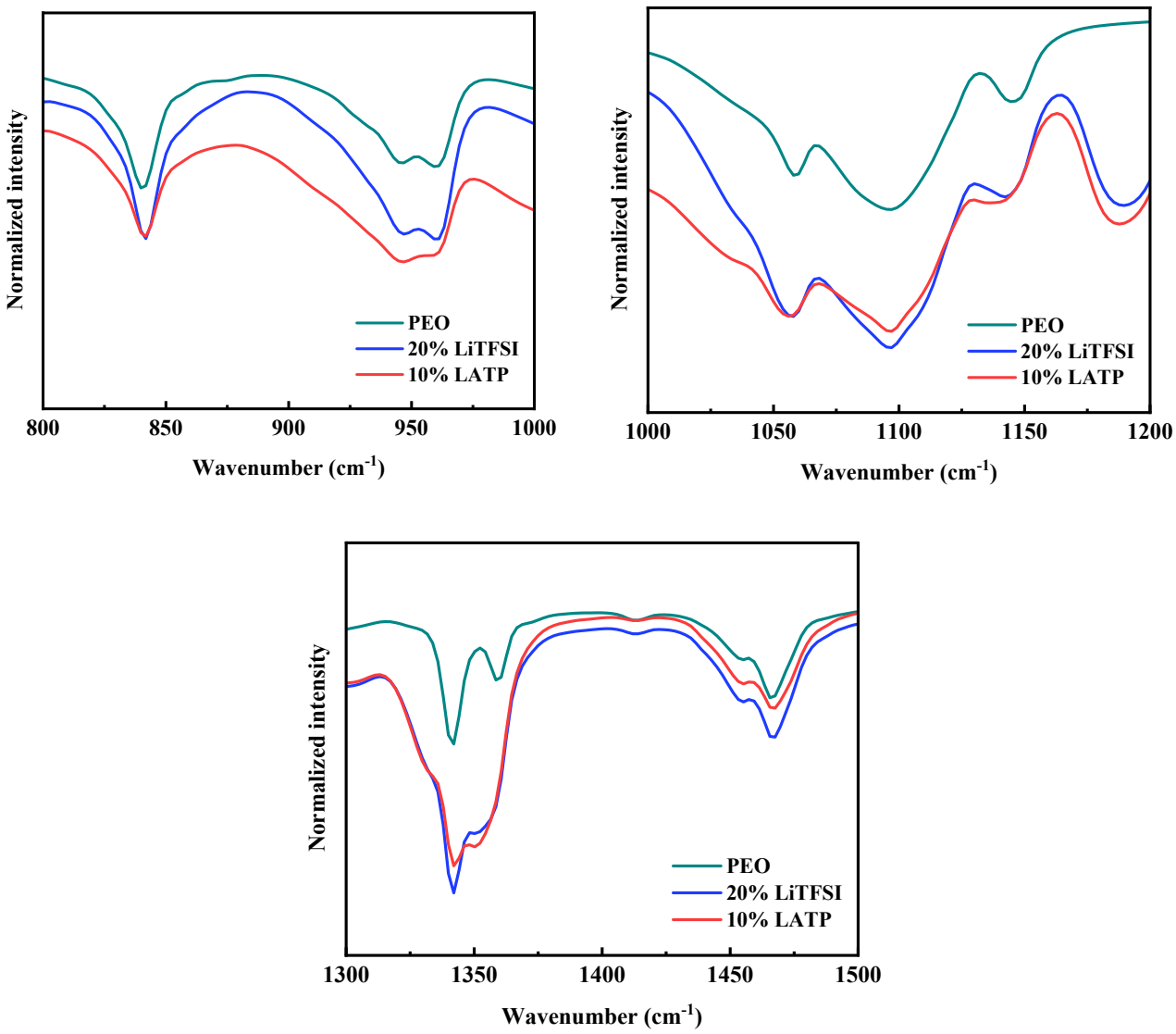

Fig. S4. Magnified regions of the FTIR spectra at specific wavenumber ranges.

