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

Supporting information

Biopolymer-based Functional Separator for Stable Li Metal Battery with Additive-Free Commercial Electrolyte

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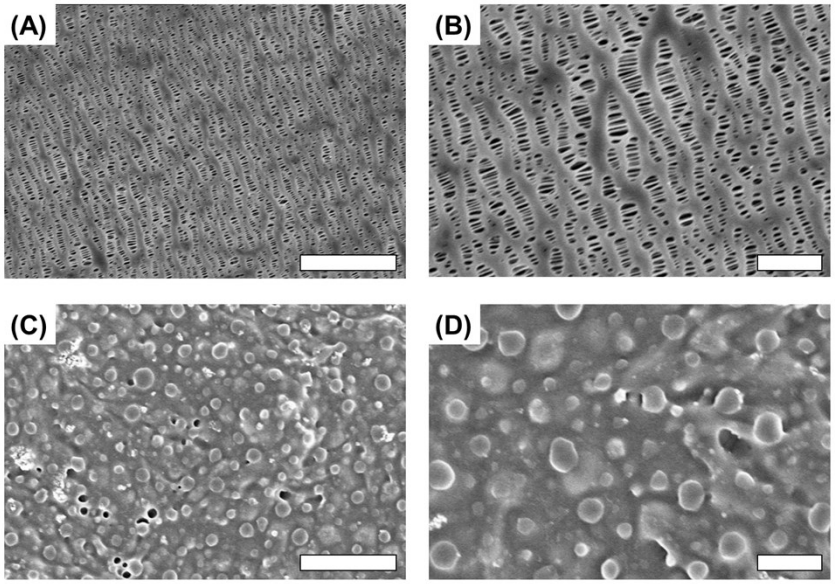

Fig. S1 SEM images of (A), (B) PP separator and (C), (D) APP film (A), (C) at low magnitude (scale bar = 3 μm) and (B), (D) at high magnitude (scale bar = 1 μm)

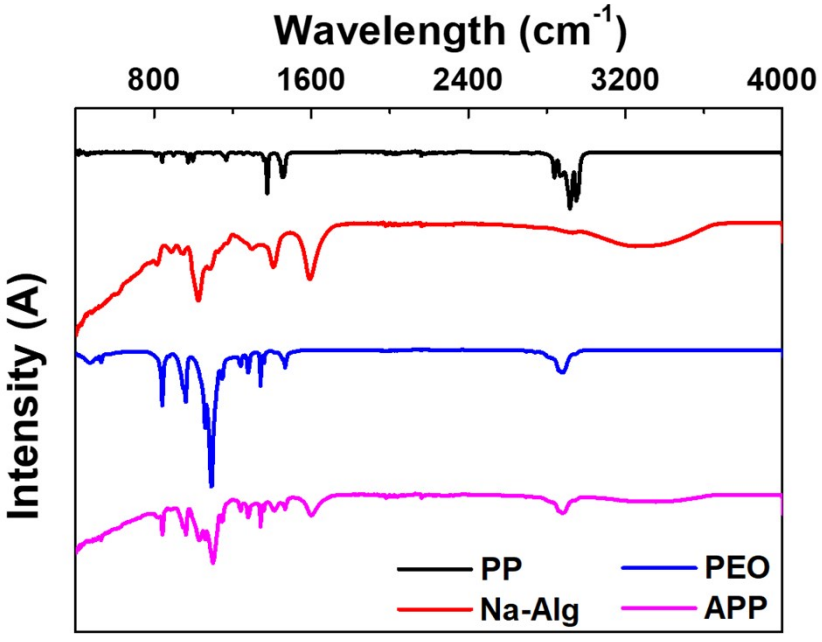

Fig. S2 Fourier-transformed infra red spectra of PP (black), APP (Magenta), Na-Alg (Red), and PEO (Blue).

