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

Organic-Inorganic Hybrid Electrolytes from Ionic Liquid-Functionalized Octasilsesquioxane for Lithium Metal Batteries

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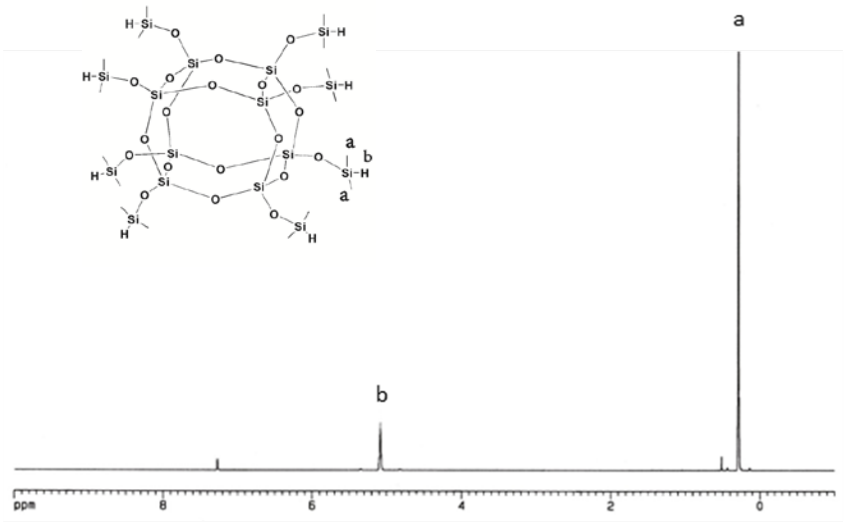

Figure S1. ^{1}H NMR spectrum of POSS.

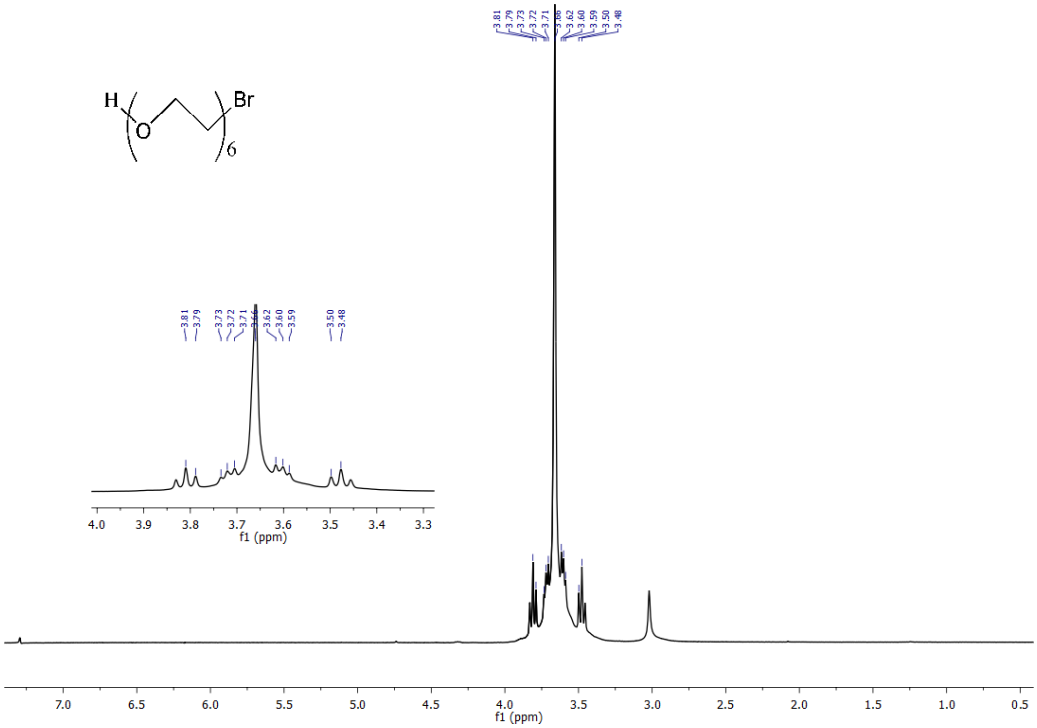

Figure S2. ^{1}H NMR spectrum of **2**.

