Supplementary Information

All Solid Flexible Supercapacitor Operating at 4V with Cross-linked Polymer-Ionic Liquid Electrolyte

Yong-keon Ahn[‡a], Bokyung Kim[‡a], Jieun Ko[a], Duck-Jea You[a], Zhenxing Yin[a], Hyunjin Kim[a], Dalwoo Shin[b], Sanghun Cho[a], Jeeyoung Yoo[*a] and Youn Sang Kim[*a,c]

a. *Program in Nano Science and Technology, Graduate School of Convergence Science and Technology, Seoul National University, Seoul 151-744, Republic of Korea. E-mail:younskim@snu.ac.kr, jyoo78@snu.ac.kr*

b. *KOREA JCC CO. LTD. R&D Center 1163, Chungcheong-daero, Bugi-myeon,Cheongwon-gun, Chungcheongbuk-do, Republic of Korea*

c. *Advanced Institutes of Convergence Technology,864-1 Iui-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-270, Republic of Korea*

‡ *These authors contributed equally to this work.*

Abbreviations

Name	Abbreviation
poly-4-vninyphenol	P_4VPh
cross-linked poly-4-vninyphenol	c-P_4VPh
1-ethyl-3-methyl imidazoium bis(trifluoromethylsulfonyl)imide	EMITFSI
composite electrolyte consisting of EMITFSI and c-P_4VPh	IL-CPX*
N-Methyl-2-pyrrolidone	NMP
Supercapacitor	SC
Symmetrical Supercapacitor with ILCPX	IL-CPX SC

