Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supporting Information

High Voltage Ionic Liquid Based Flexible Solid Polymer Electrolyte for high-Performance Li-Ion battery

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Experimental Section:

The details of loading of cathode with C-rates are given below

Table S1: The details of loading of cathode with C-rates

Cell Configuration	LFP loading (mg)	0.1C (mA)	0.2C (mA)	0.5C (mA)	1C (mA)
Li/SPE-IL-II/LFP	3.008	0.05113	0.1022	0.2556	0.5113

Table S2: The comparative literature data on the reported system

S. No	Composition	Ionic Conductivity (S/cm)	Temp	Reference
1	PEO+PTFE	6.62×10^{-8}	Room Temperature	Jokhakar, Deep A., et al. "All-solid-state Li-metal batteries: role of blending PTFE with PEO and LiTFSI salt as a composite electrolyte with enhanced thermal stability." *Sustainable Energy Fuels*, **2020**, *4*, 2229-2235
2	PEO+HEMC	1.30×10-4	Room Temperature	Wu, Hailong, et al. "A branched cellulose-reinforced composite polymer electrolyte with upgraded ionic conductivity for anode stabilized solid-state Li metal batteries." *Sustainable Energy Fuels*, **2019**, 3, 2642-2656.
3	VBIm+PEGDA	1.4×10^{-4}	Room Temperature	Zhang, Fengrui, et al. "Highly conductive polymeric ionic liquid electrolytes for ambient-temperature solid-state lithium batteries." ***ACS*** *Appl. Mater. Interfaces* **2020**, 12, 23774–23780
4	CTA+PEGMA+EMIMTFSI	1.24×10^{-3}	Room Temperature	Our System

^{1}H NMR:

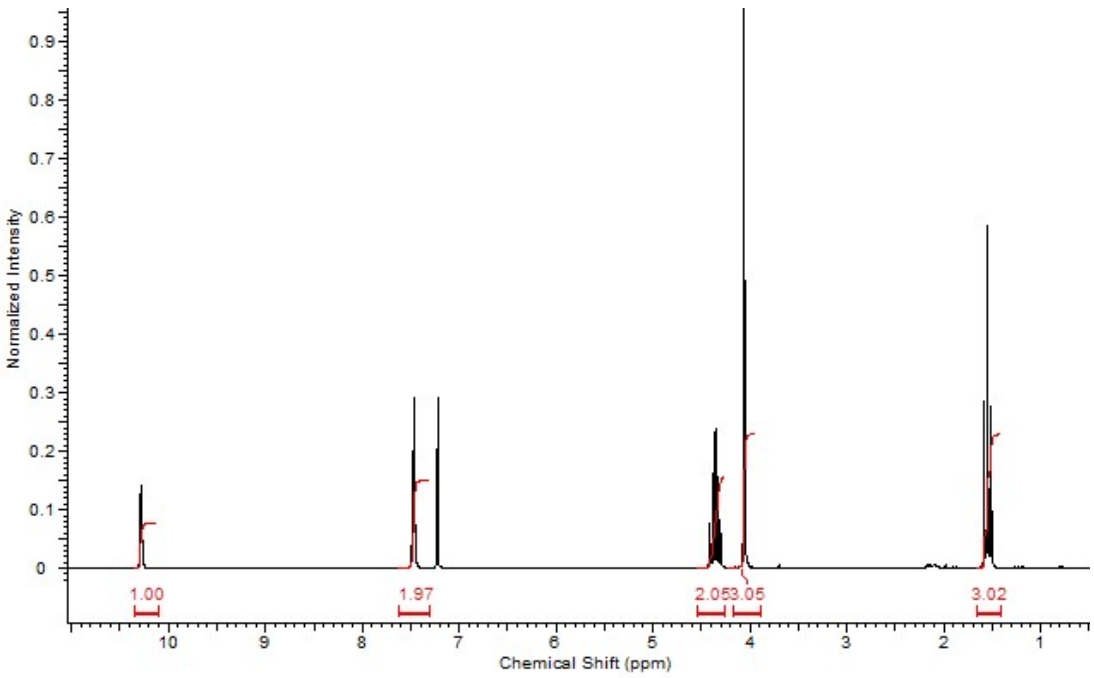

Figure S1: ^{1}H NMR for [EMIM][TFSI] 1-Ethyl-3-methyl-imidazolium Bis(trifluromethanesulfonyl) imide ionic liquids