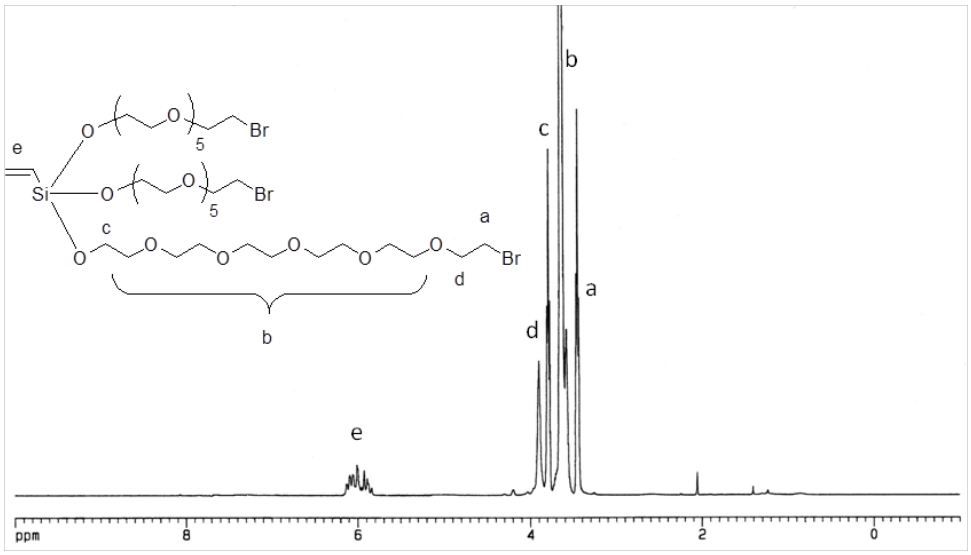

Figure S3. ^{1}H NMR spectrum of **3**.

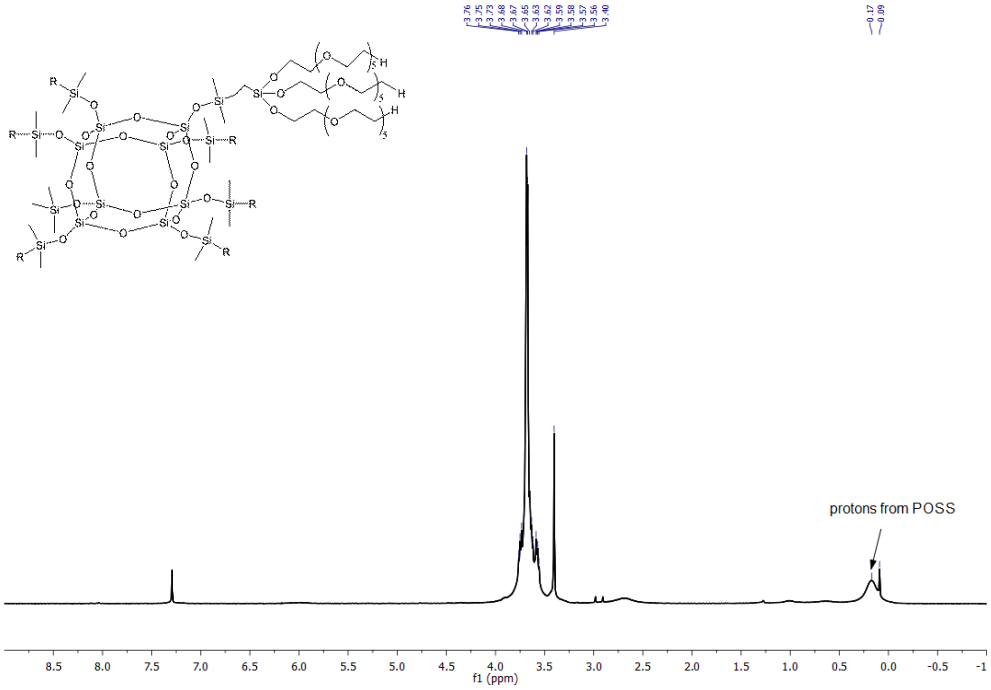

Figure S4. ^{1}H NMR spectrum of POSS-PEO. ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ: 3.56-3.76 (m, -O-C$\underline{H}_2$-), 0.17 (s, O-Si(C$\underline{H}_3$)$_2$)-).

