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

Supporting information

Solid-state Polymer Electrolytes Stabilized by Task-specific Salt Additives

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Figure S1: Solution of trinal electrolytes before making SPE.

The left is the solution without the addition of HNC. The solution appears mostly transparent. After HNC, the solution is still homogenous without any precipitation.

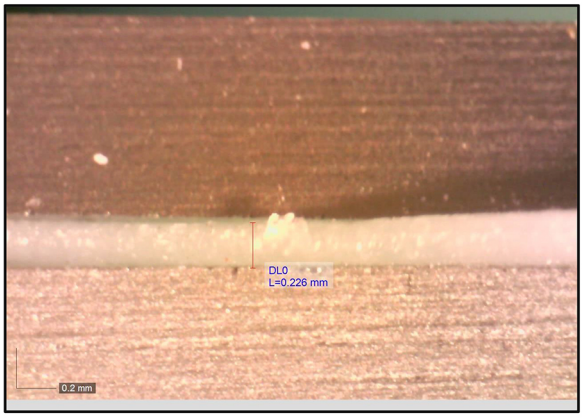

Figure S2: Typical thickness of prepared SPE.

The prepared SPE was firstly put between two glass slides. A microscopy was then used to measure the thickness of SPE.

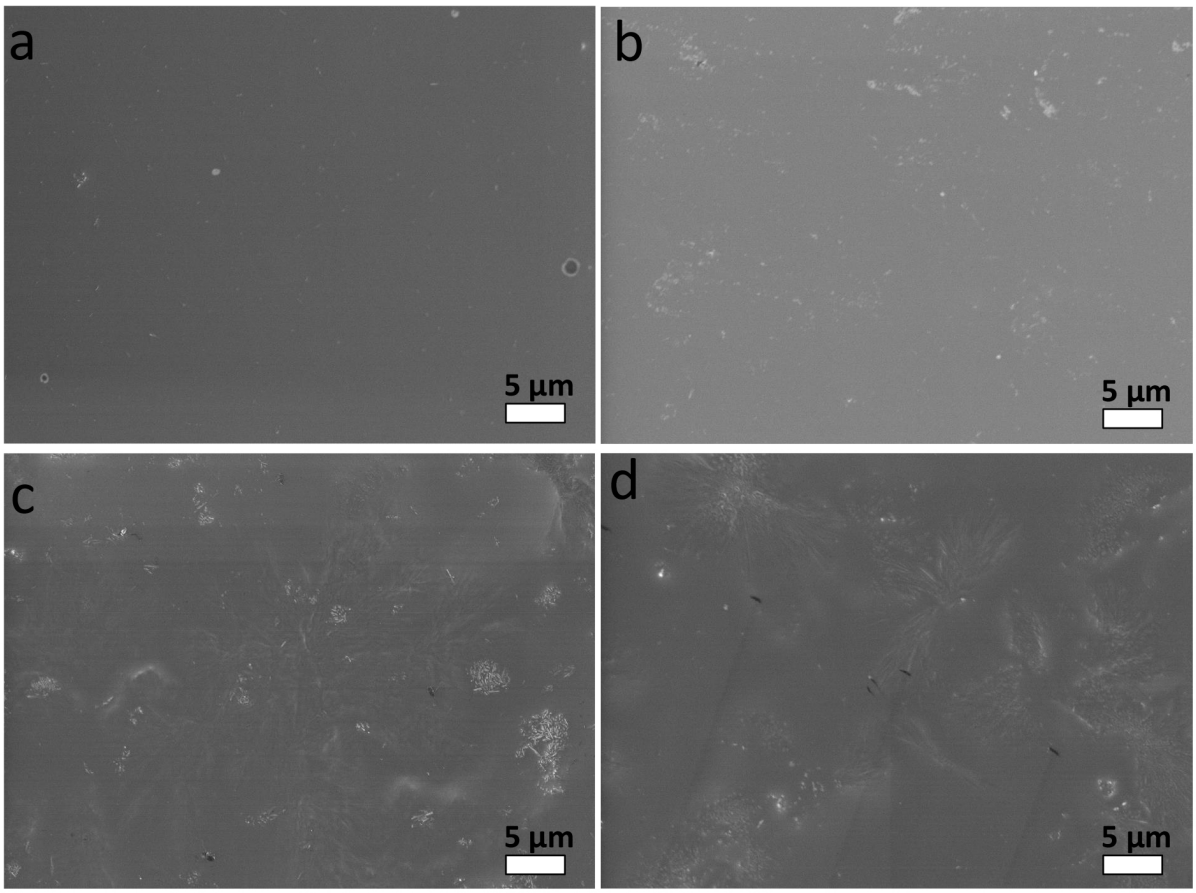