Nyquist Plot of SPE

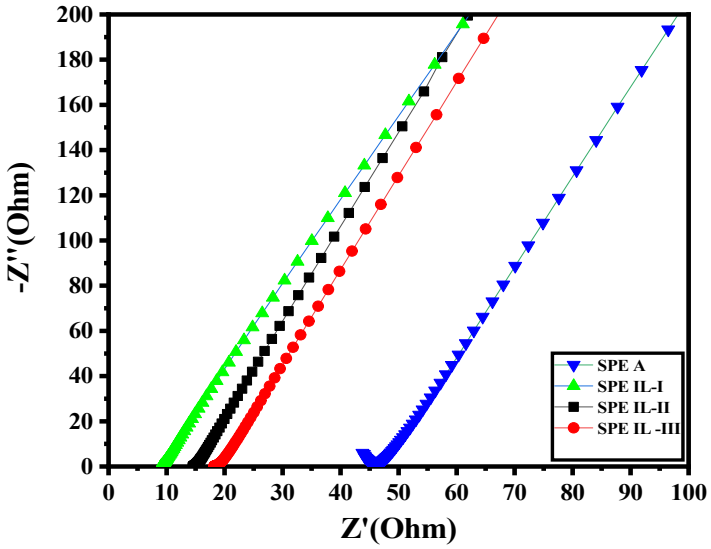

Figure S2: Impedance plot of SPE membranes

Flame Retardant Test

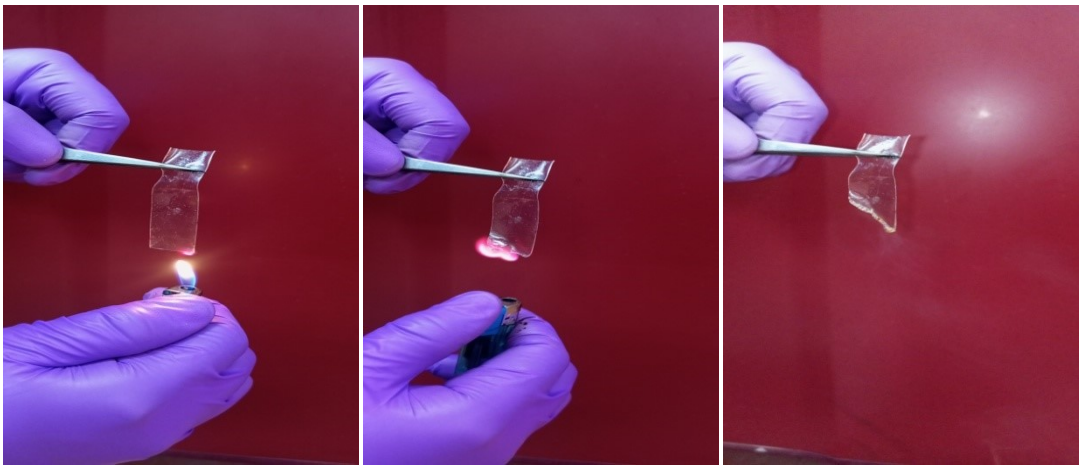

Figure S3: Flame Test of SPE-IL-II

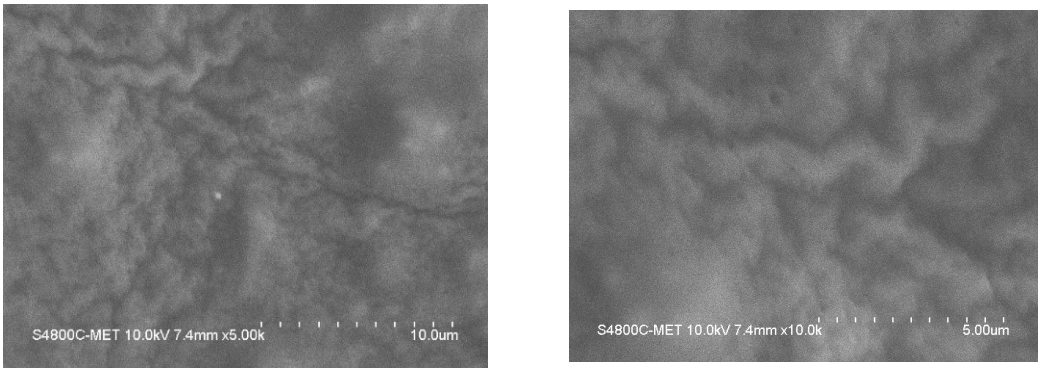

Figure S4: FESEM study after charge – discharge