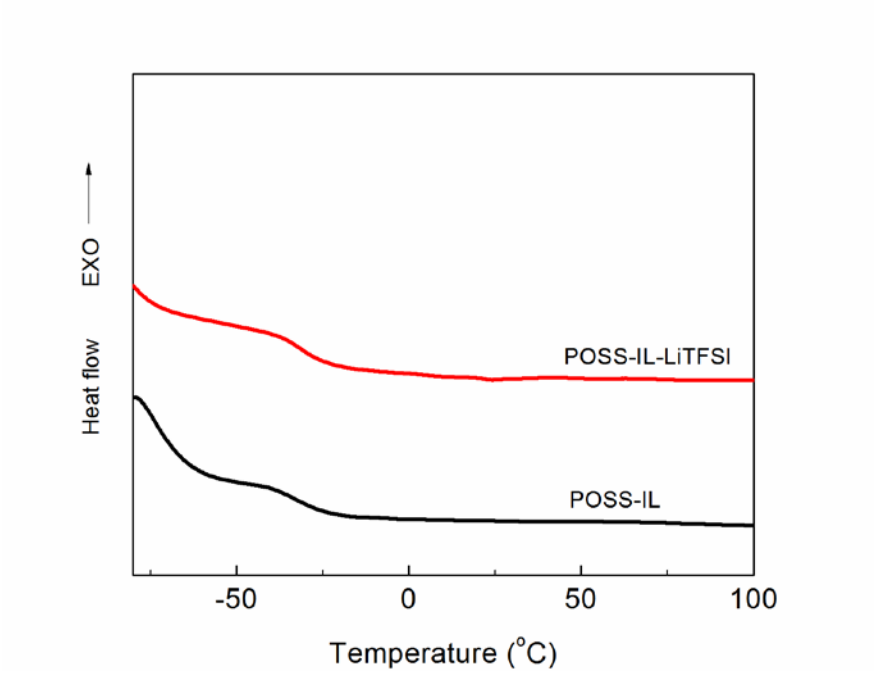

Figure S5. DSC curves of POSS-IL and POSS-IL-LiTFSI ([EO]/[Li]=12:1).

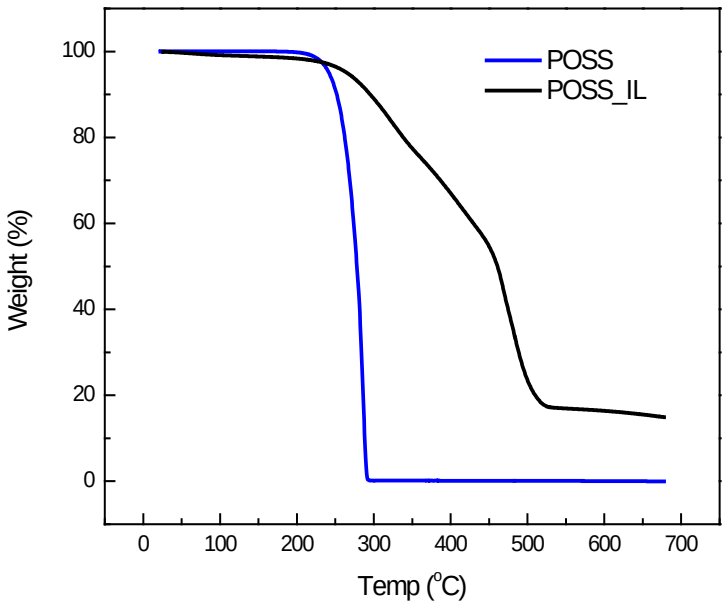

Figure S6. TGA curves of POSS-IL and POSS.

