Electronic Supplementary Information

Chemically Soft Solid Electrolyte Interphase Forming Additives for Lithium-ion Batteries

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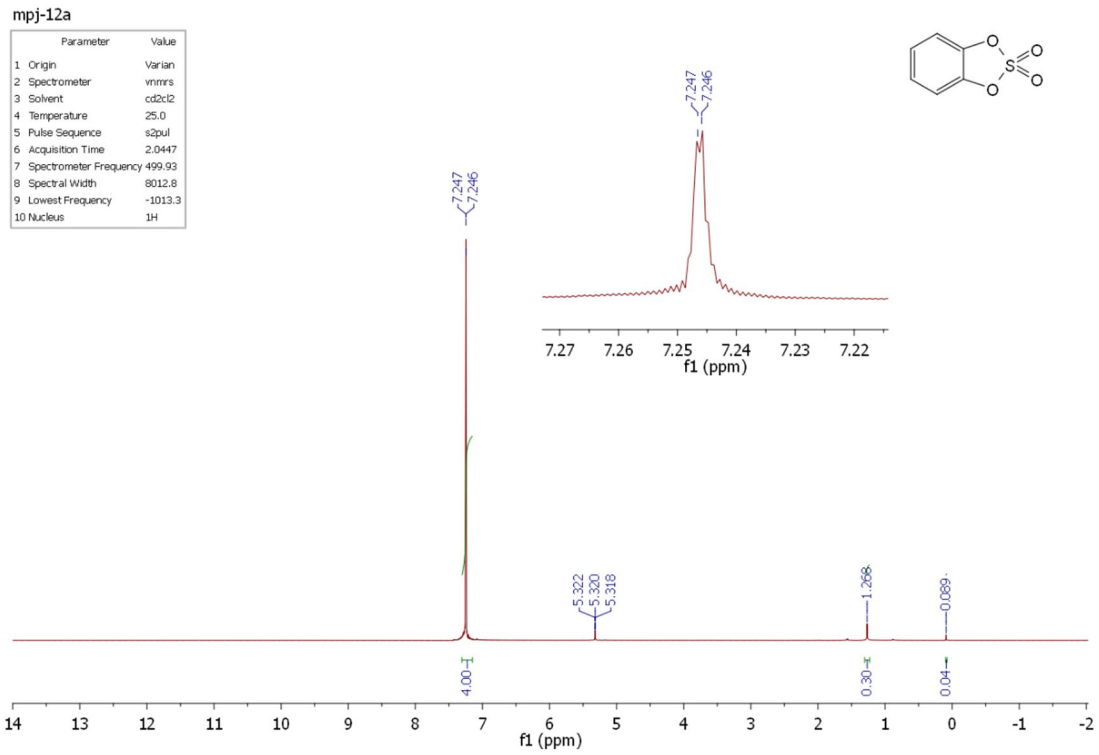

Figure S1. [1]H NMR spectrum of DTDPh.