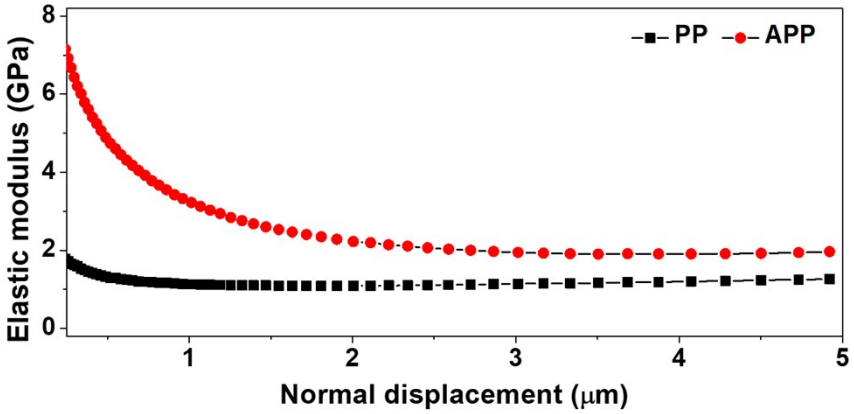

Fig. S3 Nano-indentation analysis result of PP separator (black) and APP film (red)

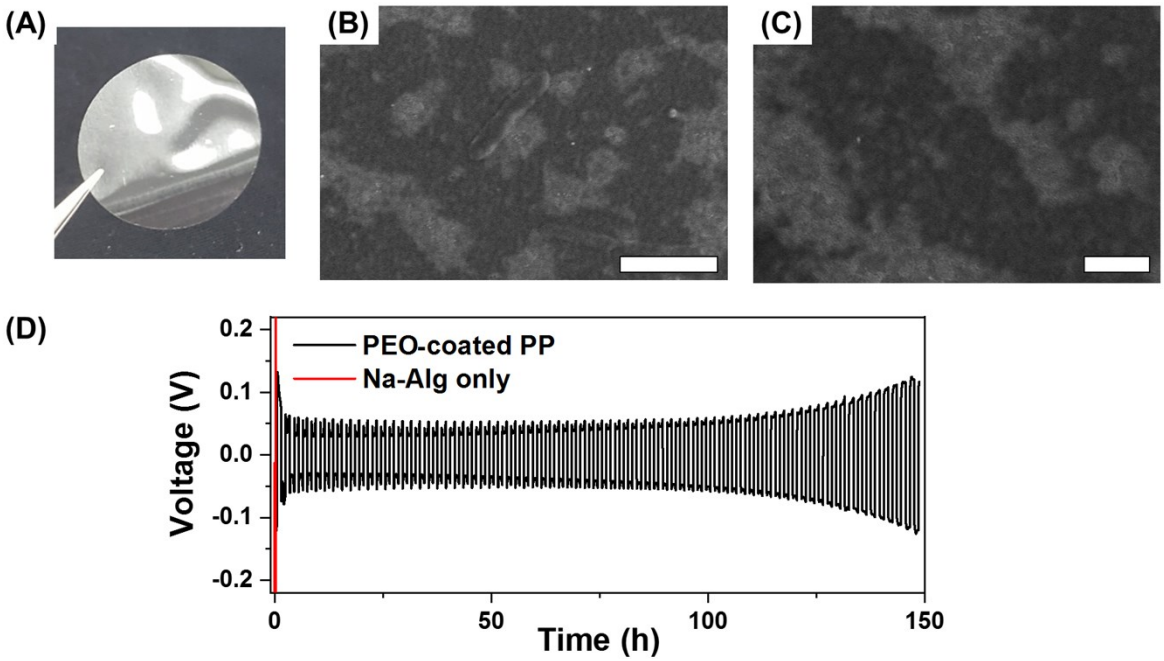

Fig. S4 Polymer film composed of only Na-Alg. (A) In photograph and SEM images at (B) low magnification (scale bar = 3 μm) and (C) high magnification (scale bar = 1 μm) and (D) voltage profile of symmetric cell test with PEO-coated PP separator and Na-Alg only film in 1 M $LiPF_6$ in EC:DMC=1:1 electrolyte at rate = 1 mA cm^{-2} and capacity cut = 1 mA h cm^{-2}.