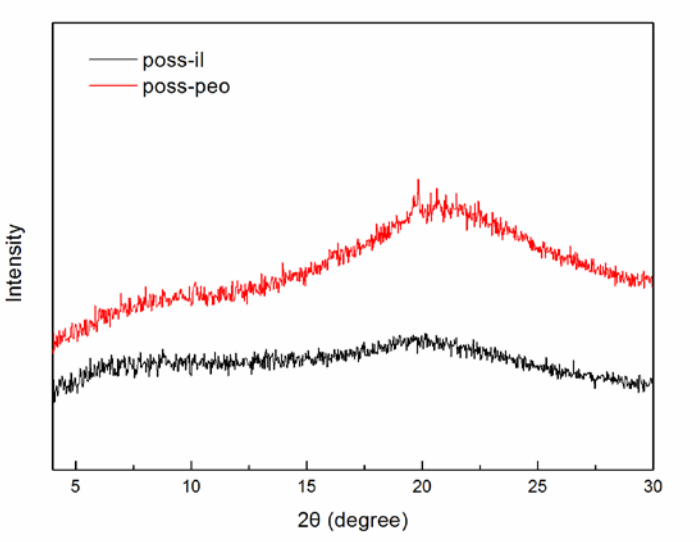

Figure S7. XRD patterns of POSS-IL and POSS-PEO.
The broad diffraction halo at 2θ=7° (d-spacing of 1.25 nm) can be related to the POSS inter distance. Another diffraction halo at 2θ=20.1° (d-spacing of 0.44 nm) could be assigned to the very weak signal of PEG in both POSS-IL and POSS-PEO, indicating the amorphous nature of the electrolytes.

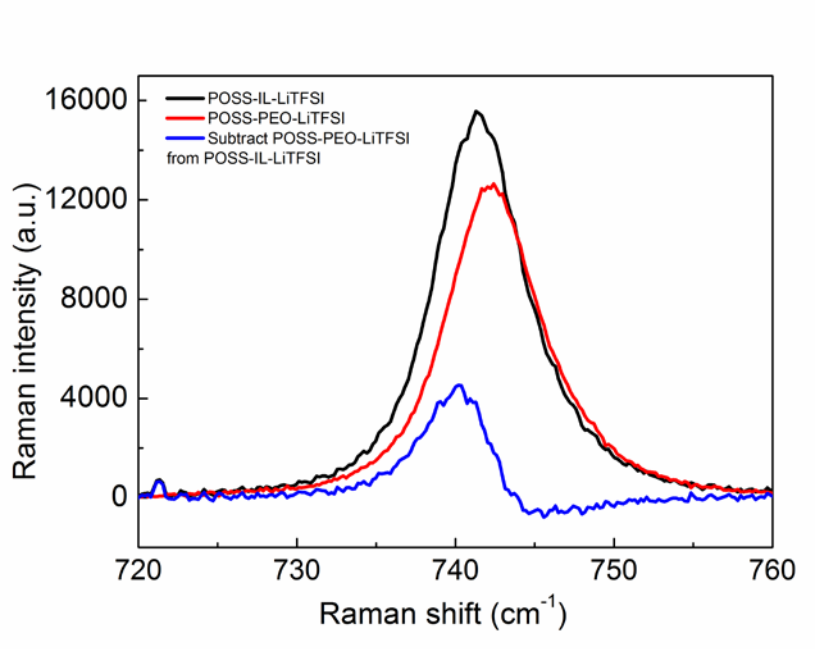

Figure S8. Raman spectra of TFSI- anion vibration of POSS-IL-LiTFSI (black), POSS-PEO-LiTFSI (red), and subtracting of POSS-PEO-LiTFSI from POSS-IL-LiTFSI (blue) at 25 ℃ in the range of 720-760 cm^{-1}.

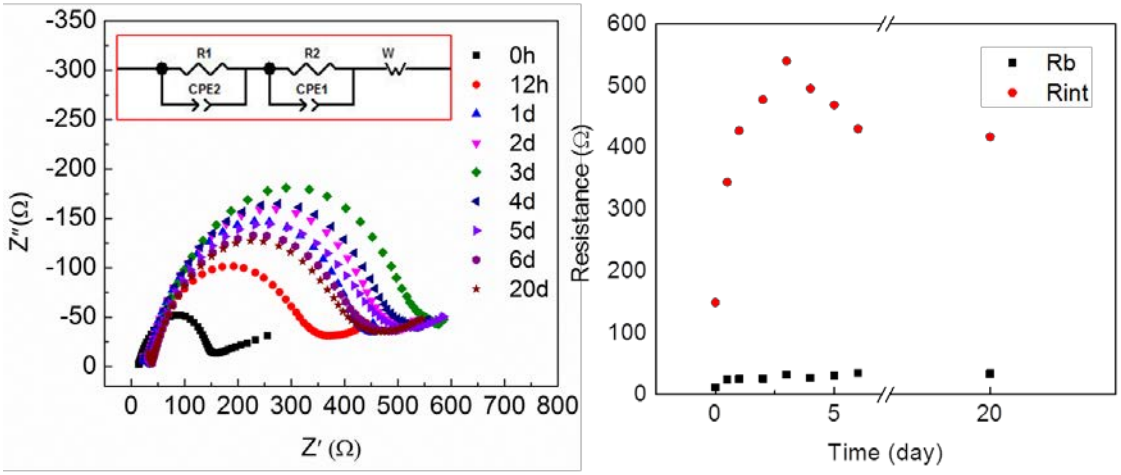

Figure S9. a) Nyquist plot of Li/POSS-IL-LiTFSI/Li symmetrical cell at different storage times. b) Evolution of R_{int} and R_b as a function of storage time. 25 °C.