* x: weight ratio of EMITFSI based P_4VPh weight

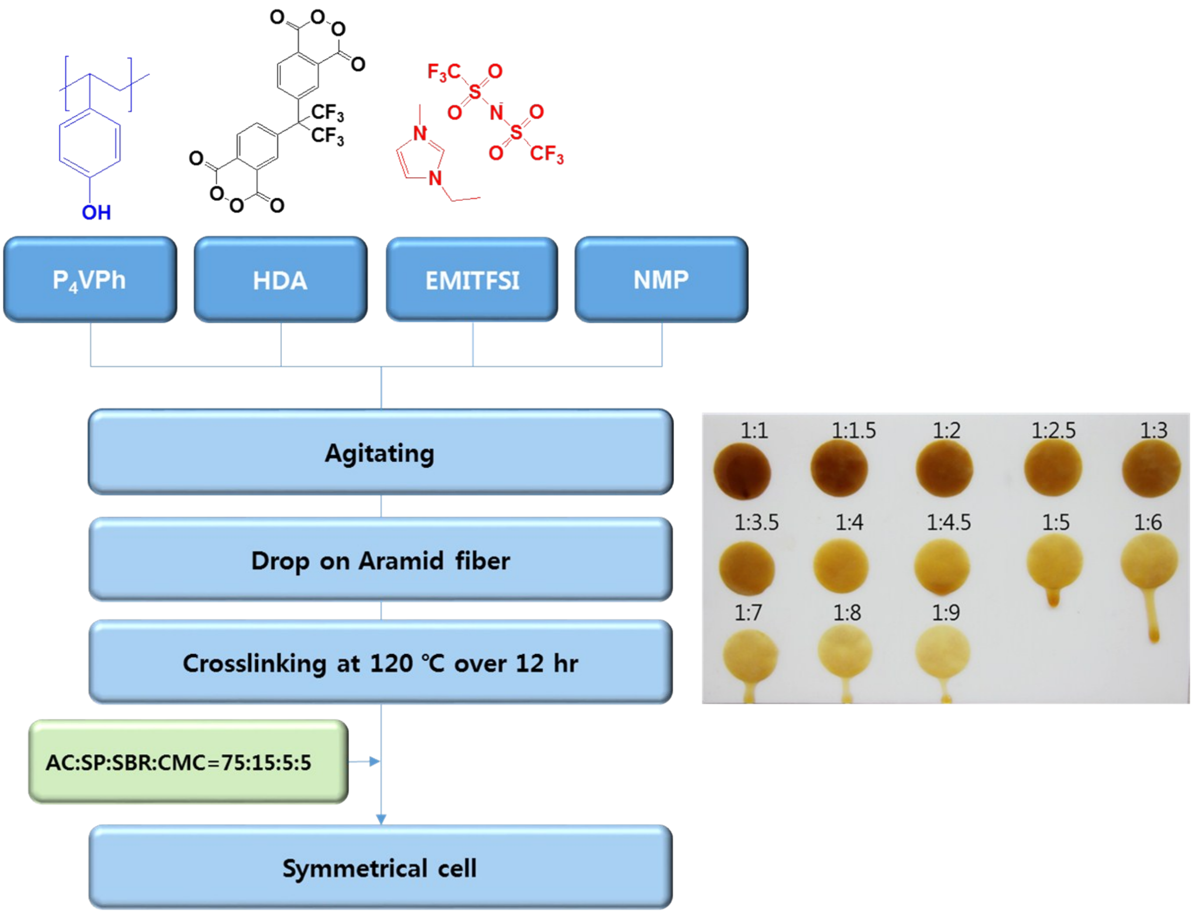

Figure S1. Preparation procedure all-solid state supercapacitor and features of synthesized IL-CPs with various EMITFSI composition.

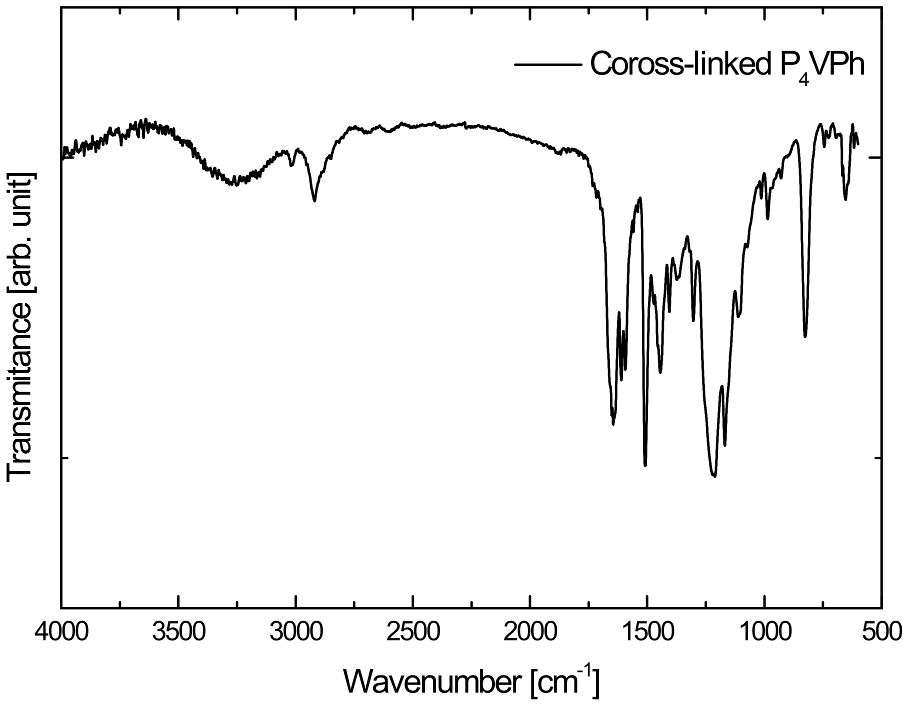

Figure S2. ATR-IR spectroscopy for cross-linked poly-4-vninyphenol

Table S1. Absorption peaks table of ATR FT-IR.

Functional groups of cation		Functional groups of anion	
N=C-N stretching vibration	1560-1520 cm^{-1}	-CF_3 stretching	1350-1120 cm^{-1}
ring C=C vibration	1605-1585 cm^{-1}	asymmetric vibration of CF_3	680-590 cm^{-1} 555-505 cm^{-1}
C-H vibration for cyclic cations	3172-3126 cm^{-1}	symmetric vibration of CF_3	600-540 cm^{-1}

(1) Socrates G. *Infrared Characteristic Group Frequencies: Tables and Charts*, 3rd Edition, Wiley & Sons: New York, 2004.