Figure S3: SEM images of prepared SPE. **(a)** single salt (LiTFSI) SPE, **(b)** dual salt (LiTFSI + 5% LiBOB) SPE, **(c)** Dual salt SPE (LiTFSI + 5% $LiNO_3$), **(d)** Trinal salt SPE (LiTFSI + 5% LiBOB + 5% $LiNO_3$).

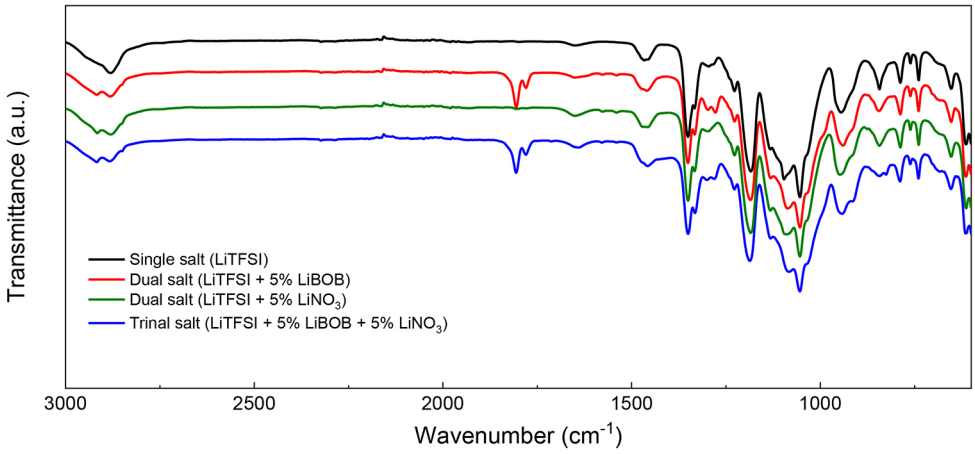

Figure S4: ATR-FTIR spectra of prepared SPE.

Due to the strong intensities of peaks and large ratios, most of peaks of SPE belong to LiTFSI and PEO.[1] The $LiNO_3$ and LiBOB only take up a small amount and their molecules may be wrapped by PEO molecules.[2] Therefore, we can only finds the vibration of C=O (at about 1800cm^{-1}) in trinal salts SPE, which belong to the LiBOB.[3]

