

Supporting Information

Poly(ionic liquid) Binders as Li⁺ Conducting Mediators for Enhanced Electrochemical Performance

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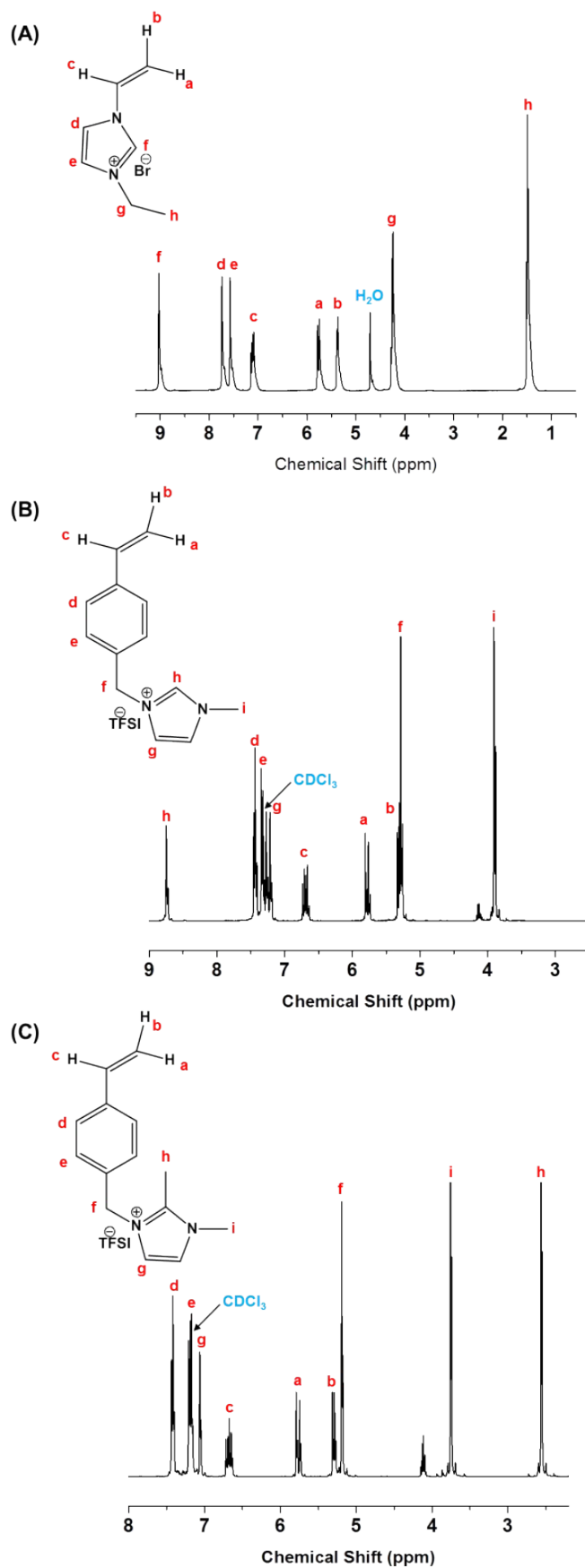


Fig. S1. $^1\text{H-NMR}$ of (A) M1, (B) M2 and (C) M3. All peaks can be assigned to their

corresponding monomer structures.

The $^1\text{H-NMR}$ spectra of the ionic liquid monomers of these PIL binders are presented in Figure S1. As shown in Figure S1A, the peaks of M1 for a, b and c can be corresponded to the vinyl group, d, e and f to the imidazolium ring, and g and h to the functionalized ethyl group. If the peak area are compared with each other (*e.g.*, c compared to g; ratio of peak area = 1:2), success functionalization can be confirmed. M2 and M3 also were confirmed by same way.

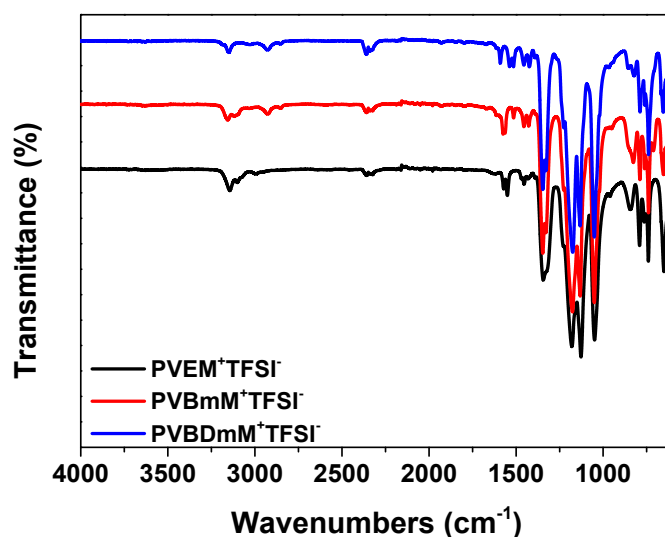


Figure S2. FT-IR spectra of the PIL polymers P1, P2 and P3.