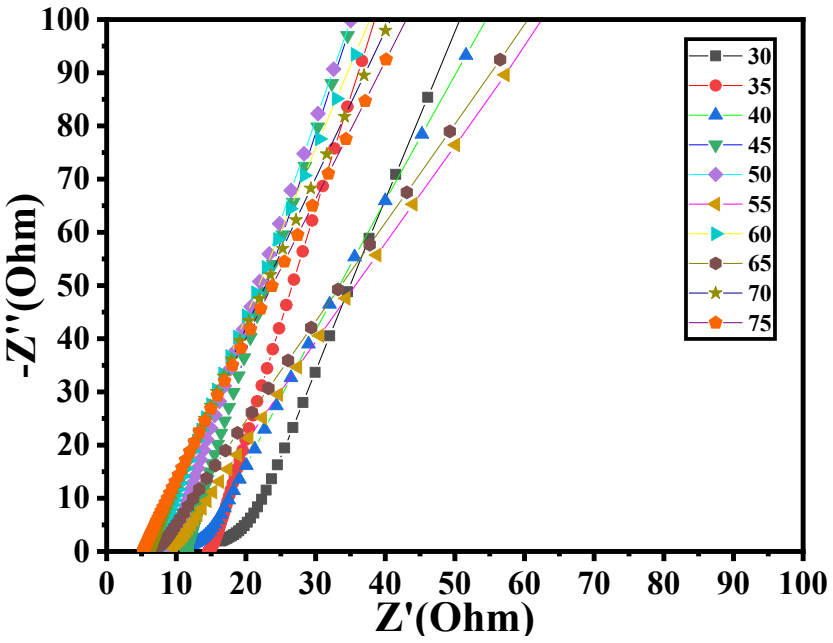

Figure S5: Impedance plot of SPE IL-II at different temperatures

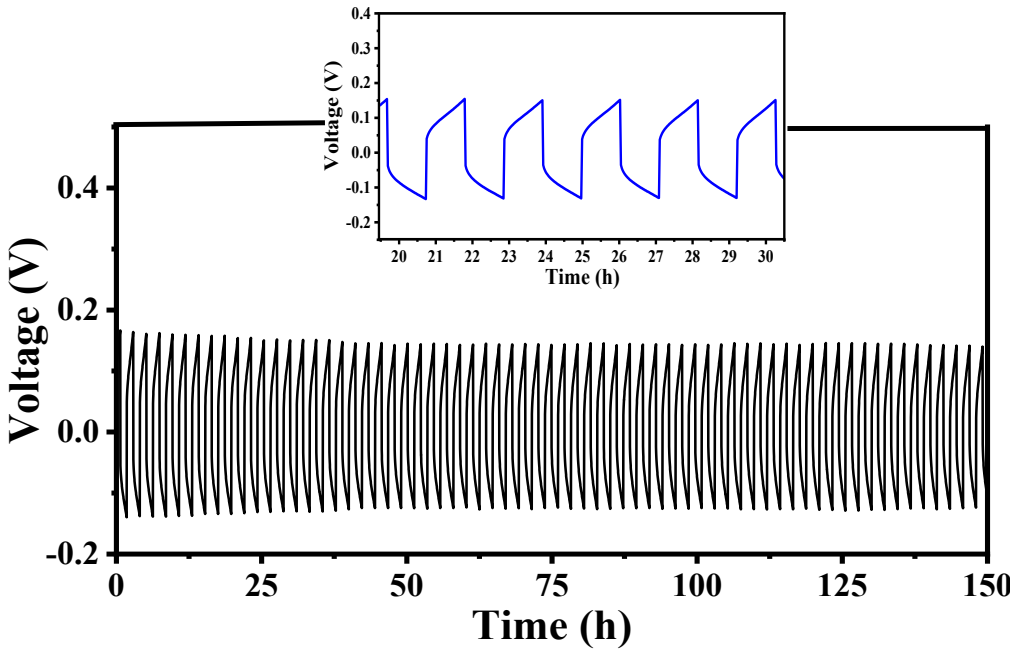

Figure S6: Strip-plate analysis at 0.1 mA cm^{-2}

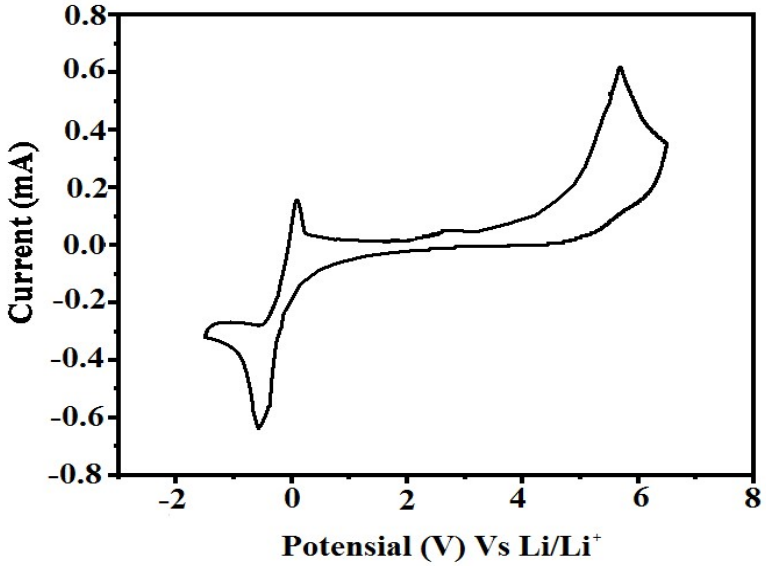

Figure S7: Cyclic voltagram of Li/SPE-IL-II/SS