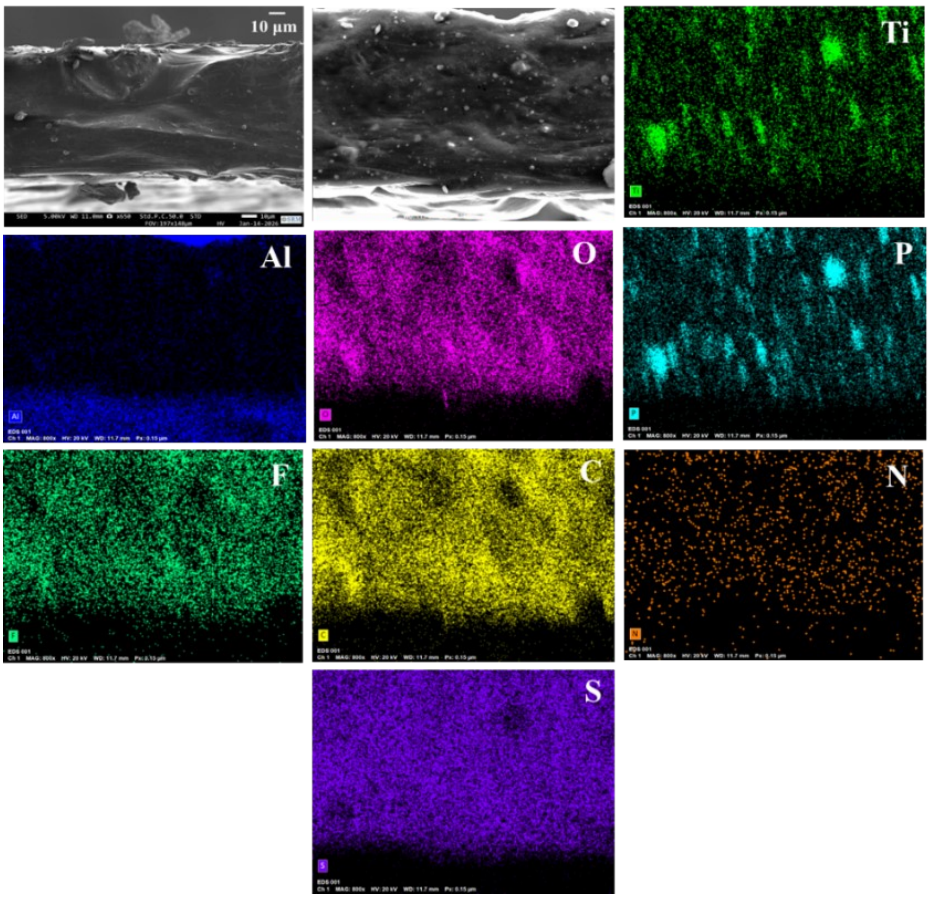

Fig S5. Cross-sectional SEM image with corresponding elemental mapping of the 10% LATP PCSE membrane.