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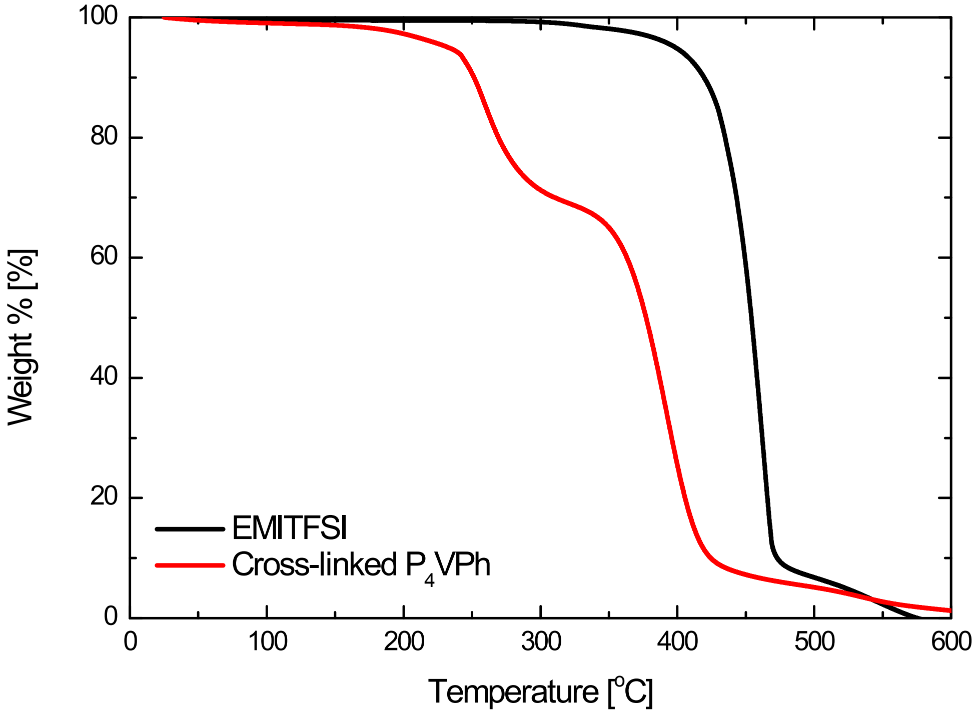

Figure S3. TGA for EMITFSI and P_4VPh

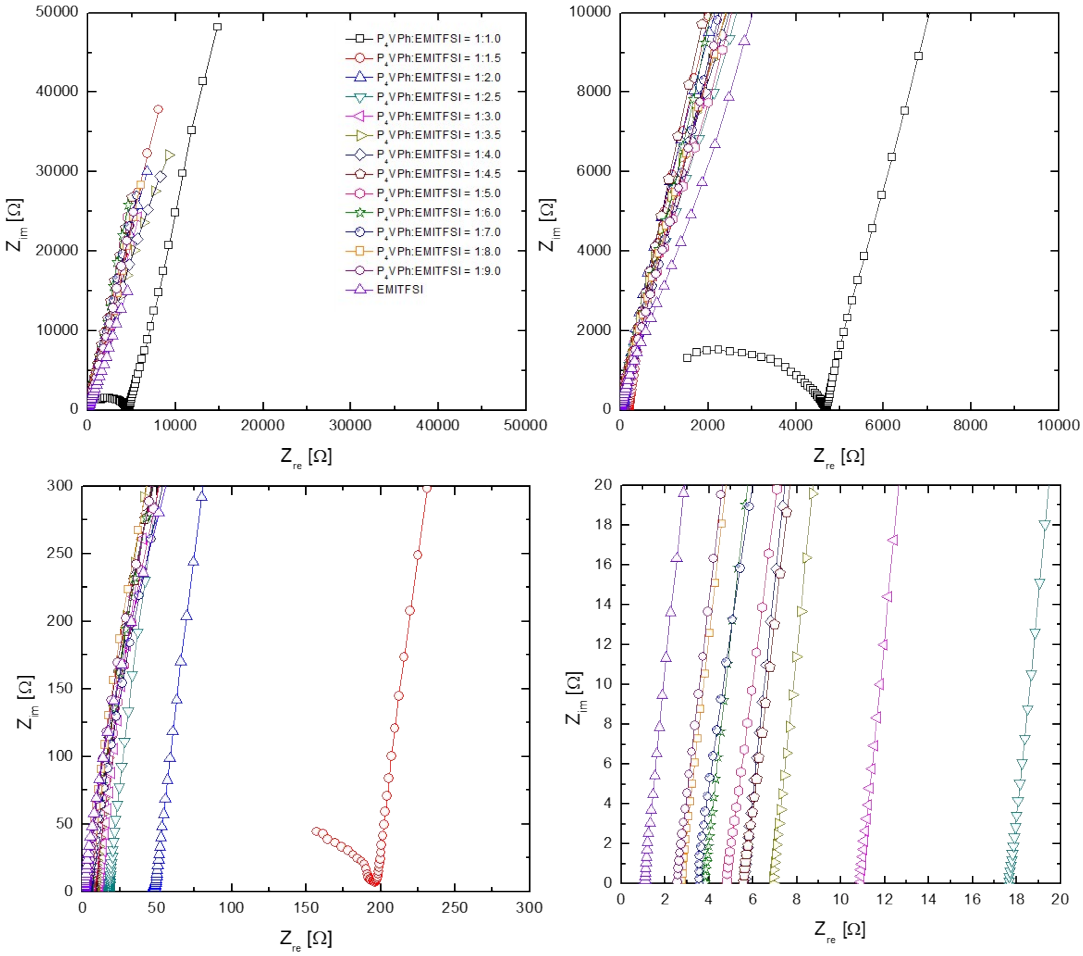

Figure S4. Electrochemical impedance spectroscopy of IL-CPs with stainless steel electrode.