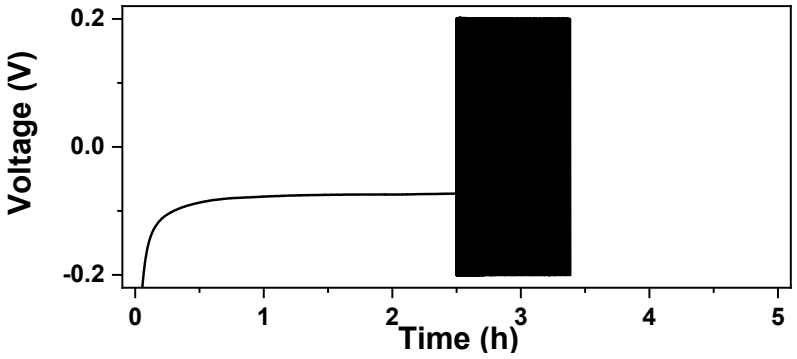

Fig. S5 Cycle life of symmetric cell using PP separator and 1 M $LiPF_6$ in EC:DMC=1:1 electrolyte at rate = 5 mA cm^{-2} and capacity cut = 5 mA h cm^{-2}.

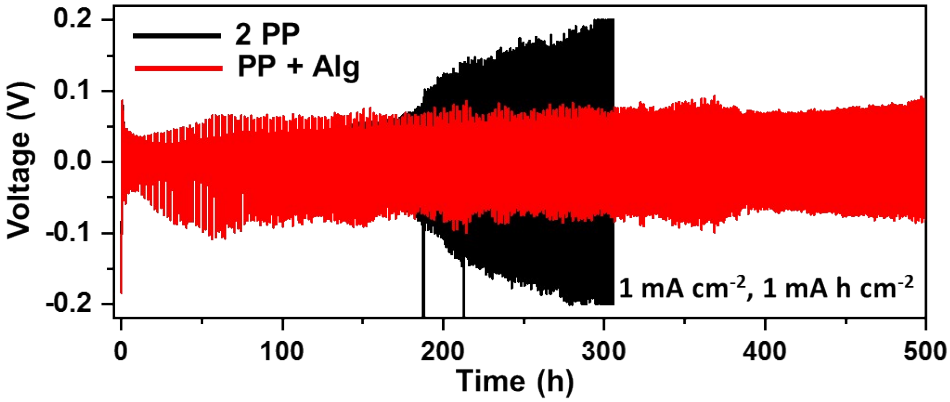

Fig. S6 Voltage profile of symmetric cell test with two PP separator and PP + APP film in 1 M $LiPF_6$ in EC:DMC=1:1 electrolyte at rate = 1 mA cm^{-2} and capacity cut = 1 mA h cm^{-2}.