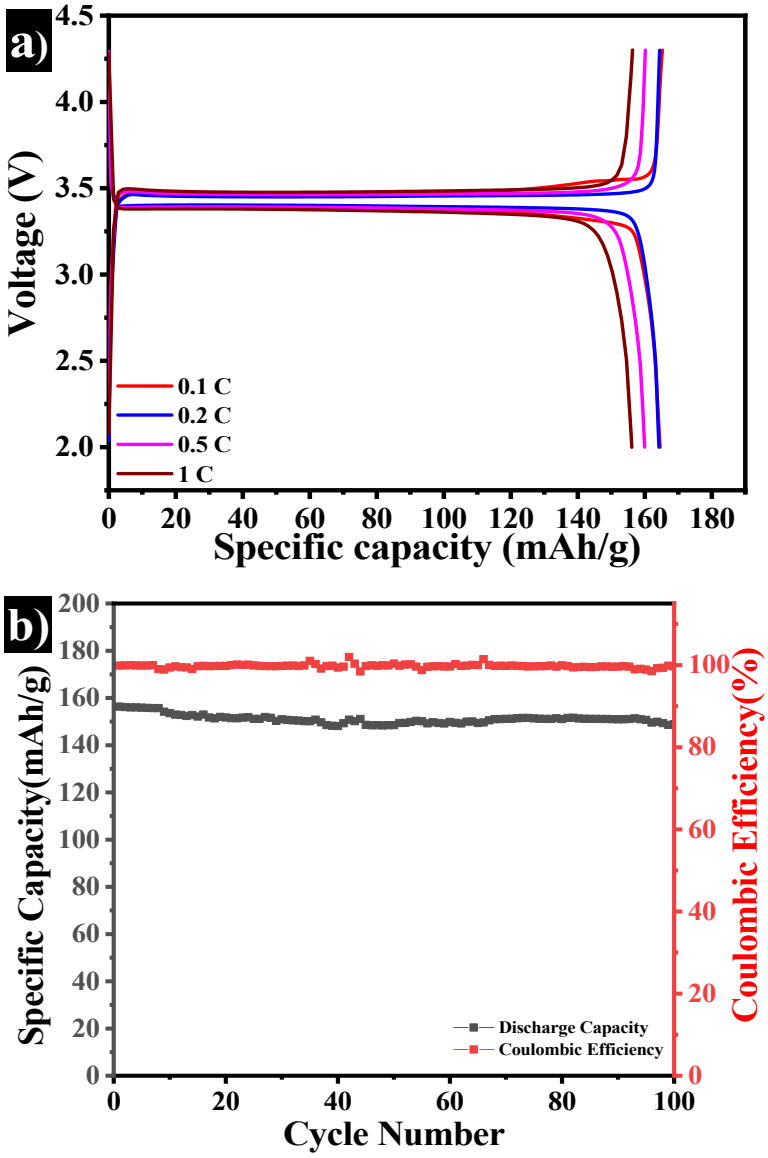

Figure S8: a) Galvanastatic charge-discharge of half-cell Li/1M $LiPF_6$ EC:DMC(1:1v)/LFP at different current densities, b) Discharge capacity and coulombic efficiency at 1C of half-cell Li/1M $LiPF_6$ EC:DMC(1:1v)/LFP