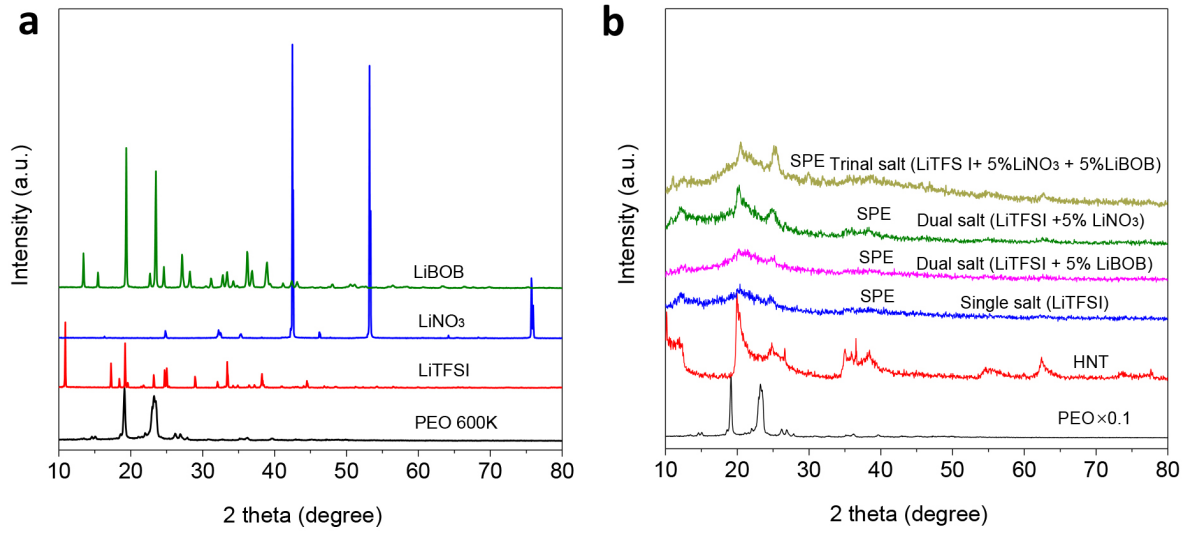

Figure S5: XRD patterns of raw materials and prepared SPEs.

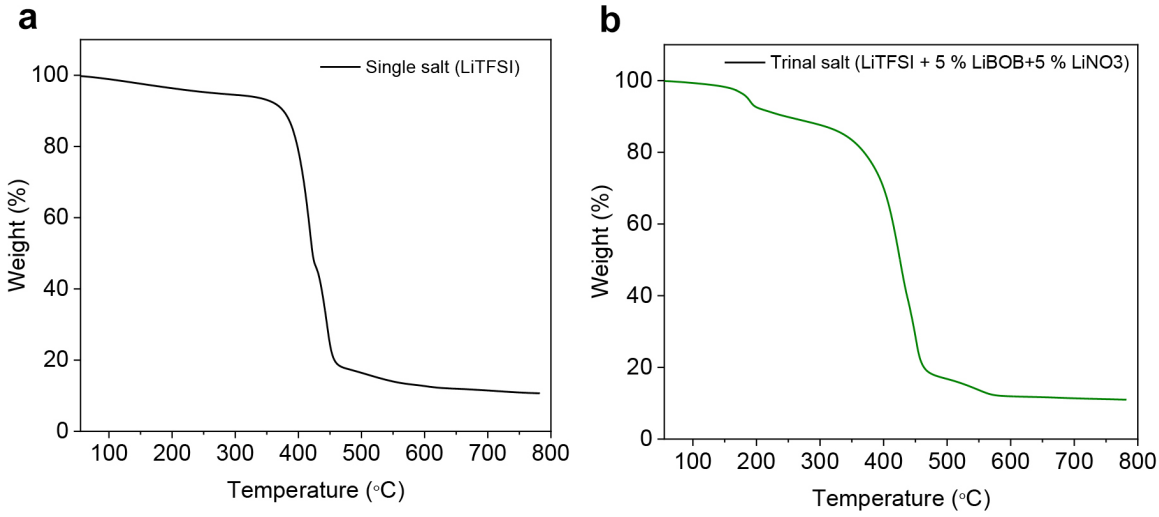

Figure S6: TGA analysis of prepared (a) single salt SPE and **(b)** Trinal salt (SPE).

The weight change below 400 °C belongs to the loss of absorbed water, the loss of structured water, the decomposition of LiBOB[4] and $LiNO_3$[5]. After 400°C, the weight change belongs to the decomposition of LiTFSI, PEO and HNT.[6]