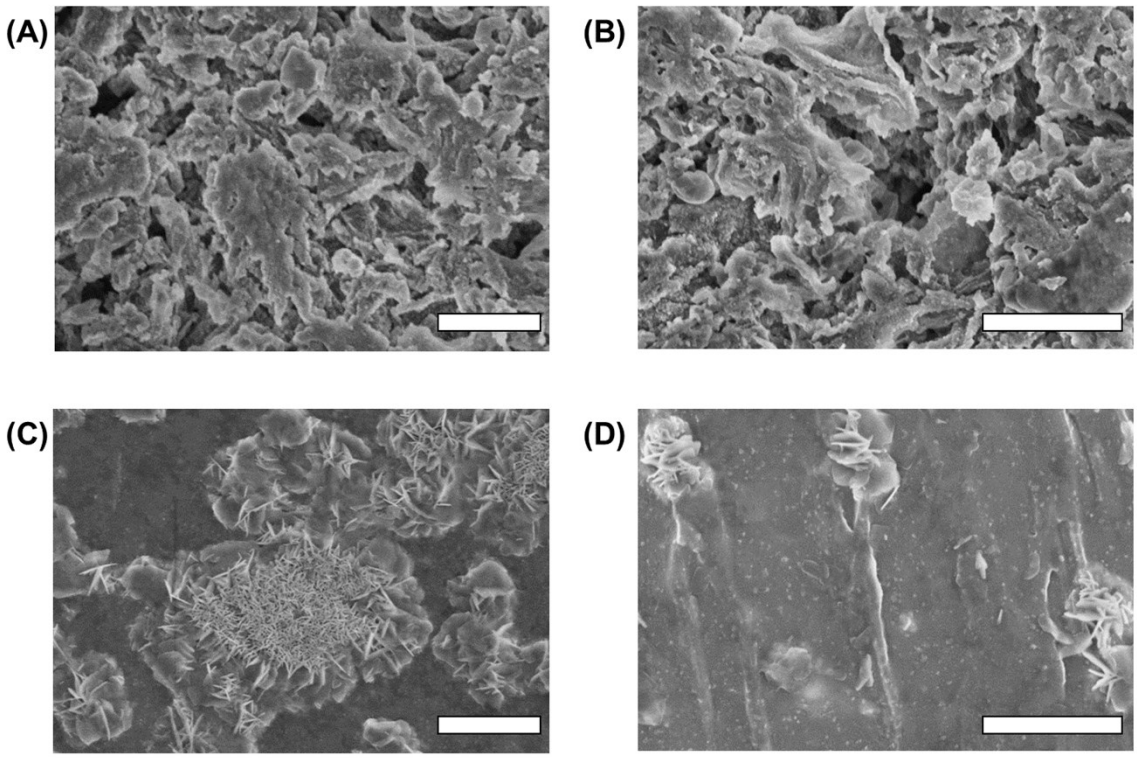

Fig. S7 SEM images of (A), (B) PP-Li and (C), (D) at different part of Li metal. (all scale bars = 2 μm)

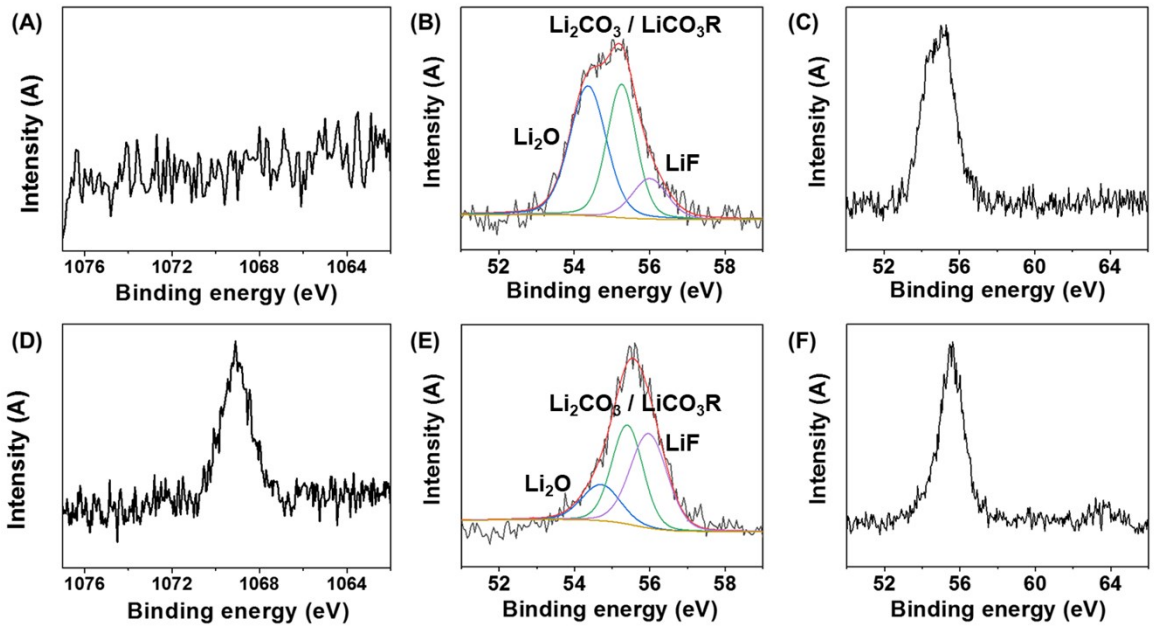

Fig. S8 XPS spectra of (**A**)-(**C**) PP-Li and (**D**)-(**F**) APP-Li. (**A**),(**D**) Na 1s, (**B**),(**E**) Li 1s, and (**C**),(**F**) Li 1s with Na 2s binding energy range.