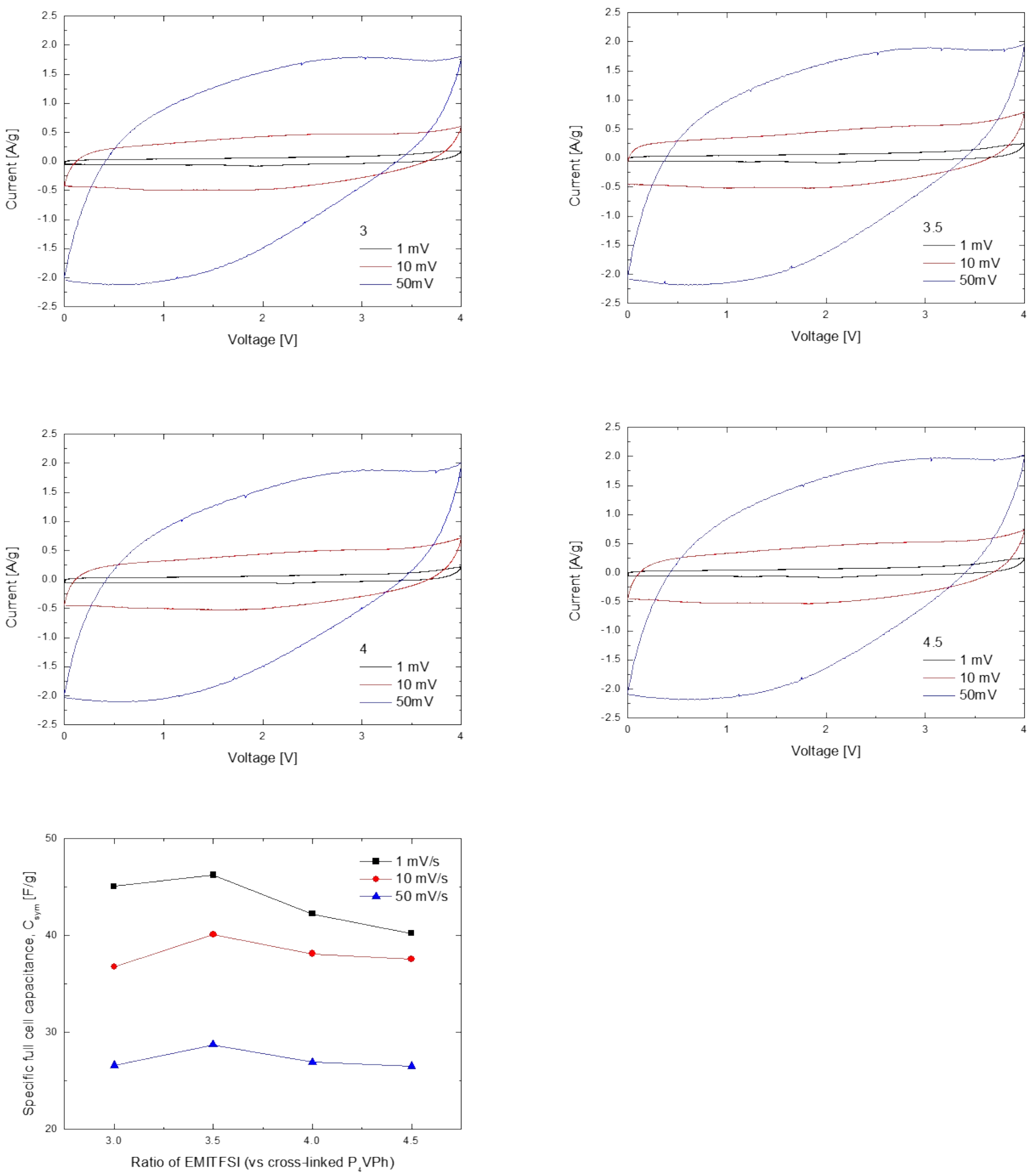

Figure S5. Cyclio-voltammograms and full cell capacitance of IC-CPx SCs with porous carbon symmetrical full cell (x=3, 3.5, 4 and 4.5)

