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Electronic Supplementary Material

Polymeric ionic liquid gels composed of hydrophilic and hydrophobic units for high adsorption selectivity of perrhenate

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1. IR and XPS of PC_2-$C_{12}vimNO_3$-A

Before the measure of *SF* of the adsorbent towards ReO_4^- against NO_3^-, the anion of the gel should be exchanged into NO_3^- in order to get rid of the effect of Br^-. PC_2-$C_{12}vimBr$-A was immersed into excess *ca.* 1.5 M HNO_3 to equilibrium for 2 times, then into water for 3 times and dried. To confirm the exchange was complete and the polycation of the gel had no change in the ion-exchange process, IR and XPS were performed to the resulted PC_2-$C_{12}vimNO_3$-A (Fig. S1).

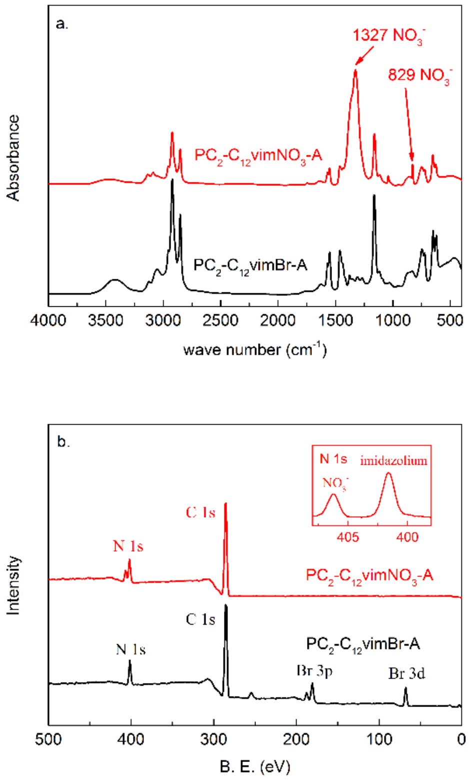

Fig. S1 (a.) IR and (b.) XPS of PC_2-$C_{12}vimNO_3$-A prepared from PC_2-$C_{12}vimBr$-A.

The absorption peak at 1327 and 829 cm^{-1} of NO_3^- occurred in the IR spectrum of PC_2-$C_{12}vimNO_3$-A, while the other part of the spectrum was similar to that of PC_2-$C_{12}vimBr$-A, indicating that NO_3^- had been exchanged onto the gel and the polycation showed no change. In the XPS of PC_2-$C_{12}vimNO_3$-A, the peak of Br disappeared, and the peak of N was divided into double peaks, which belonged to the N atoms in NO_3^- and imidazolium respectively.