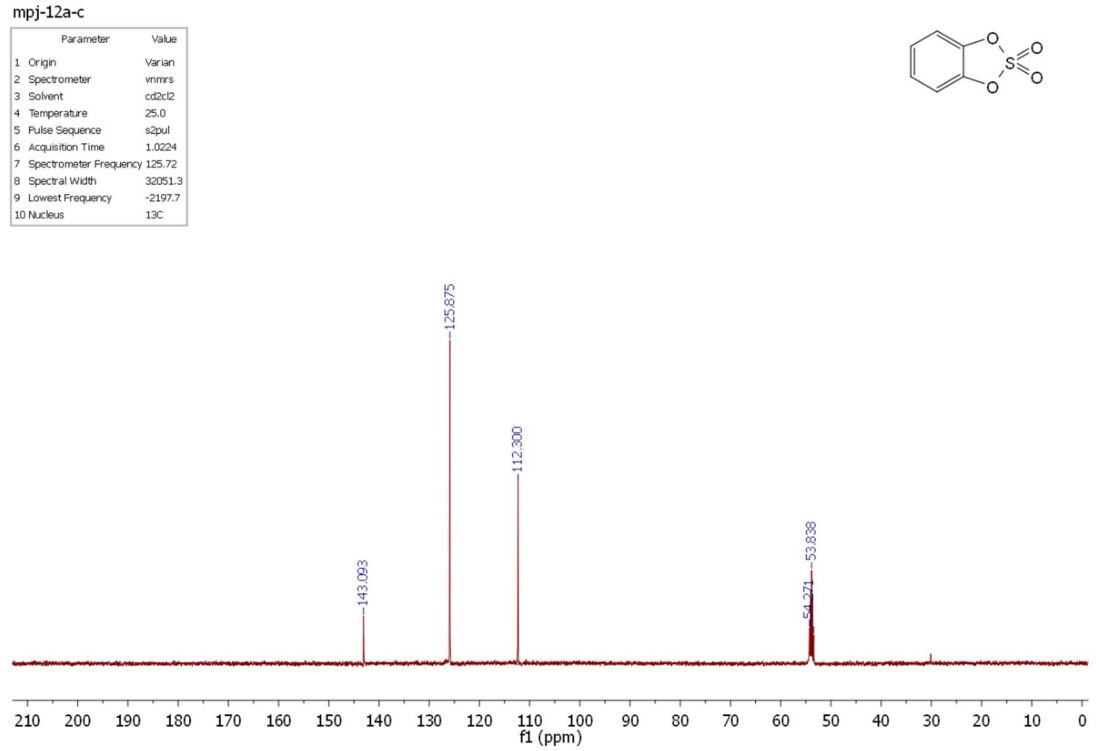

Figure S2. [13]C NMR spectrum of DTDPh.

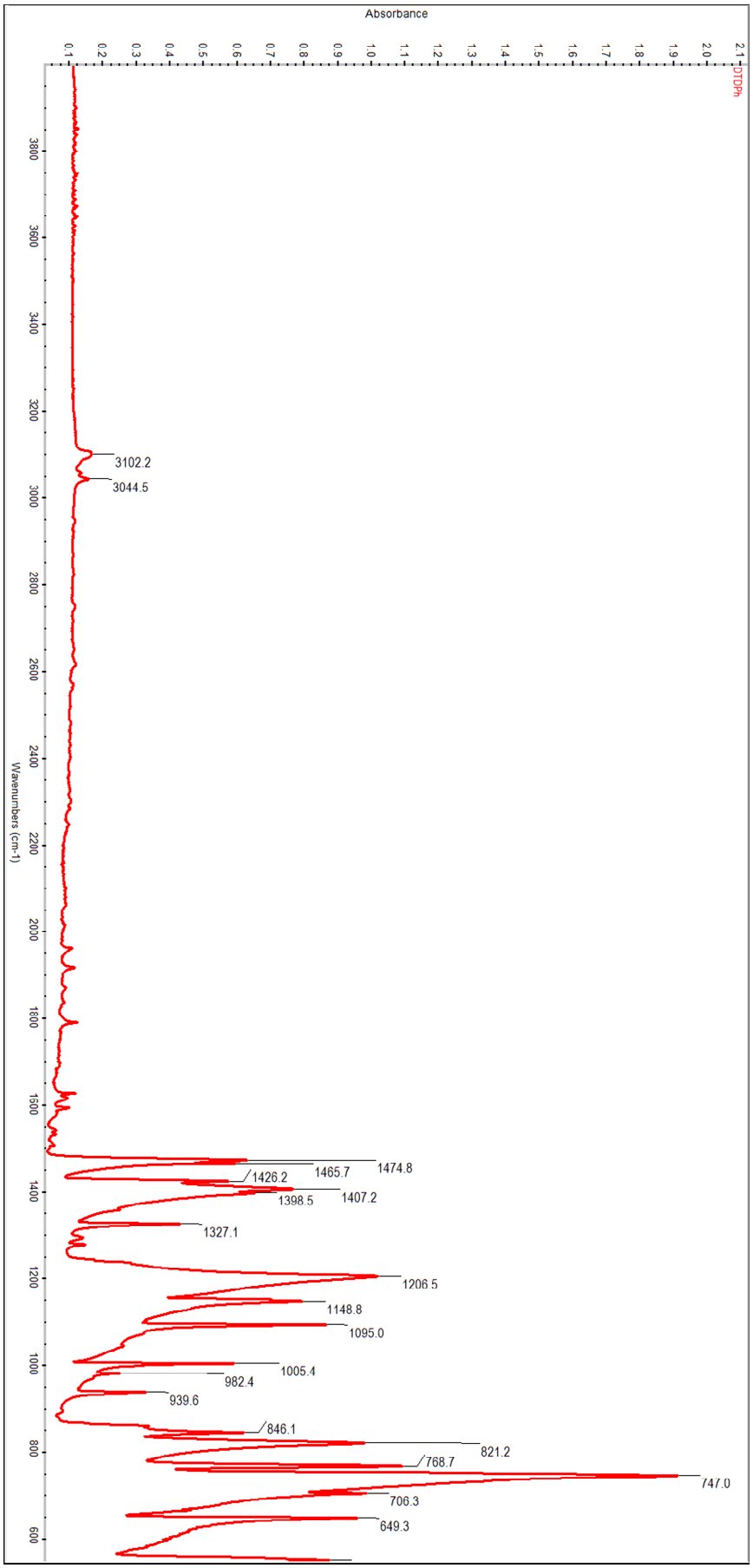

Figure S3. FTIR spectrum of DTDPh.