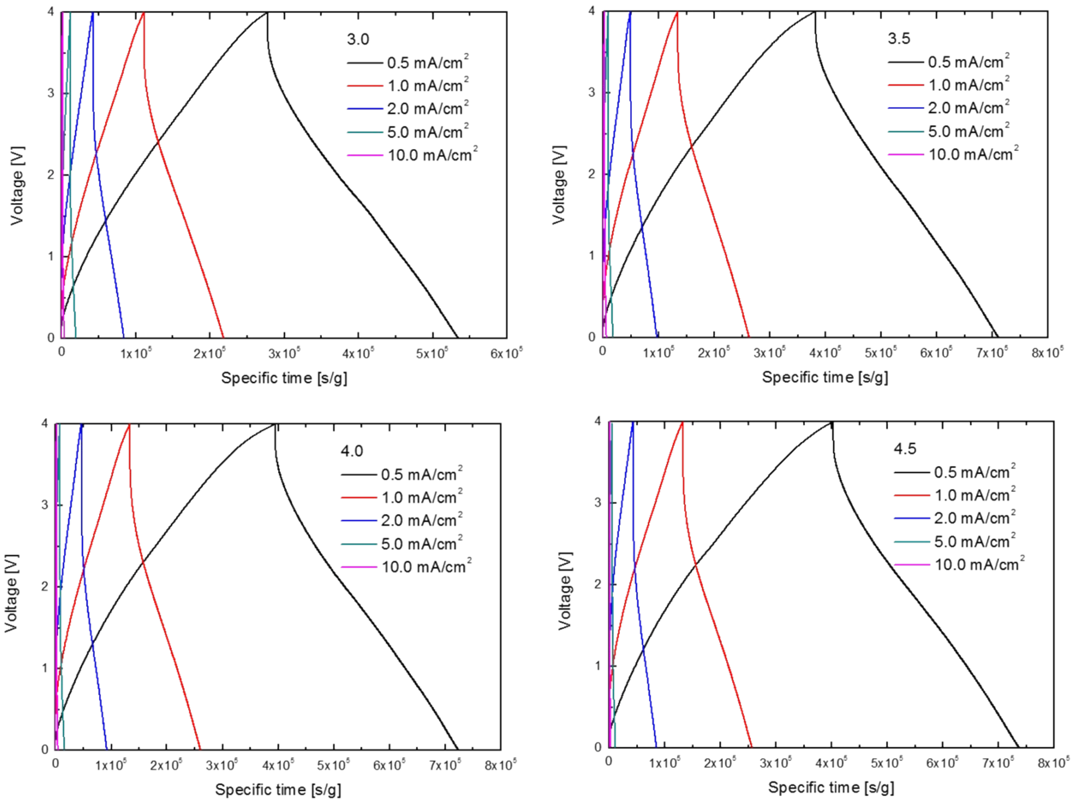

Figure S6. Galvanostatic charge-discharge profiles of IC-CPx SCs with porous carbon symmetrical full cell (x=3, 3.5, 4 and 4.5)