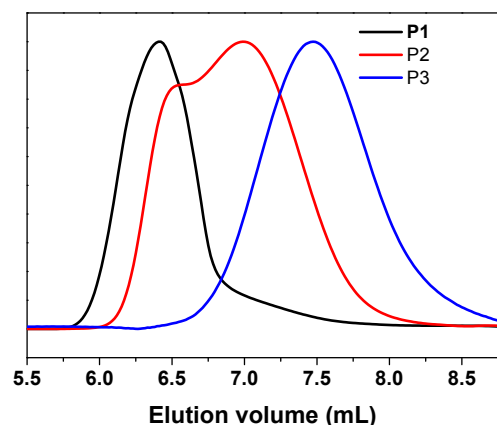


Fig. S3 GPC trace measured for P1, P2 and P3. For P1, average degree of polymerization $DP_n = 321$ and polydispersity index $PDI = 3.4$; for P2, $DP_n = 118$ and $PDI = 3.1$; for P3, $DP_n = 75$ and $PDI = 3.0$. The bimodal distribution of P2 may be caused by coupling reactions at the end of the polymerization due to the dramatically increased viscosity in the reaction mixture. The average DP or the molar mass presented here is the apparent molecular weight of these polymers due to the lack of PIL standard for GPC.

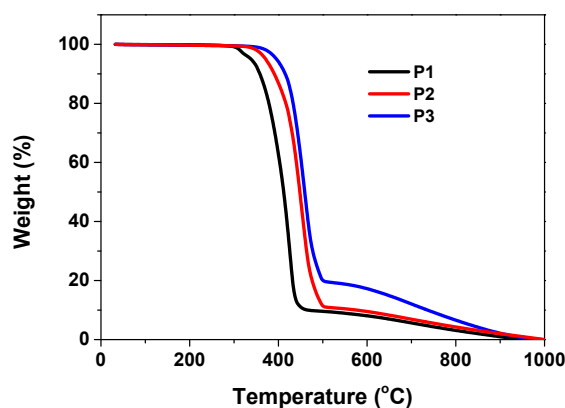


Fig. S4 Thermo-gravimetric analysis of (A) P1, (B) P2 and (C) P3.

Thermal stability is among the most important characteristics of binder materials. Figure 3 shows the decomposition temperature under thermal condition. PVEM obviously exhibited the lower decomposition temperature. The temperature of 5% loss-weight for PVEM, PVBmM and PVBDmM are 337, 371 and 395 °C, a continuous degradation takes place. According to benzyl and methyl functionalization, the thermal stability of PILs was improved because the aromatic ring is well-known stable structure and methyl group provide compactness of entanglement in the polymer matrix.