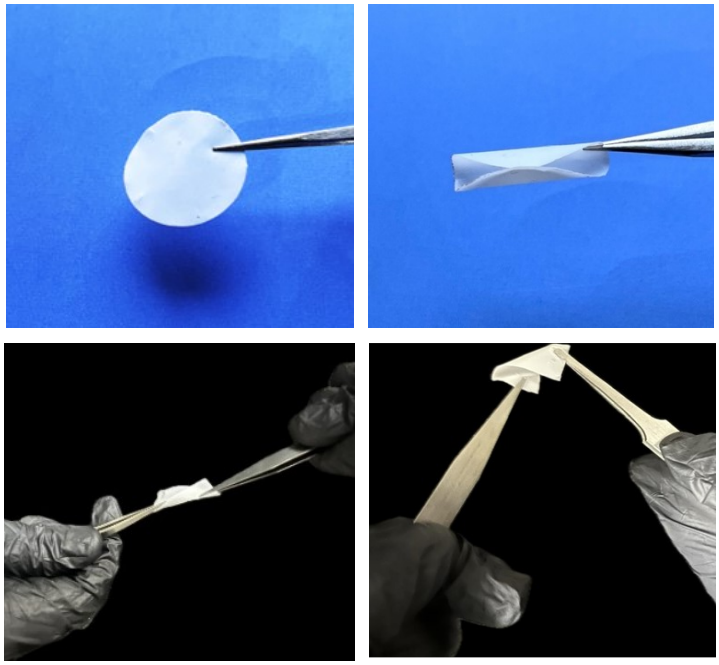

Fig S6. Digital photographs showing the flexibility of the 10% LATP PCSE membrane under bending and twisting tests.

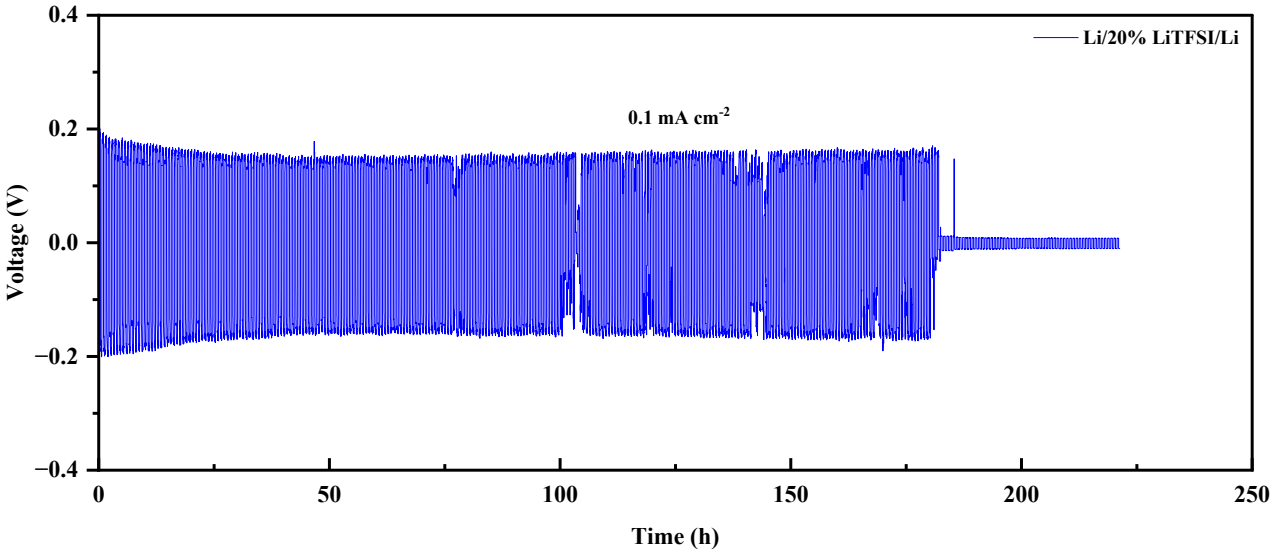

Fig. S7. Cycling stability of the Li/20% LiTFSI/ Li symmetric cell during lithium stripping-plating at a constant current density of 0.1 mA cm^{-2}.

