

# Supporting information

## Solid polymer electrolytes based on poly(ethylene oxide)/carbonated soybean oil blends

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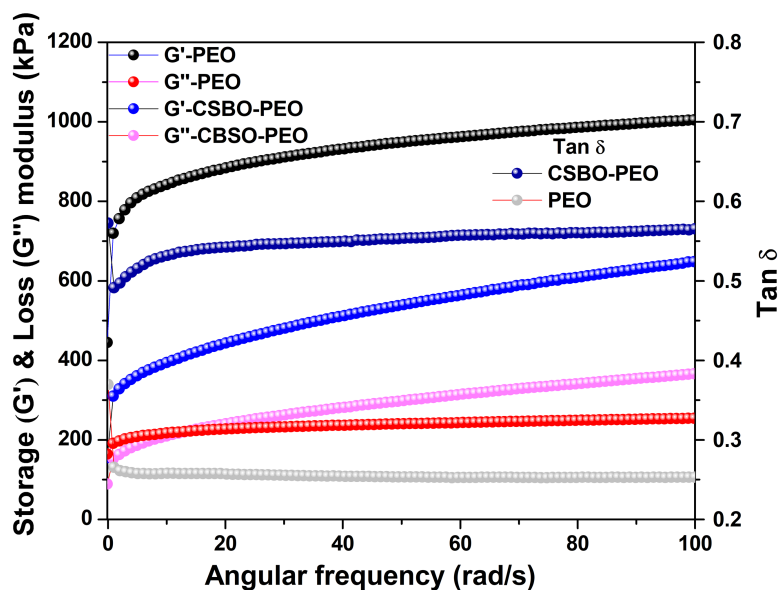
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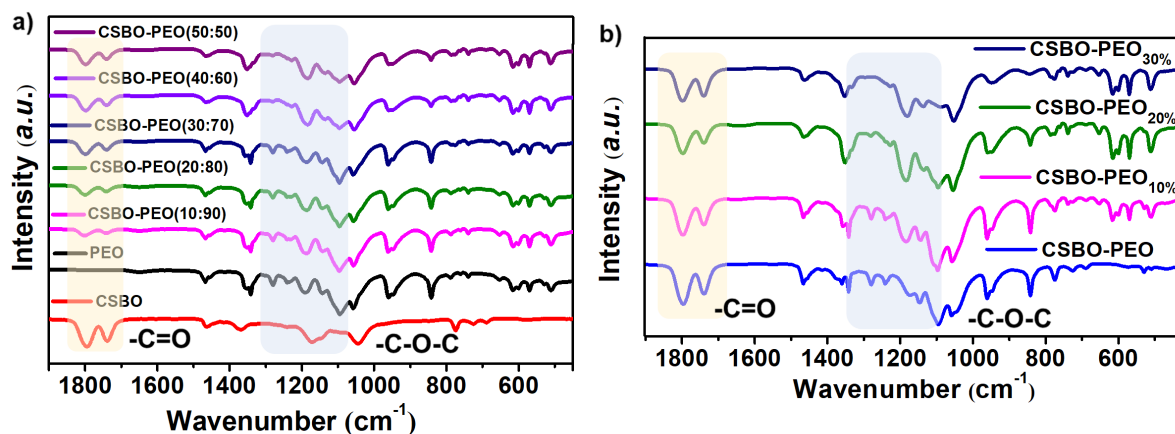