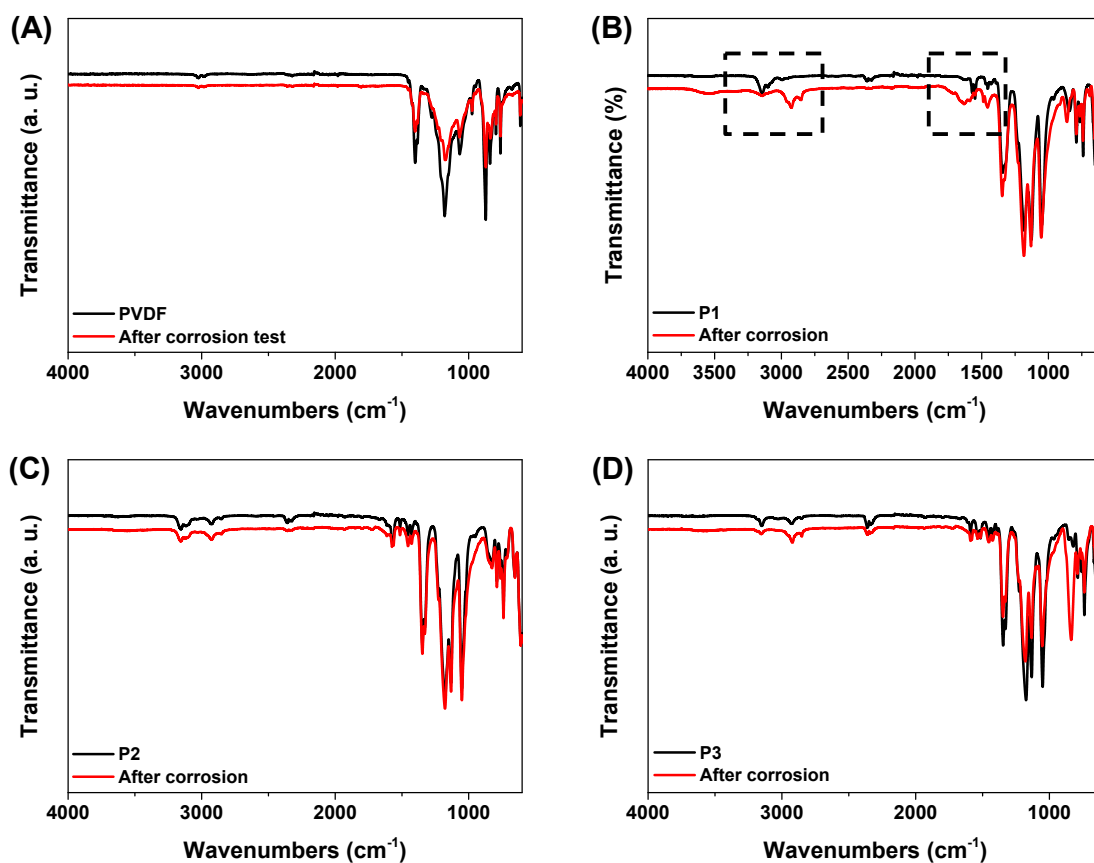


Fig. S5 FT-IR of PVDF and PIL binders before (black) and after (red) corrosion test. The dashed boxed in B denotes the changes in the spectra.

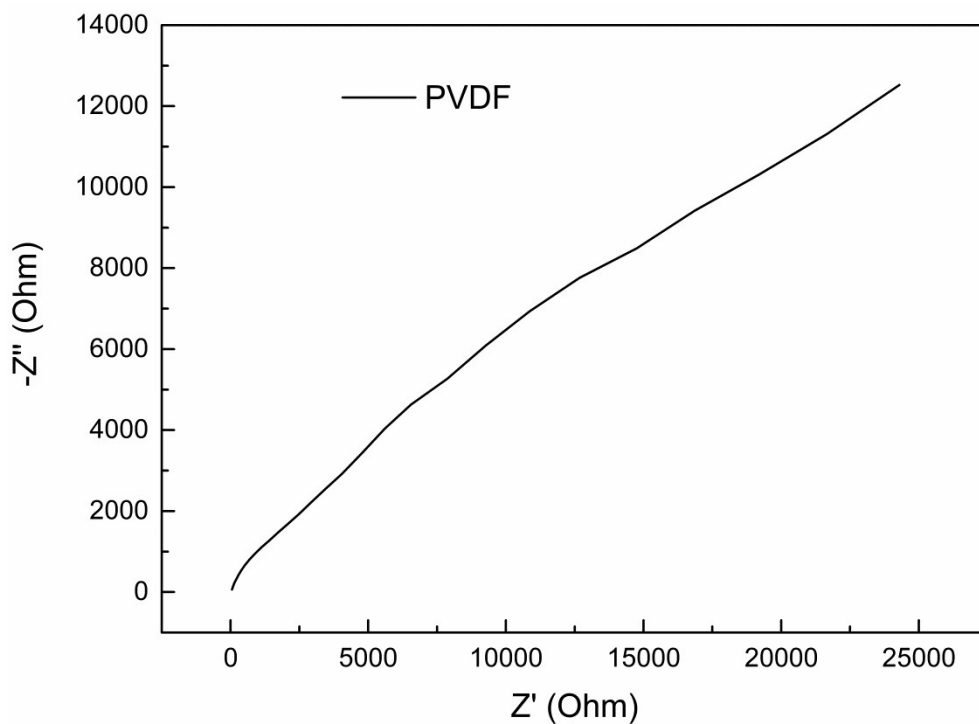


Fig. S6 EIS curve for a PVDF electrode.

Table S1. Fitting results of experimental EIS for PIL binder electrodes

Samples	R_s (Ohm)	R_1 (Ohm)	R_2 (Ohm)	T_{CPE1} (μFs^{p-1})	T_{CPE2} (μFs^{p-1})	α_{CPE1}	α_{CPE2}
P1	127.4	2002	797.9	3.305	17.98	0.733	0.816
P2	120.6	3468	945	1.357	0.148	0.838	0.487
P3	24.46	1830	511	7.428	0.207	0.713	0.506

Reference

1 Lane, G. H.; Bayley, P. M.; Clare, B. R.; Best, A. S.; MacFarlane, D. R.; Forsyth, M.; Hollenkamp, A. F. J. *Phys. Chem. C* 2010, **114**, 21775.

2 Ramesh, S.; Lu, S.-C. *J. Power Sources* 2008, **185**, 1439.