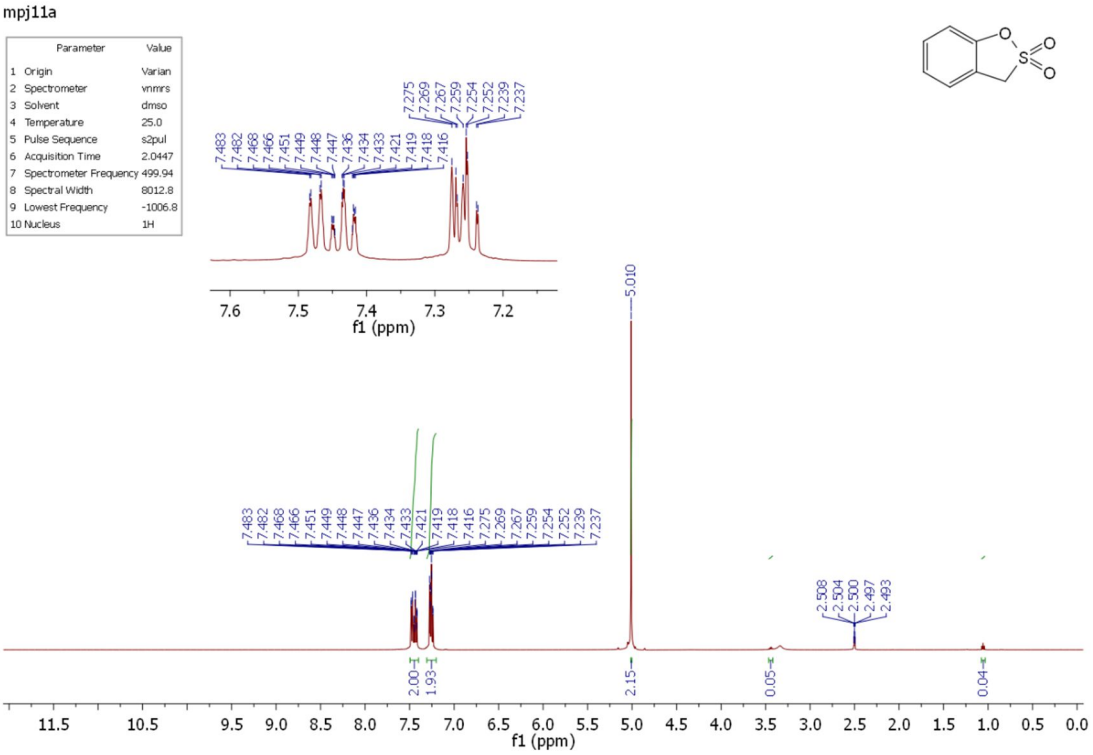

Figure S4. [1]H NMR spectrum of PSPh.