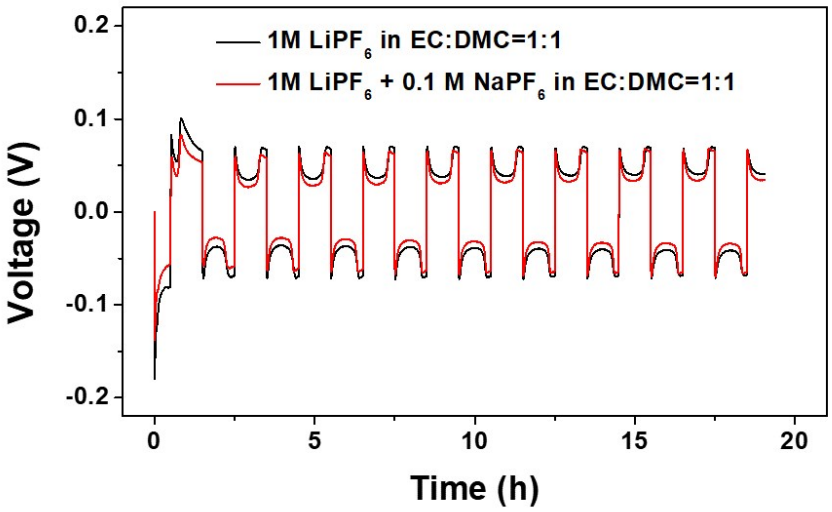

Fig. S9 Voltage profile symmetric cell with and without $NaPF_6$ in electrolyte with PP as separator.

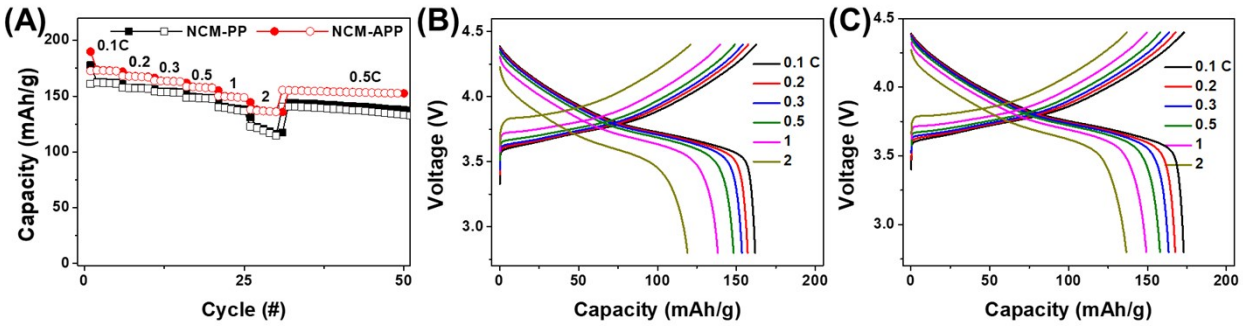

Fig. S10 (**A**) Rate performance of NCM622 full-cell with PP or APP as separator and its voltage profile of (**B**) PP full-cell and (**C**) APP full-cell

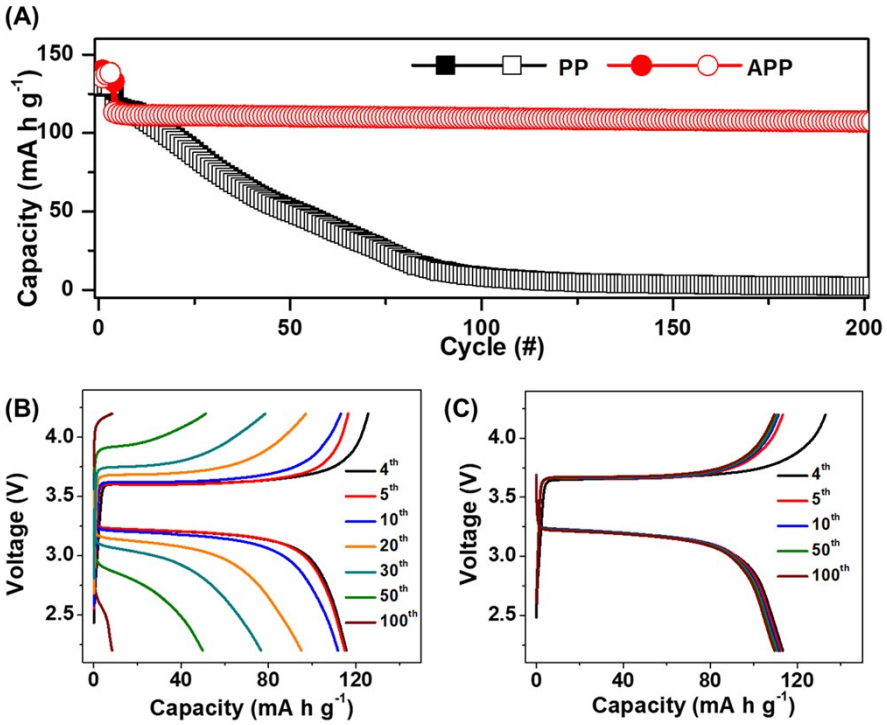

Fig. S11 $LiFePO_4$ (LFP) full-cell performance with 1 M $LiPF_6$ in EC:DMC=1:1 electrolyte. (**A**) Cycle life, and voltage profile of (**B**) PP cell and (**C**) APP cell (4^{th}, 5^{th}, 10^{th}, 20^{th}, 30^{th}, 50^{th}, and 100^{th} cycle).