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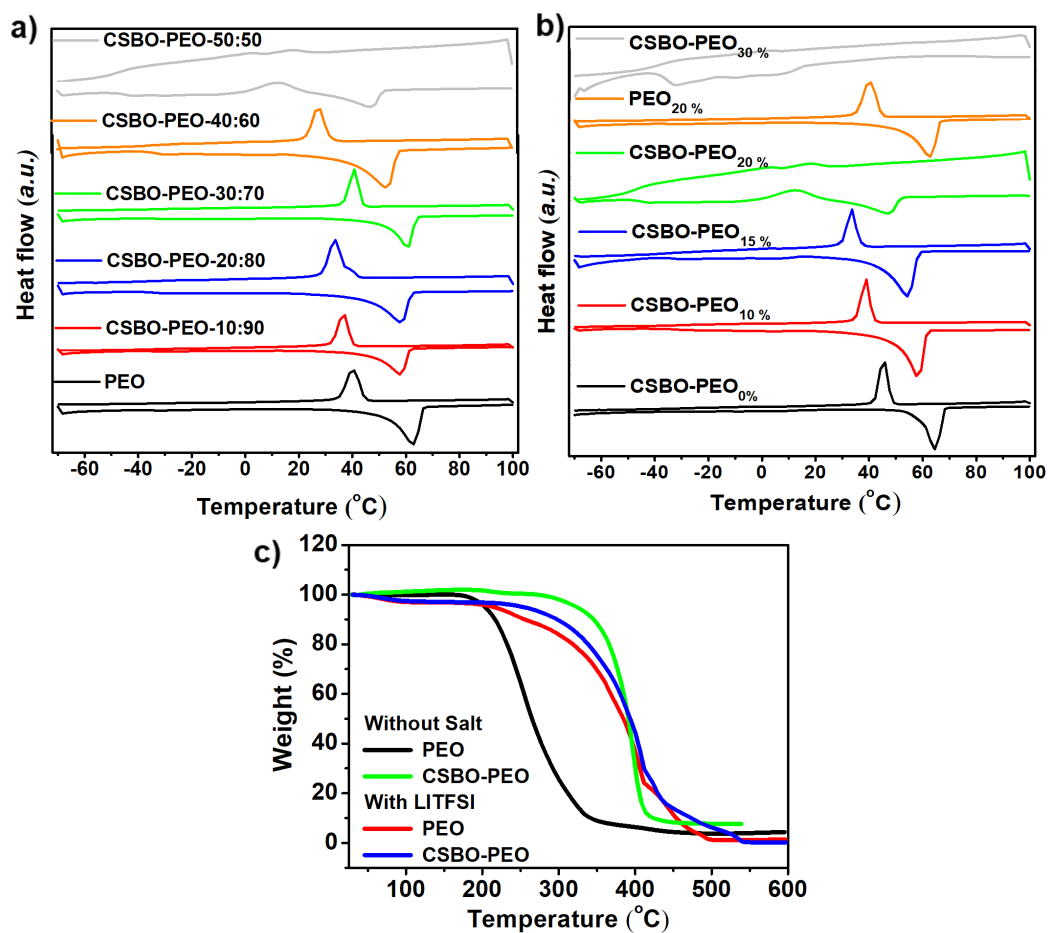
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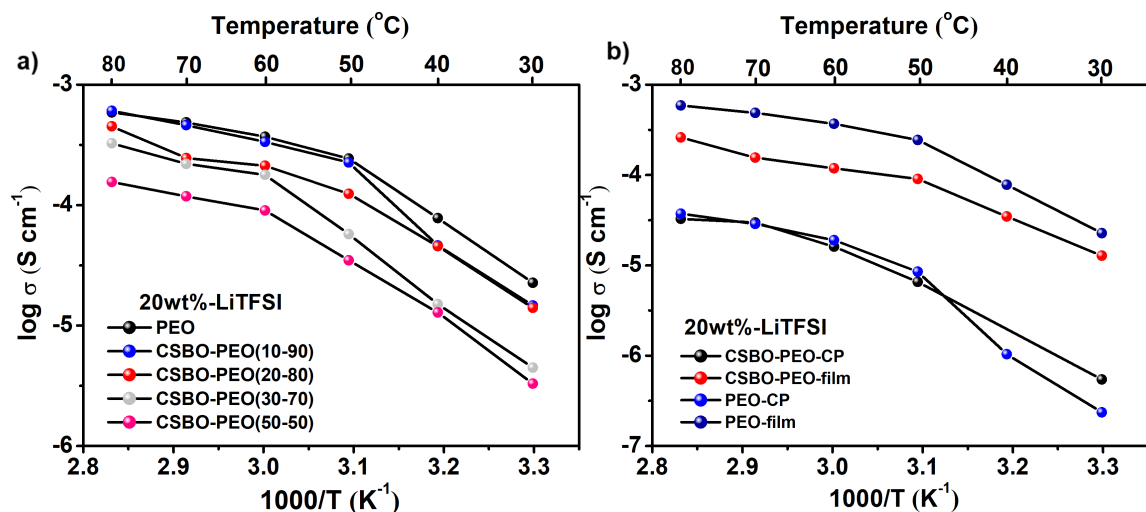
**Figure S1.** Rheology of PEO and CSBO-PEO (50:50 wt:wt) SPE membranes loaded with 20 wt% LiTFSI for storage ( $G'$ ) and loss ( $G''$ ) modulus,  $\tan \delta$  versus angular frequency.