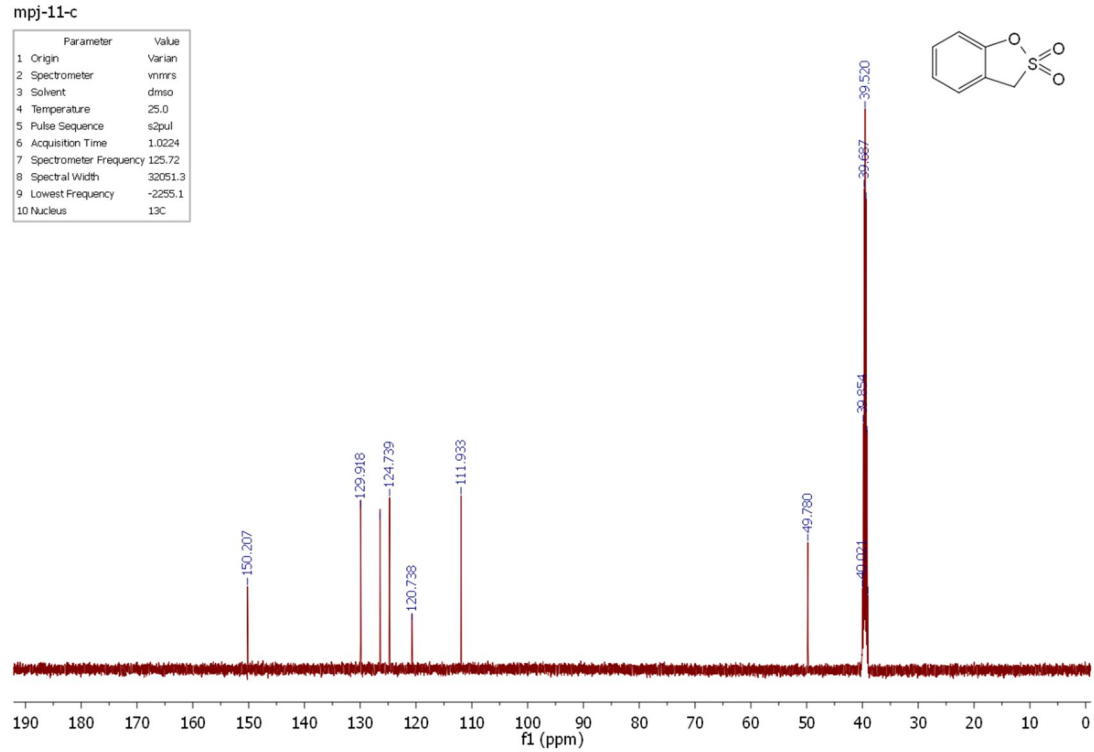

Figure S5. [13]C NMR spectrum of PSPh.

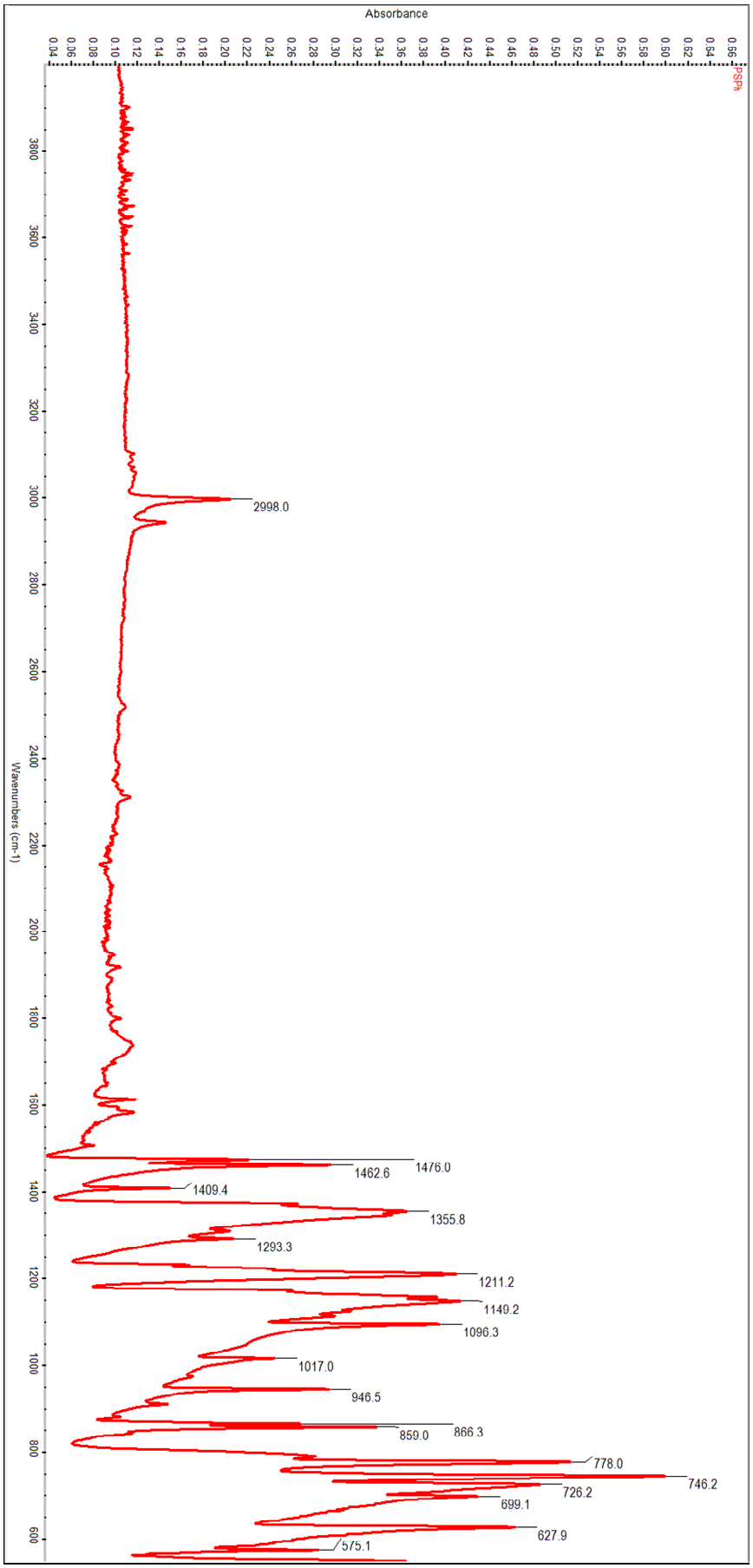

Figure S6. FTIR spectrum of PSPh.