2. IR spectra of C$_2$vimBr, C$_{12}$vimBr, C$_6$vim$_2$Br$_2$, PC$_2$vimBr, PC$_2$-C$_{12}$vimBr-A and PC$_{12}$vimBr.

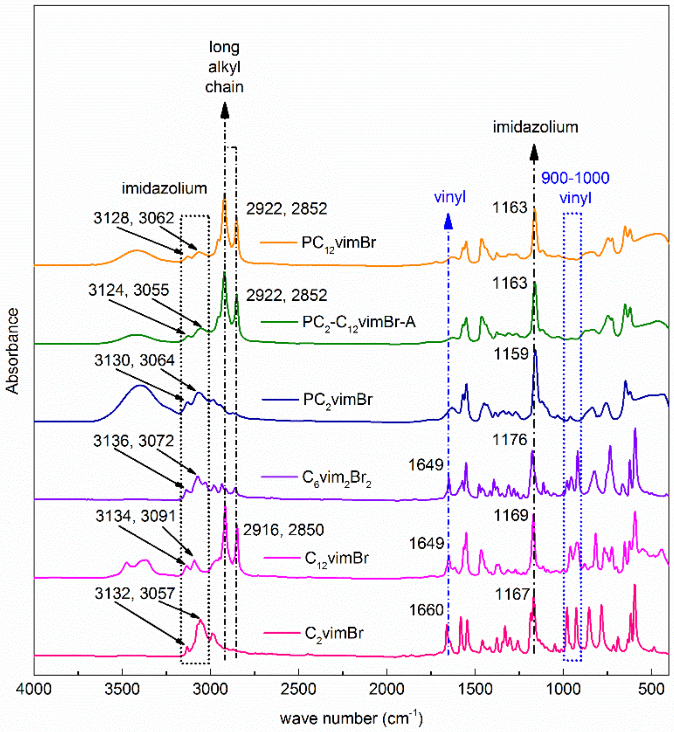

Fig. S2 IR spectra of C$_2$vimBr, C$_{12}$vimBr, C$_6$vim$_2$Br$_2$, PC$_2$vimBr, PC$_2$-C$_{12}$vimBr-A and PC$_{12}$vimBr.

IR was performed to the monomers, crosslinker and the resulted gels (Fig. S2). The IR spectra of C$_2$vimBr, C$_6$vim$_2$Br$_2$ and PC$_2$vimBr were similar to those we reported before[1]. The IR spectrum of C$_{12}$vimBr was similar to that of C$_2$vimBr, but the peak of the alkyl chain at 2916 and 2850 cm^{-1} were much stronger. The IR spectra of PC$_2$-C$_{12}$vimBr-A and PC$_{12}$vimBr were similar to those of the monomers and the crosslinker, but the peaks of vinyl around 1649-1660 cm^{-1} and in 900-100 cm^{-1} disappeared in the resultant gels, indicating the successful synthesis of gels.

3. TGA of PC_2vimBr, PC_2vimNO_3, PC_2-$C_{12}vimBr$-A and PC_2-$C_{12}vimNO_3$-A

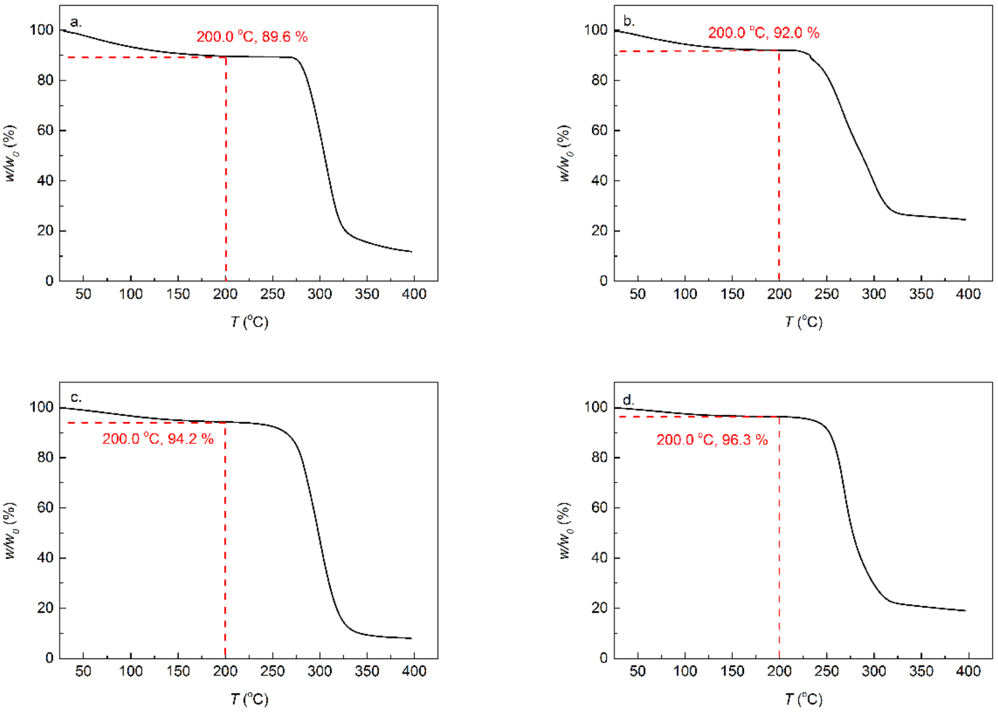

Fig. S3 TGA of (a) PC_2vimBr, (b) PC_2vimNO_3, (c) PC_2-$C_{12}vimBr$-A and (d) PC_2-$C_{12}vimNO_3$-A.