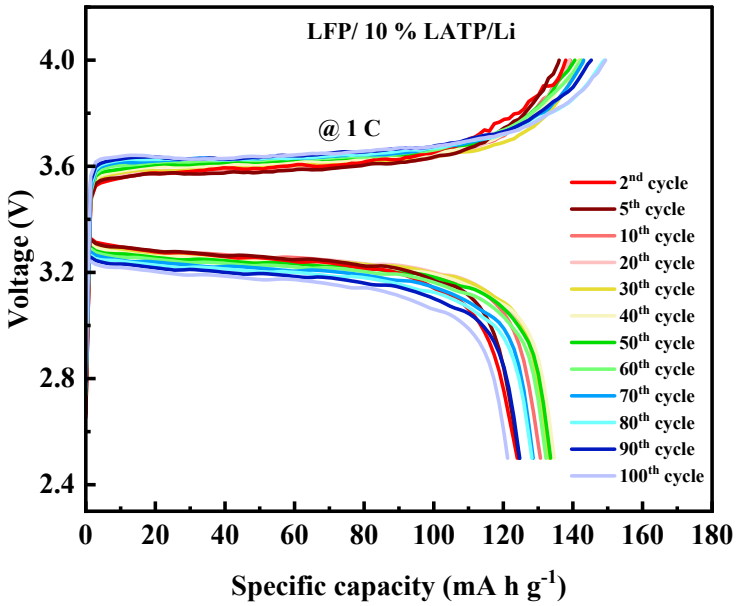

Fig. S8. Galvanostatic charge-discharge profiles showing the cycling performance of LFP/10% LATP/Li cell at 1 C.

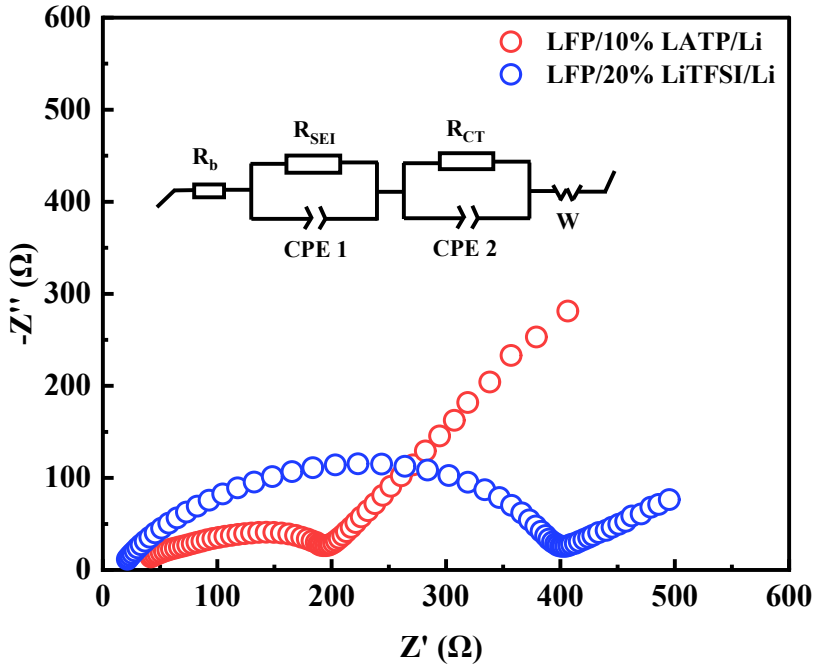

Fig. S9. Nyquist plots of the LFP/PCSE/Li cell before cycling at 60°C.