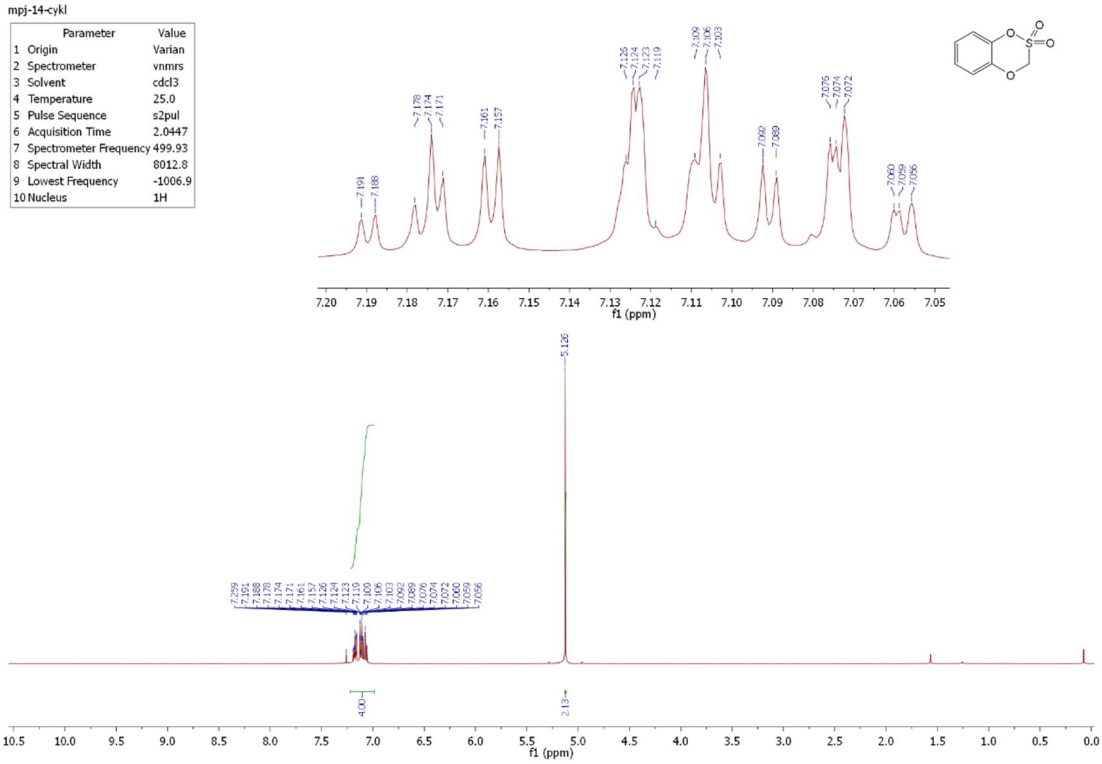

Figure S7. [1]H NMR spectrum of PSOPh.