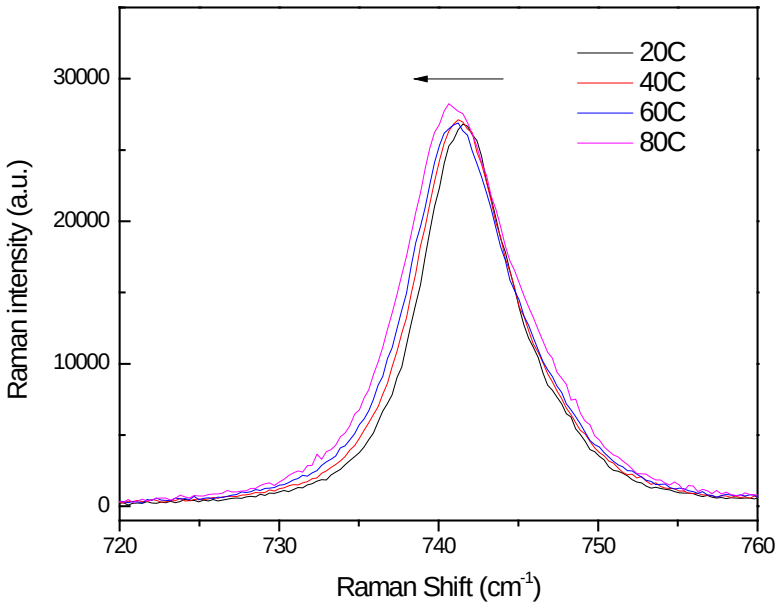

Figure S10. Temperature dependent Raman spectra in the $TFSI^-$ vibration region.
Figure S1 showed the Raman bands of POSS-IL-LiTFSI around 742 cm^{-1} at different temperatures. The band width increased and band position showed downshift when temperature was increased.

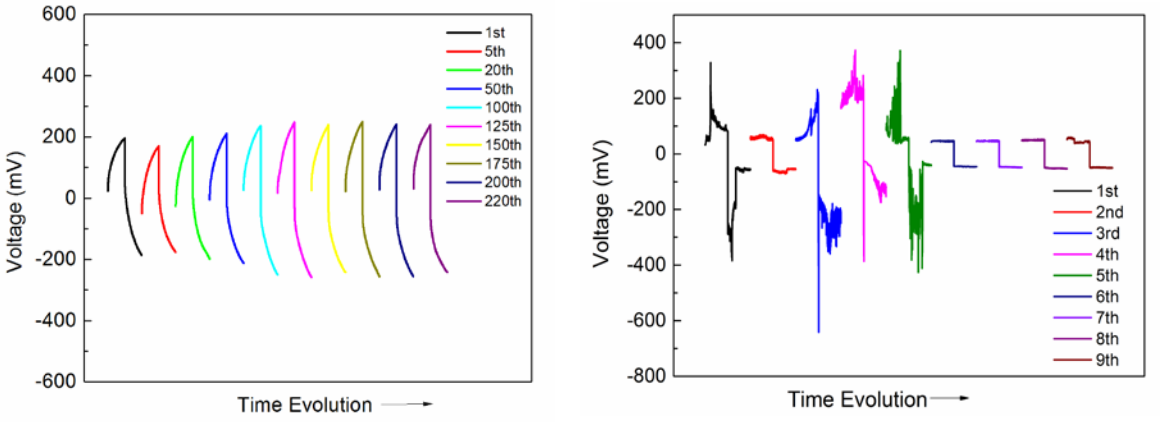

Figure S11. Selected galvanostatic stripping/plating cycles of Li/Li symmetrical cells with: left) POSS-IL-LiTFSI and right) 1 M LiTFSI in ED/DMC (1:1, v/v) at a current density of 0.05 mA/cm^2. (each cycle includes 1 h stripping and 1 h plating)