Table S1 Performance of results in various LMB studies ordered by their experimental details. Note that additives are components for electrolytes in most of other works.[1-8]

Modified part	Material used	Cell test	Fabrication method	Test condition: Rate ($mA\ cm^{-2}$)	Test condition: Capacity cut ($mA\ h\ cm^{-2}$)	Cycle life of sym. cell (h / cycle) (at rate/capacity cut)	Overpotential (mV)	Electrolyte
Separator	Na-Alg + PEO	Symmetric	Polymer solution (Na-Alg+PEO dissolved in water) was casted on Al dish and then water was evaporated	0.5 ~ 10	1 ~ 8	1000 / 500 (at 1 / 1)	< 10	1 M $LiPF_6$ in EC/DMC=1:1
Electrode	Sn foil	Symmetric	Roll-pressing of Li foil & Sn foil by repetitive calendaring and folding under Ar	5 ~ 30	5 ~ 30	400 / 200 (at 5 / 5)	< 10	1 M $LiPF_6$ in EC/PC/DEC=1:1:1 + 10% FEC or 1% VC
Electrode	C_{60} & Mg	Symmetric	Vacuum thermal evaporation deposition of C_{60} and Mg	1 ~ 7	1	550 / 275 (at 1 / 1)	50	1 M $LiPF_6$ in EC/DEC/EMC=1:1:1
Electrode	P(SF-DOL)-GO nanosheet	Symmetric (electro-deposited Li)	Li-electrodeposited 3-D Cu was immersed with solution of graphene oxide (GO) and P(SF-DOL) with THF as solvent under Ar	2	4	320 / 80 (at 2 / 4) (99.1% retention)	-	1 M $LiPF_6$ in EC/EMC/FEC=3:7:1 or EC/DMC + 2% LiBOB
Electrode	1,3-dioxolane	Symmetric	Li foil was treated with 1,3-diooxolane under Ar	1	1	167 / 84 (at 1 / 1)	~10	1 M LiTFSI in TEGDME
Electrode	$g-C_3N_4$ coated Ni foam	Symmetric (electro-deposited Li)	Ni foam was immersed into the solution with exfoliated $g-C_3N_4$ by ultrasonication in water and then Li was electrodeposited with amount of 9 $mA\ h\ cm^{-2}$	1 ~ 2	1 ~ 8	1000 / 500 (at 1 / 1)	10	1 M LiTFSI in DOL/DME=1:1 + 1% $LiNO_3$
Separator	Egg shell membrane	Half & Symmetric	Egg shell membrane collected after acetic acid etching was solvethermally-treated with 90% trifluoroethanol solution	1 ~ 10	1 ~ 5	2000 / 1000 (at 1 / 1)	12	(Half) 1 M LiTFSI in DOL/DME=1:1 + 1% $LiNO_3$ (Sym.) 1 M $LiPF_6$ in EC/DEC/EMC=1:1:1 + 1% FEC
Separator	MOF (HKUST-1) & PVdF-HFP	Symmetric	Solution of synthesized HKUST-1 nanoparticles and PVdF-HFP with acetone as solvent was poured on PP separator at vacuum state	0.5 ~ 20	0.25 ~ 10	1000 / 1000 (at 10 / 5)	185	1 M LiTFSI in DOL/DME=1:1 + 0.2% $LiNO_3$
Separator	Mesoporous SiO_2 film	Symmetric	Synthesized mesoporous SiO_2 film (GO templated) was coated on commercial PP separator by vacuum filtration	1 ~ 2	1 ~ 2	230 / 115 (at 1 / 1)	30	1 M LiTFSI in DOL/DMC=1:1 + 1% $LiNO_3$

Reference

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