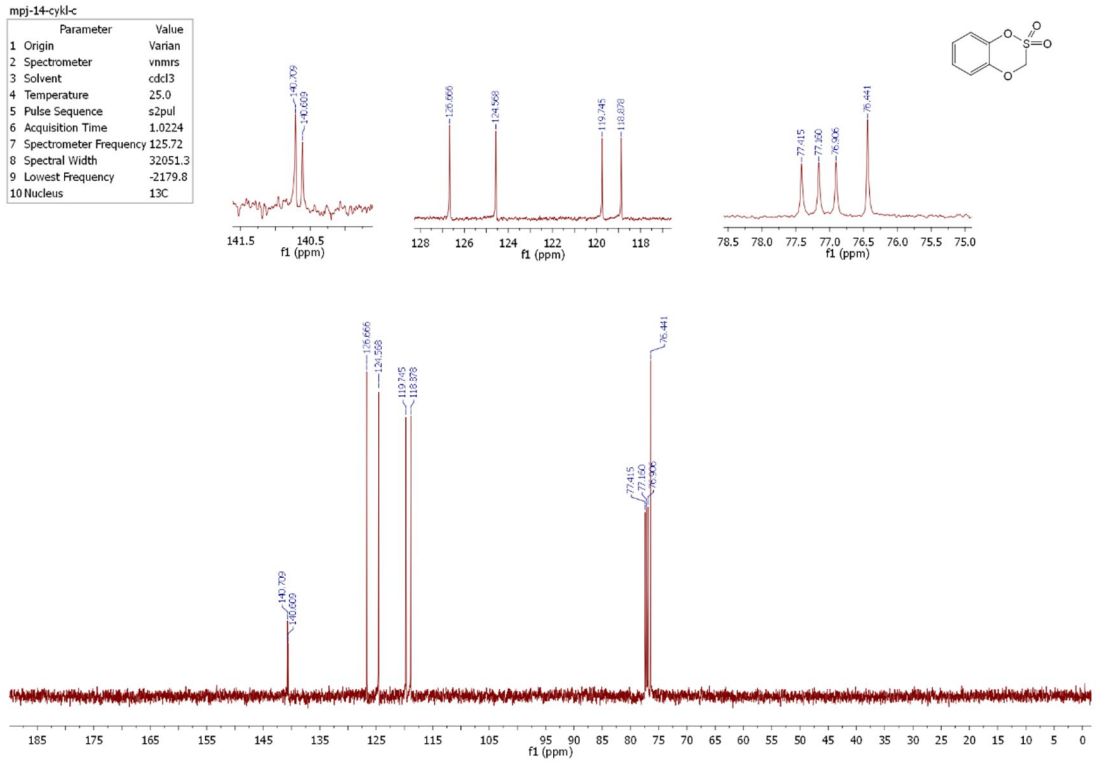

Figure S8. [13]C NMR spectrum of PSOPh.

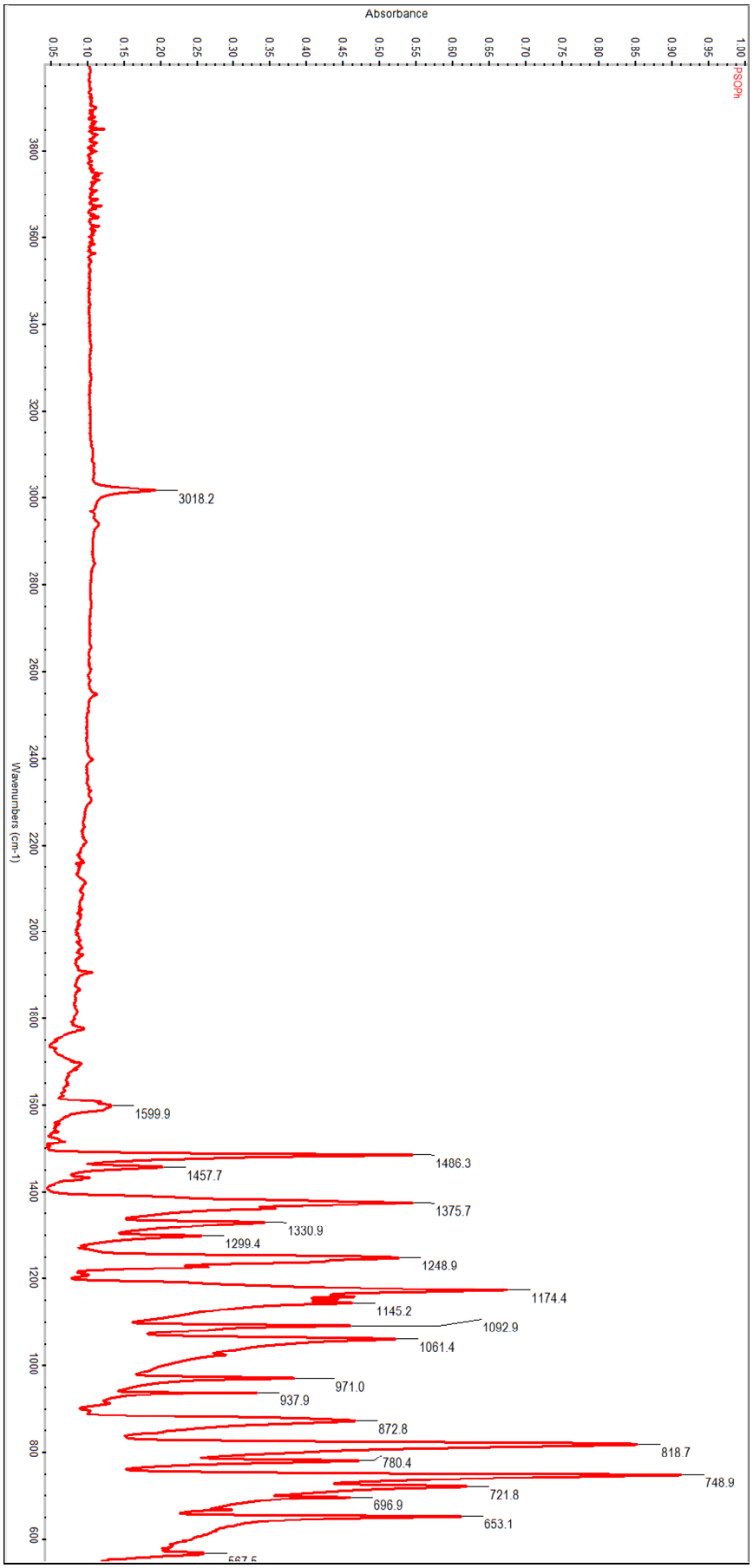

Figure S9. FTIR spectrum of PSOPh.