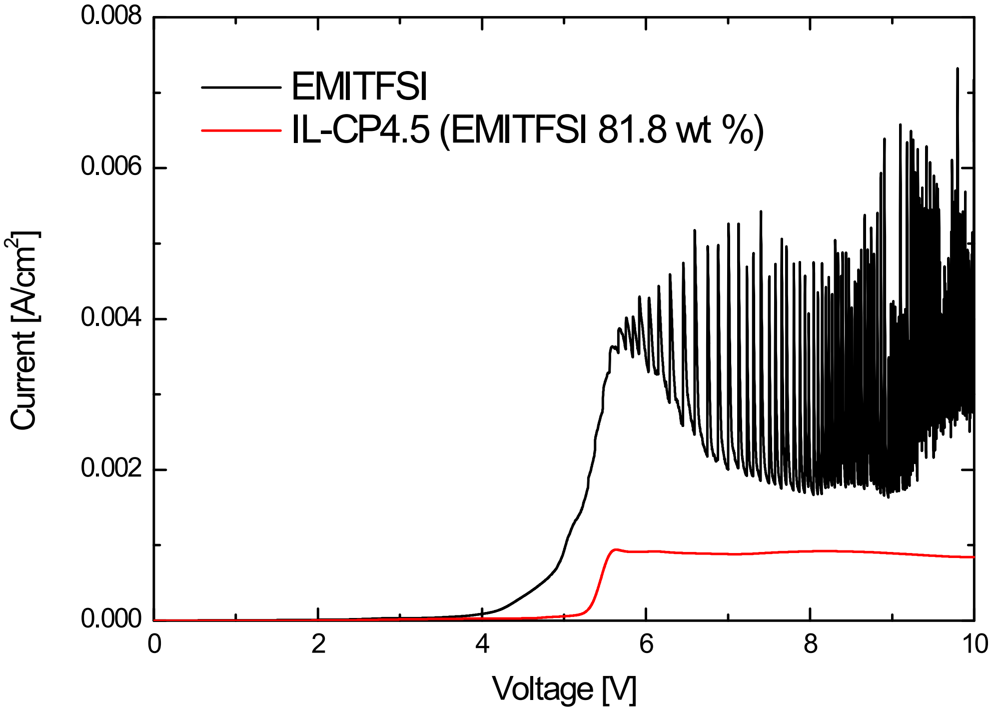

Figure S7. Linear sweep voltammogram of EMITFSI and IL-CP4.5 against Al foil in Al/Al cell (scan rate: 10 mV/s)

Table S1. Comparisons between prepared polymer electrolyte and other reported polymer electrolytes.

Ref.	electrolyte type	polymer	ionic liquid	solvent	ionic conductivity [mS cm^{-1}]	electrode material	rated voltage [V]	capacitance	method	energy density [Wh kg^{-1}]	additives
1	B	PAN	EMIBF4	none	15	AC	3	45 F g^{-1}	CV (5 mV s^{-1})	-	sulpholane
2	A	PVdF-HFP	EMTf	EC-PC		AC	2	136 F g^{-1}	Galvanostatic charge/discharge (1 mA cm^{-2})	18.8	-
3	B	PVdF-HFP	EMITFSI	none	1.5	AC	2~4	20 F g^{-1}	Galvanostatic charge/discharge (10 mA cm^{-2})	20	zeolite
4	B	PEO	EMTf	none	0.1	MWCNT	2	3 F g^{-1}	Galvanostatic charge/discharge (0.2 mA cm^{-2})	-	-
5	B	PEO	EMIHSO4	none	1.82	graphite	1.5	2 mF cm^{-2}	CV (1 mV s^{-1})	-	silica
6	B	PEO	EMITri	none	16.2	AC	3	92 F g^{-1}	Galvanostatic charge/discharge (2 mA cm^{-2})	0.01	-
7	B	PAN	BMIMTFSI	none	2.42	RGO	3	108 F g^{-1}	Galvanostatic charge/discharge (2 mA cm^{-2})	30.51	-
8	A	PVdF-HFP	EMITf	EC-PC	1	AC	2	167 F g^{-1}	Galvanostatic charge/discharge (1 mA g^{-1})	23.1	lithium triflate
9	A	pDADMATFSI	$PYR_{14}TFSI$	none	0.5	AC	3.5	100 F g^{-1}	Galvanostatic charge/discharge (1 mA cm^{-2})	37	-
this work	**B**	**c-P_4VPh**	**ENITFSI**	**none**	0.4	porous carbon	**4**	**172 F g^{-1}**	Galvanostatic charge/discharge (1 mA cm^{-2})	**72.29**	**-**

Electrolyte type A : incorporation of an IL in a polymer matrix (The role of polymer is separator)

Electrolyte type B : polymerization of a monomer in an IL

Electrolyte type C : poly ionic liquid

Abbreviation in Table S1.

$EMIBF_4$: 1-ethyl-3-methyl-imidazolium tetrafluoroborate

EMITf : 1-ethyl-3-methyl-imidazolium trifluoromethanesulfonate

$EMIHSO_4$: 1-ethyl-3-methylimidazolium hydrogensulfate

EMITri : 1-ethyl-3-methyl-imidazolium triflate

$PYR_{14}TFSI$: N-methyl-N-butylpyrrolidinium bis(trifluoromethanesulfonyl) imide

PAN : poly acrylonitrile

PVdF-HFP : poly(vinylidenefluoride−hexafluoropropylene)

PEO : poly ethylene oxide

pDADMATFSI : poly(diallyldimethylammonium) bis(trifluoromethanesulfonyl)imide

EC : ethylene carbonate

PC : propylene carbonate

AC : activated carbon

MWCNT : multi-walled carbon nanotube

Reference

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