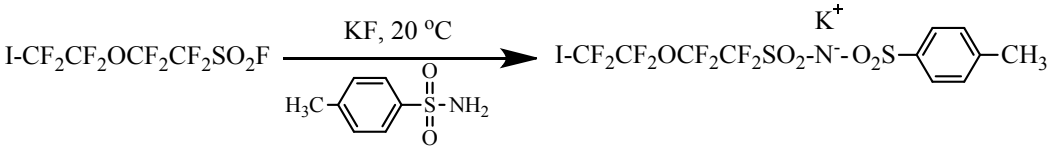
Supporting Information

# Flexible Fluorine Containing Ionic Binders to Mitigate the Negative Impact Caused by The Drastic Volume Fluctuation from Silicon Nano-Particles in High Capacity Anodes of Lithium-Ion Battery

Dejun Qin, Lixin Xue**, Bing Du, Jian Wang, Feng Nie, and Lele Wen*

**Synthesis of PSI-K**

Potassium fluorinated sulfonimide salt (PSI-K) was prepared from an iodo perfluorinated sulfonyl fluoride (PSA) precursor (Shanghai Sino fluoro Scientific Co., Ltd, China) following the reaction scheme presented in Scheme S1. The PSA was reacted with 4-toluene sulfonamide in $CH_3CN$ (HPLC, Aladdin, China) for 4 h and the product PSI-K was prepared.

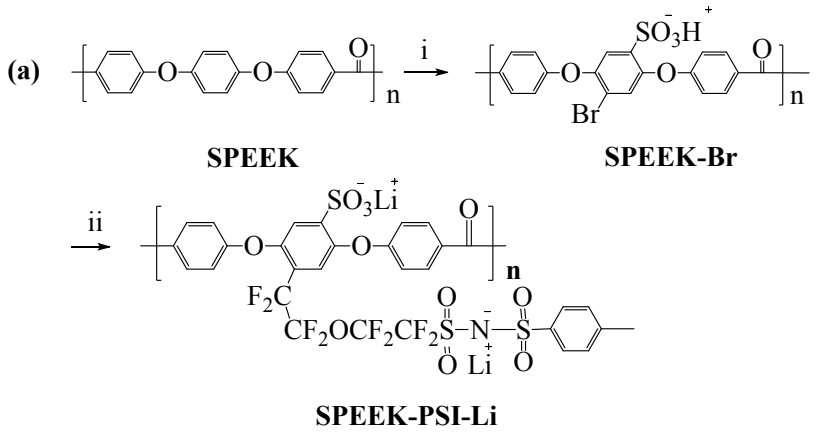



**Scheme S1**. Synthesis of PSI-K

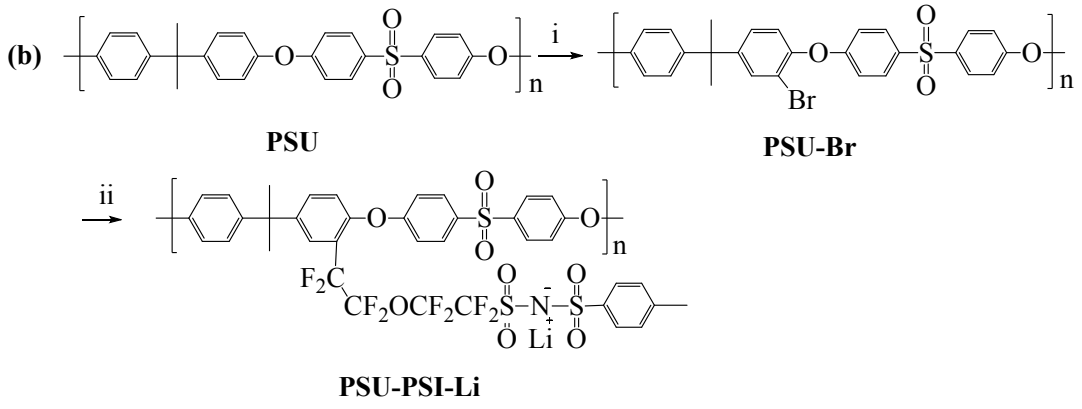
**Synthesis of ionic polymer**

The SPEEK-PSA-Li was prepared from sulfonated polyether ether ketone with PSA as our previous work,[1] the SPEEK-PSI-Li and PSU-PSI-Li were prepared with the similar procedure, as Scheme S2 shown, firstly the SPEEK-Br and PSU-Br were prepared, SPEEK was dissolved in the sulfuric acid and stirred for another 24 h and PSU was dissolved in the dimethyl sulfoxide (DMSO) respectively, then the bromine was added into the solution and stirred for 24 h at 30 °C, the products were washed with deionized water and dried at 60 °C. The fluorinated sulfonimide (PSI) group was grafted to the polymer via coupling reaction by adding the prepared PSI-K into the SPEEK-Br and PSU-Br in DMSO solvent with the copper powder as the catalyst respectively. The mixture were stirred for 10 h at 120 °C, the resulting compound were precipitated in hydrochloric acid solution

and washed several times to remove the copper powder. The prepared ionic polymer was immersed into the 1mol $L^{-1}$ of lithium hydroxide solution for 24 h, then lithiated ionic polymer SPEEK-PSI-Li and PSU-PSI-Li were prepared.