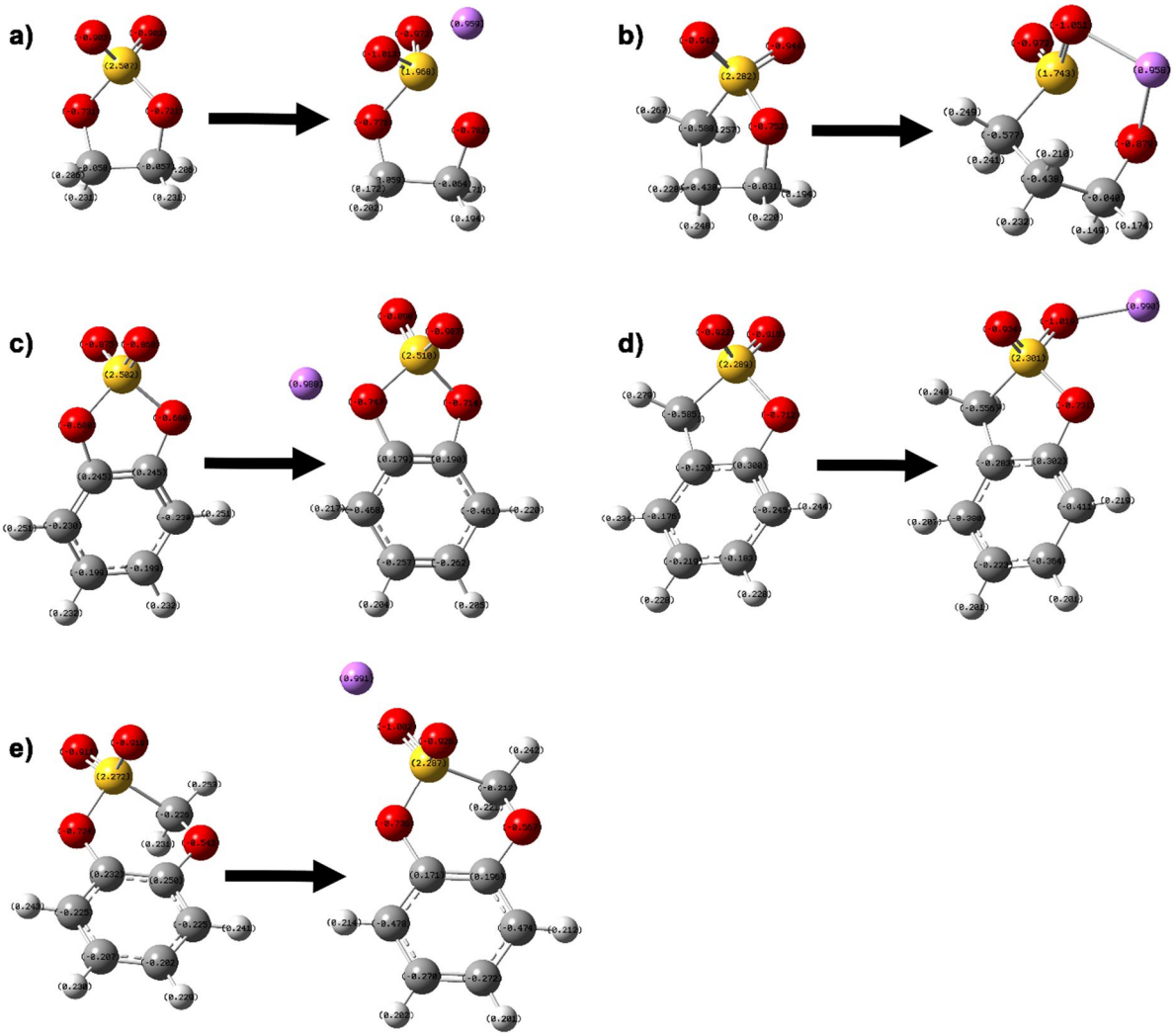

Figure S10. Changes in charge distribution by reduction of additives: DTD (a), PS (b), DTDPh (c), PSPh (d) and PSOPh (e).

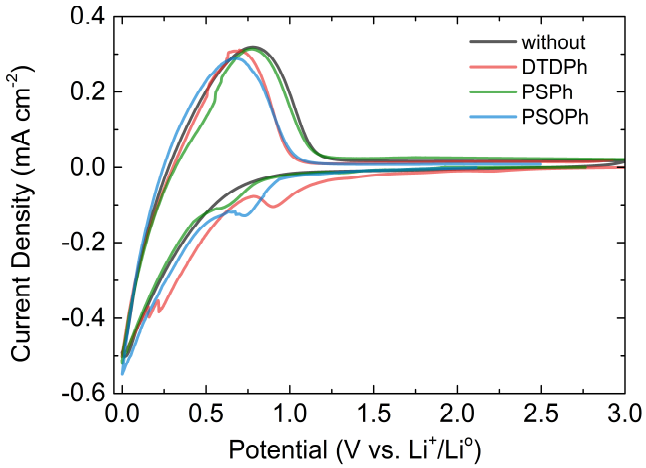

Figure S11. Cyclic voltammogram of graphite electrode with commercial style electrolyte without/with 5 wt% additive; sweep rate 1 mV s^{-1}.