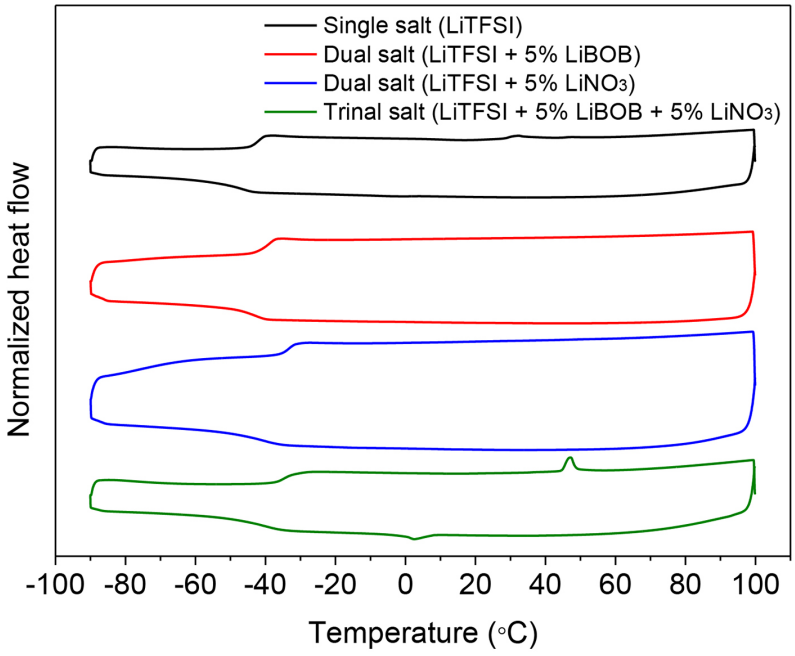

Figure S7: Full DSC curves of single salt, dual salt, and trinal salt SPE.

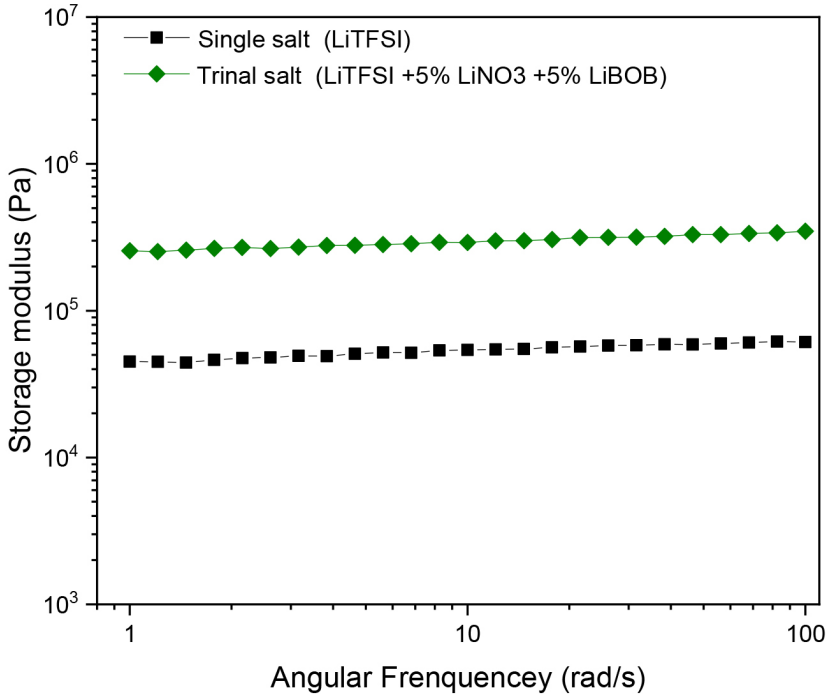

Figure S8: SAOS measurements of prepared single salt and trinal salt SPE.

References:

1. Y.-l. Su, J. Wang and H.-z. Liu, *Macromolecules*, 2002, **35**, 6426-6431.
2. I. Rey, J. C. Lassègues, J. Grondin and L. Servant, *Electrochimica Acta*, 1998, **43**, 1505-1510.
3. V. Aravindan and P. Vickraman, *Ionics*, 2007, **13**, 277-280.
4. E. Zinigrad, L. Larush-Asraf, G. Salitra, M. Sprecher and D. Aurbach, *Thermochimica Acta*, 2007, **457**, 64-69.
5. G. E. McManis, *J. Electrochem. Soc.*, *1984*, **131**, 283.
6. Y. Lin, X. Wang, J. Liu and J. D. Miller, *Nano Energy*, *2017*, **31**, 478-485.