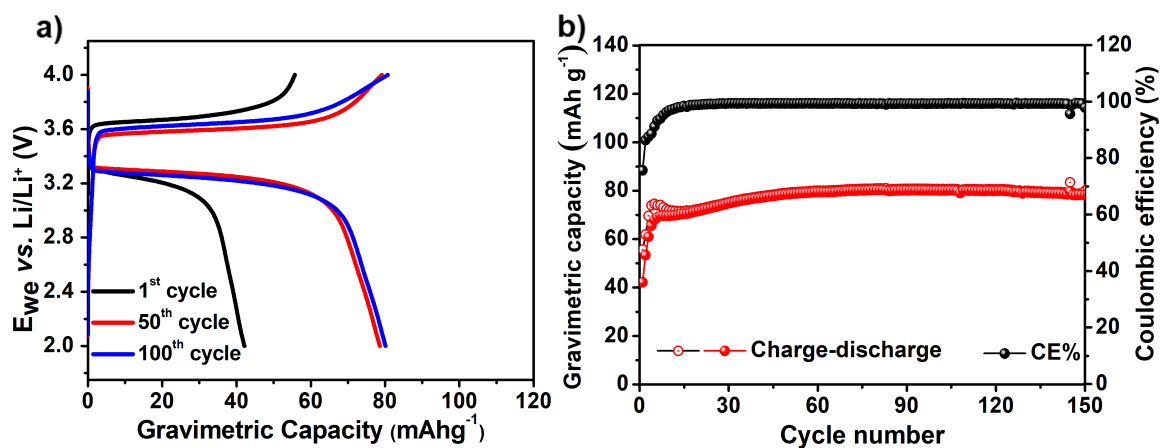
**Figure S2.** a) Comparative FTIR spectra of CSBO, PEO and CSBO-PEO (wt:wt) blends with various formulations, respectively with 20 wt% of LiTFSI; and b) FTIR of CSBO-PEO (50:50 wt:wt) blends with various amounts LiTFSI (in subscript in wt%).



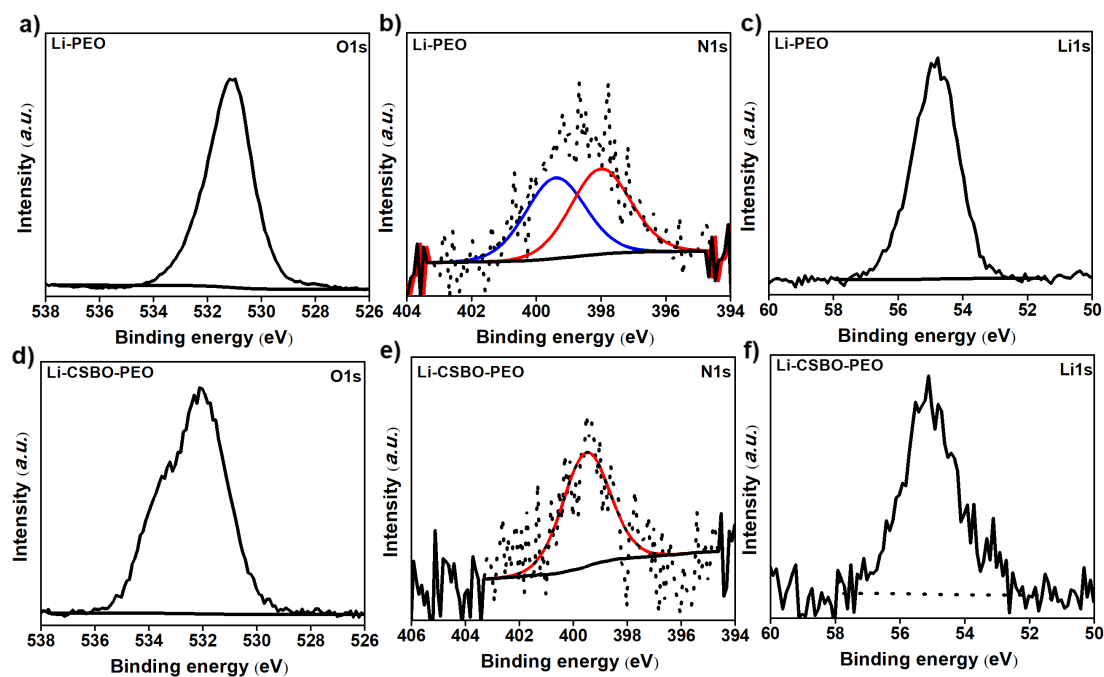
**Figure S3.** DSC thermograms of SPE membranes, a) different compositions of CSBO-PEO (y:z wt:wt) with LiTFSI (20 wt%); b) CSBO-PEO (50:50 wt:wt) with LiTFSI (wt% in subscript); and c) Thermogravimetric analysis of PEO and CSBO-PEO (50:50 wt:wt) with and without LiTFSI, respectively.