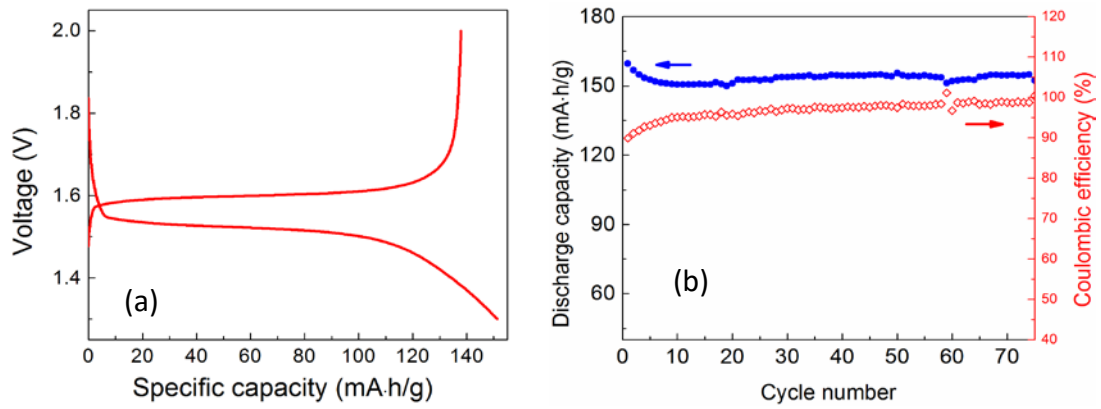

Figure S12. a) Typical voltage vs Specific Capacity profile of a galvanostatic charge-discharge cycling of Li/POSS-IL-LiTFSI/LTO cell at 0.1 C. b) Rate capability of Li/POSS-IL-LiTFSI/LTO cell. c) Cycling stability test of Li/POSS-IL-LiTFSI/LTO cell at 0.1 C. All tests were under 25 ^{o}C.

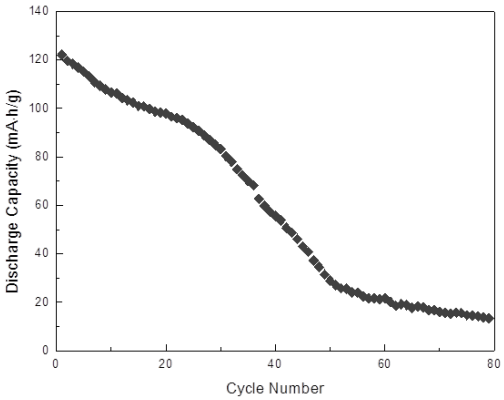

Figure S13. Cycling stability test of Li/POSS-PEO-LiTFSI/LFP at 60 °C and 0.1 C.

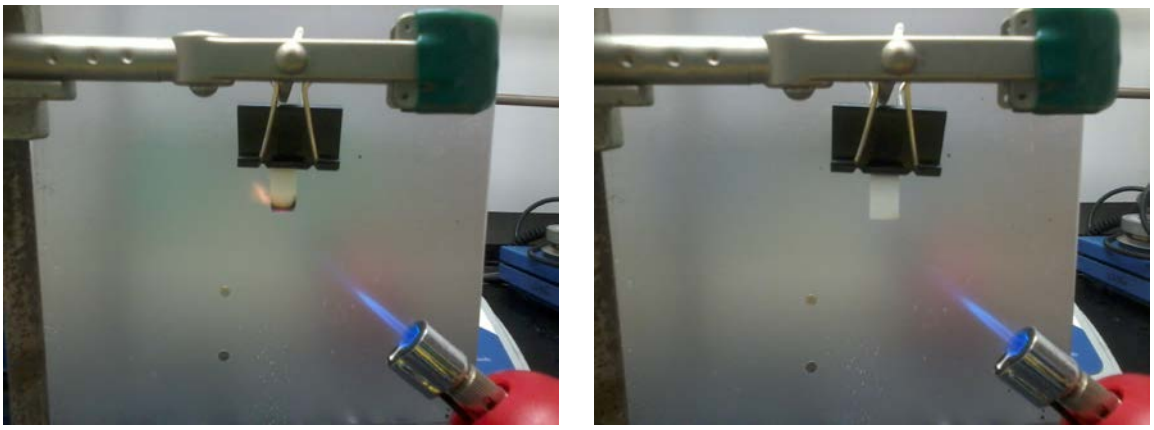

Figure S14. Flammability test of left) 1 M LiTFSI in EC/DMC. right) POSS-IL.