(i) (1) $H_2SO_4$, 25 °C, 24 h. (2) $Br_2$, $H_2SO_4$, 30 °C, 24 h. (ii) (1) Cu, DMSO, 120 °C, 2 h. (2) PSI-K, DMSO, 120 °C, 10 h. (3) LiOH, 30 °C, 24 h




(i) (1) DMSO, $Br_2$, 30 °C, 24 h. (ii) (1) Cu, DMSO,120 °C, 2 h. (2) PSI-K, DMSO, 120 °C, 10 h. (3) LiOH, 30 °C, 24 h

**Scheme S2**. Synthesis of (a) SPEEK-PSI-Li and (b) PSU-PSI-Li

**Characterization of PSI-K, SPEEK-PSI-Li and PSU-PSI-Li**

$^{19}$FNMR spectra were recorded for PSA, PSI, SPEEK-PSA-Li, SPEEK-PSI-Li and PSU-PSI-Li using a Bruker AV-400 spectrometer at 400 MHZ using DMSO-d6 as lock solvent. As demonstrated in Fig. S1, the PSA exhibits four obvious single peaks corresponding the four $CF_2$ groups from the molecular, the chemistry shift of -82.9 and -86.1 were attributed to $CF_2OCF_2$, the -73.9 and -113.2 were attributed to $ICF_2$ and $CF_2SO_2F$, comparatively, the four $CF_2$ groups of PSI-K

are changed to -81.2, -85.5 ($CF_2OCF_2$), -72.8 ($ICF_2$), -116.2 ($CF_2SO_2$) ppm respectively. After the iodo-group was reacted with the SPEEK-Br (PSU-Br), the chemical shift of $ICF_2$ at -72.8 ppm disappeared and a new peak around -110.9 ppm could be found which indicated the PSI group had been successfully grafted to SPEEK (PSU) backbone.

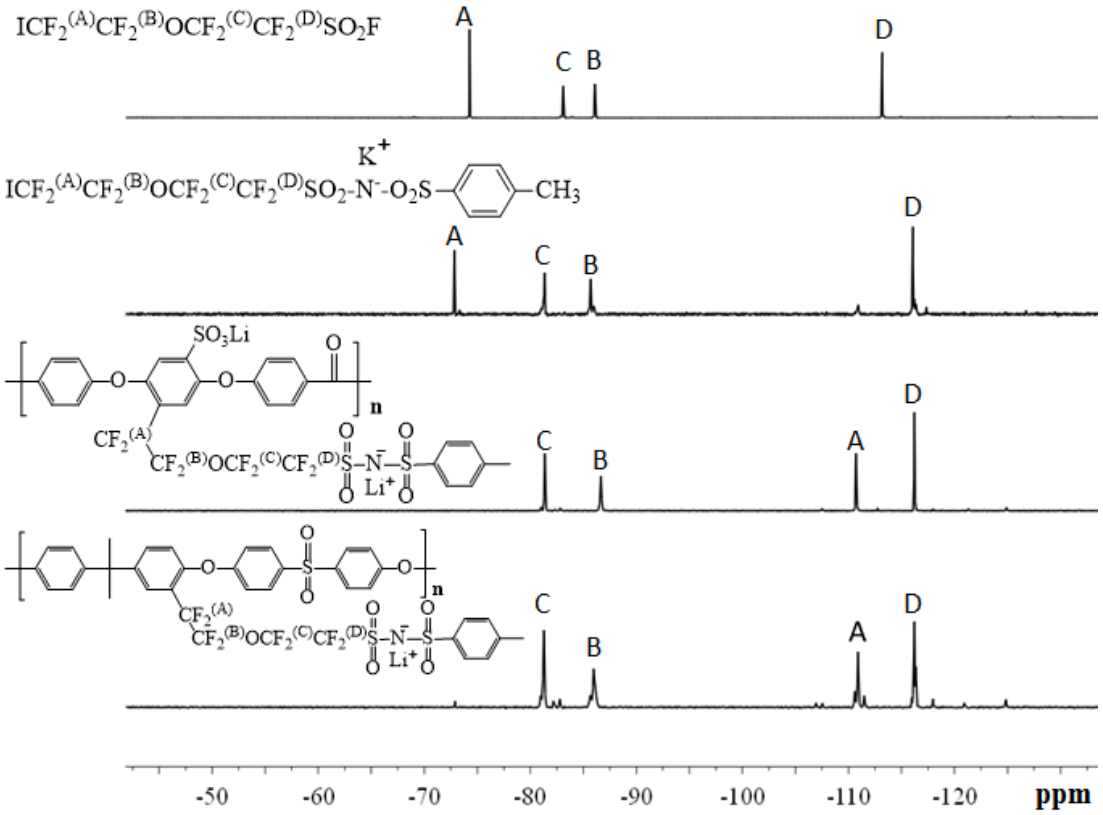



**Fig. S1**. (a) SPEEK-PSI-Li and (b) PSU-PSI-Li

1. Z. Wei, L. Xue, F. Nie, J. Sheng, Q. Shi and X. Zhao, *J. Power Sources*, 2014, **256**, 28-31.