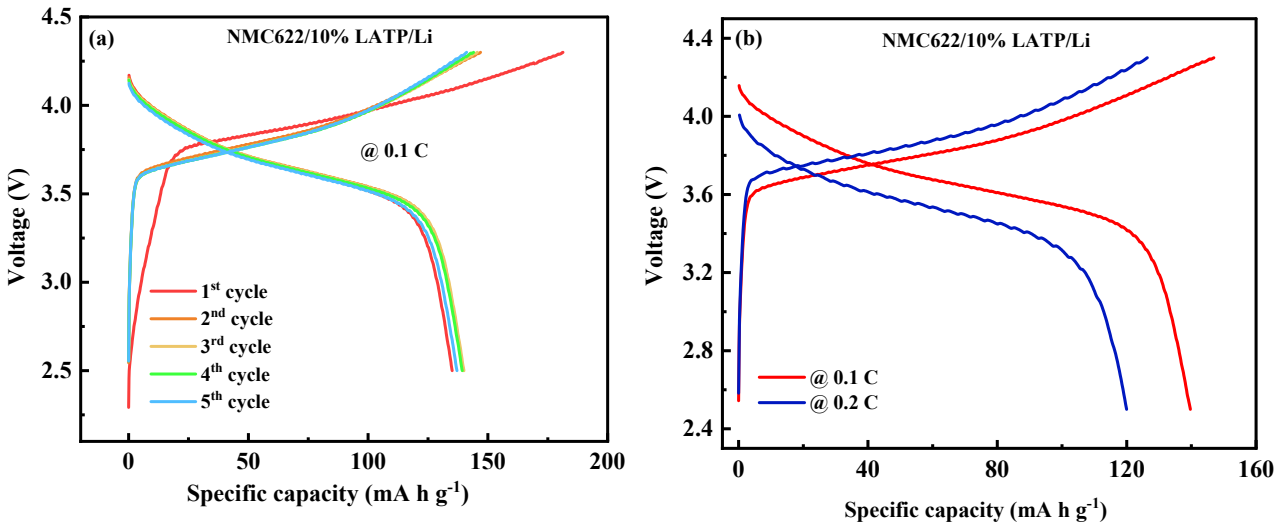

Fig. S10(a) Charge-discharge profiles of NMC622/10% LATP/Li cell at 0.1 C. **(b)** Charge-discharge curves of NMC622/10% LATP/Li cell at two different current rates.

Table S1: Conductivity values of different PEO-based polymer membranes.

Sample name	Conductivity (RT) (S cm^{-1})	Conductivity (60°C) (S cm^{-1})
15% LiTFSI	0.13×10^{-5}	0.30×10^{-4}
20% LiTFSI	0.28×10^{-5}	0.22×10^{-3}
10% LATP	0.34×10^{-5}	0.19×10^{-3}
20% LATP	0.26×10^{-5}	0.81×10^{-4}
30% LATP	0.22×10^{-5}	0.49×10^{-4}

Table S2. Comparison of the ionic conductivity and electrochemical performance of 20% LiTFSI and 10% LATP polymer membranes with previously reported values for polymer and composite polymer electrolytes.

Polymer Electrolyte	**Ionic conductivity (S cm^{-1})**	**Discharge capacity (mA h g^{-1}) $LiFePO_4$//Li**	**Current rate**	**Reference**
PEO-LITFSI	2.95×10^{-4} at 55°C	151.6 at 55°C	0.2 C	**1**
PEO-LITFSI	2.86×10^{-4} at 60°C	152.02 at 60°C	0.2 C	**2**
PVDF−HFP- LiTFSI	7.1×10^{-5} at RT	112 at RT	0.2 C	**3**
PVDF–HFP-LiTFSI	2.5×10^{-4} at 25°C	127.4 at 25°C	0.1 C	**4**
PEO-LiTFSI (20 % LiTFSI)	2.2×10^{-4} at 60°C	143.4 at 60°C	0.1 C	This work
PEO-$LiClO_4$-LATP	1.6×10^{-3} at 80°C	130.2 at 80°C	0.2 C	**5**
PEO-LiTFSI-LATP-FEC	1.99×10^{-4} at 30°C	147 at RT	0.1 C	**6**
PEO-LiTFSI-LAGP	1.6×10^{-5} at 20°C	166 at 80°C	0.1 C	**7**
PEO-LiTFSI-LLZTO	2.12×10^{-4} at 60°C	153.8 at 60°C	0.3 C	**8**

PVDF-LiTFSI-LATP	2.44×10^{-4} at 25°C	155 at 30°C	0.2 C	**9**
PEO-LiTFSI-LATP (10% LATP)	1.9×10^{-4} at 60°C	151.6 at 60°C	0.1 C	This work

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