**Figure S4.** Temperature dependent ionic conductivity of SPEs with 20% of LiTFSI, a) y:z: by wt% in comparison to PEO, and b) with and without cellulose separator (CP: cellulose paper, without CP: film), respectively.



**Figure S5.** a) Galvanostatic charge-discharge voltage profile with gravimetric capacity at following charge and discharge of 1<sup>st</sup>, 50<sup>th</sup> and 100<sup>th</sup> at 0.1C and b) Capacity retention plot with cycle number for Li|CSBO-PEO<sub>20%</sub>|LFP at 40  $^{\circ}\text{C}$ .



**Figure S6.** HR-XPS of a) and d) Oxygen (O1s), b) and e) Nitrogen (N1s), c) and f) Lithium (Li1s), for Li-anode surface of cell based on PEO and CSBO-PEO, respectively.

**Table S1.** Activation energy and pre-exponential factor as calculated from the two-region linear fitting of VFT plots (region 1 and region 2 correspond to lower (20 °C – 50 °C) and higher temperature (60 °C – 80 °C), respectively).

CSBO-PEO (1:1)	Adj. $R_1^2$	Adj. $R_2^2$	$\ln A_1$	$\ln A_2$	$E_{a1}$ (kJ·mol <sup>-1</sup> )	$E_{a2}$ (kJ·mol <sup>-1</sup> )
PEO	0.99	0.99	5.0	-0.4	-15.4	-4.9
10%	0.91	0.75	4.3	-0.5	-19.8	-5.6
15%	0.98	0.99	2.6	0.3	-14.3	-8.0
20%	0.99	0.92	2.8	0.4	-15.5	-9.2

**Table S2.** Aging analysis: Interfacial ( $R_{in}$ ) and bulk ( $R_b$ ) resistance. (in Ohm) of the symmetric Li-Li cells at OCP.

Day	at OCP			
	PEO <sub>20%</sub>		CSBO-PEO <sub>20%</sub>	
	$R_b$	$R_{in}$	$R_b$	$R_{in}$
1 <sup>st</sup>	2836	17185	362	25267
2 <sup>nd</sup>	3489	23687	432	31579
4 <sup>th</sup>	3799	27934	531	33645
7 <sup>th</sup>	5283	38323	858	48160
14 <sup>th</sup>	6769	46708	912	59864

**Table S3.** Quantification table of XPS analysis of Li-anode post-cycling indicating binding energy (BE), full width half maxima (FWHM) and abundance ratio (%).

		F 1s			O 1s	N 1s			C 1s						S 2p <sub>3/2</sub>	Li 1s
		$\underline{F-C}$	$\underline{F-Li}$	F total		$\underline{NH^+-(C,H)}$	$\underline{N-(C,H)}$	N total	$\underline{O-C=O/C-O_3^{2-}}$	$\underline{O-C=O/CO_3^-}$	$\underline{O=C/-O-C-O-}$	$\underline{C-(O,N)}$	$\underline{C-(C,H)}$	C total		
Li-PEO-cycled	BE	688.46	684.71		530.98	399.4	398.01		289.79	288.82	287.8	286.36	284.8			54.78
	FWHM	1.676	1.676		1.898	2.174	2.174		1.43	1.43	1.43	1.43	1.43			1.609
	A%	0.233	1.999	2.232	32.241	0.185	0.195	0.38	0.891	3.395	0.577	5.164	27.315	37.342	0.199	26.991
Li-CSBO-PEO-cycled	BE	688.5	684.63		532.12	399.53			290.44	289.1	287.8	286.48	284.8			55.12
	FWHM	1.85	1.85		2.911	2.055			1.257	1.257	1.257	1.257	1.257			1.624
	A%	1.511	0.451	1.962	18.228	0.301		0.301	1.049	3.375	2.023	9.103	57.971	73.521	0.469	5.246