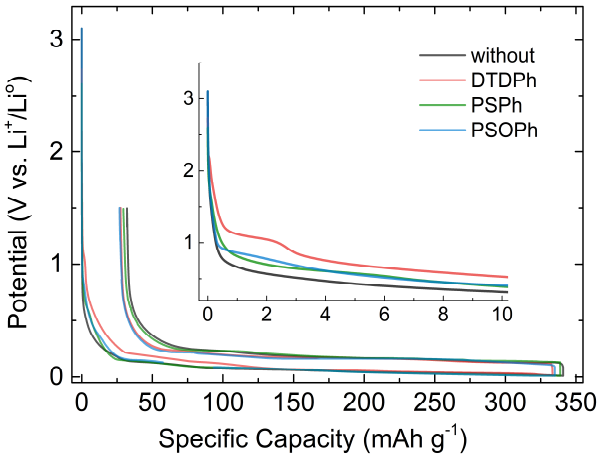

Figure S12. Potential profile of the first charge-discharge cycle of half-cell with commercial style electrolyte without/with 5 wt% of additive at C/20 rate. Inset shows in detail the initial stage of the charge cycle.

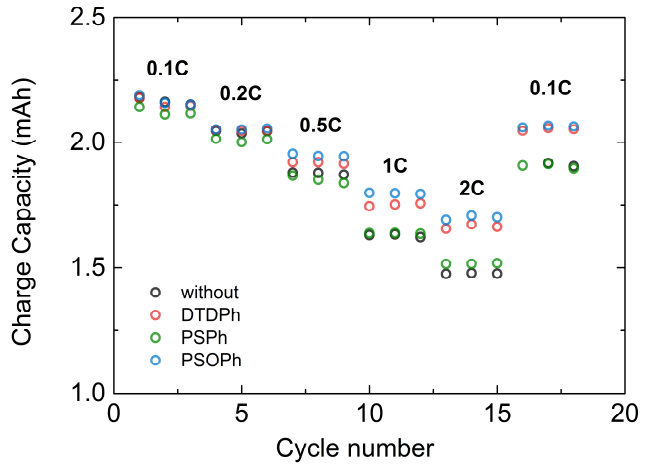

Figure S13. Cycling performance of full-cells without/with 1% of additive at different current rates.

Table S1. Comparison of electrochemical performance of cells with LiTDI-based electrolyte.

Study	Electrodes	Electrolyte	Results
L. Niedzicki et al. *J. Power Sources*, 2011, 196, 8696	Li/LMO	1M LiTDI in EC:DMC (1:1)	96% capacity retention after 22 cycles at 1C rate
S. Paillet et al. *J. Power Sources*, 2015, 299, 309	Graphite/Li	1 M LiTDI in EC:DEC (3:7)	Reduction of salt at 0.9-0.7 V *vs.* Li^+/Li^o (twin peak)
S. Paillet et al. *J. Power Sources*, 2015, 299, 309	LTO/LFP	1 M LiTDI in EC:DEC (3:7)	85.4% capacity retention after 900 cycles at 1C rate
S. Paillet et al. *J. Power Sources*, 2015, 299, 309	LTO/NMC	1 M LiTDI in EC:DEC (3:7)	85.8% capacity retention after 450 cycles at 0.25C rate
S.A. Delp et al. *Electrochimica Acta*, 2016, 209, 498	GC/Li	1 M LiTDI in EC:EMC (3:7)	Reduction of salt at 1.6 V *vs.* Li^+/Li^o
G.G. Eshetu et al. *ACS Appl. Mater. Interfaces* 2016, 8, 16087	Graphite/Li	1 M LiTDI in EC:DMC (1:2)	Reduction of salt at 0.9V *vs.* Li^+/Li^o
I.A. Shkrob et al. *J. Phys. Chem. C,* 2016, 120, 28463	Graphite/Li	0.5 M LiTDI in EC:EMC (3:7)	~35% capacity retention after 7 cycles at 0.05C rate; reduction of salt at 0.68-0.74 V vs. Li (twin peak)
This work	Graphite/Li	1 M LiTDI in EC:DMC (1:1)	Reduction of salt at 1.3 and 0.8 V *vs.* Li^+/Li^o
This work	Graphite/LFP	1 M LiTDI in EC:DMC (1:1)	25% capacity retention after 10 cycles (~0% after 30 cycles) at 0.05C rate