TGA was performed for different gels (Fig. S3). The gels with Br^- anion had good thermal stability under 250°C, while those with NO_3^- began to decompose at lower temperature of *ca.* 220°C. Since all gels were stable under 200°C and a flat curve were obtained at that temperature, the gels at 200°C was considered as dried completely, and the w/w_0 at those points was marked in the figures.

4. EA of PC_2-$C_{12}vimBr$ gels

Table S1 EA of PC_2-$C_{12}vimBr$ gels

Sample	N (wt%)	C (wt%)	H (wt%)
$PC_{12}vimBr$	7.78	57.1	9.12
PC_2-$C_{12}vimBr$-A	8.40	55.4	8.66
PC_2-$C_{12}vimBr$-B	9.31	51.2	8.14
PC_2-$C_{12}vimBr$-C	10.1	47.8	7.52
PC_2-$C_{12}vimBr$-D	11.3	43.5	6.74

N contents of PC_2-$C_{12}vimBr$ gels increased from $PC_{12}vimBr$ to PC_2-$C_{12}vimBr$-D, corresponding to the increasing ratio between C_2vimBr units and $C_{12}vimBr$ units, while the C and H content decreased.

5. XPS of PC_2-C_{12}vimBr gels

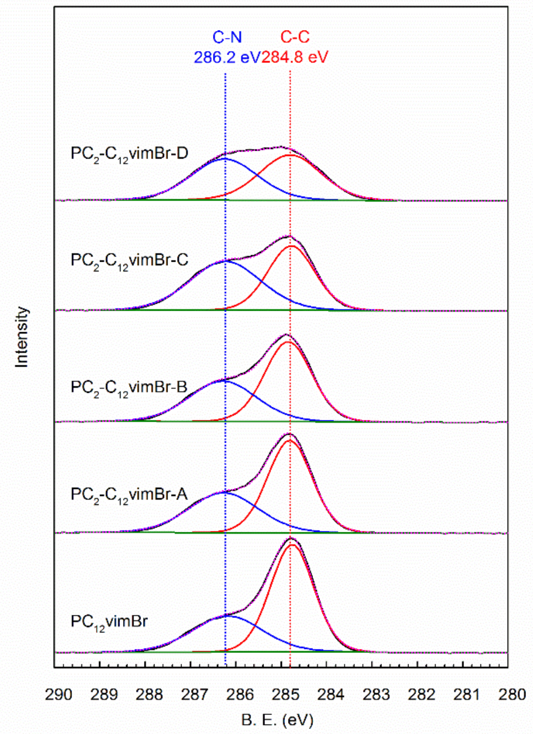

Fig. S4 XPS of PC_2-C_{12}vimBr gels

The XPS of C element in PC_2-C_{12}vimBr gels were shown in Fig. S4. The C 1s peaks in the XPS showed that the C in the gels could be divided into 2 kinds, namely C (C-N) and C (C-C). The C (C-N) atoms have higher B. E. than those of the C (C-C) atoms on the alkyl chains[2]. As the C_2vimBr content increased from 0 in PC_{12}vimBr to 80 mol% in PC_2-C_{12}vimBr-D, the relative intensity of C-C peak *vs.* C-N peak decreased. It agreed with their composition of the gels, because C_{12}vimBr units had more C (C-C) atoms in the alkyl chains.

6. *SF* of PC_2-$C_{12}vimNO_3$ gels

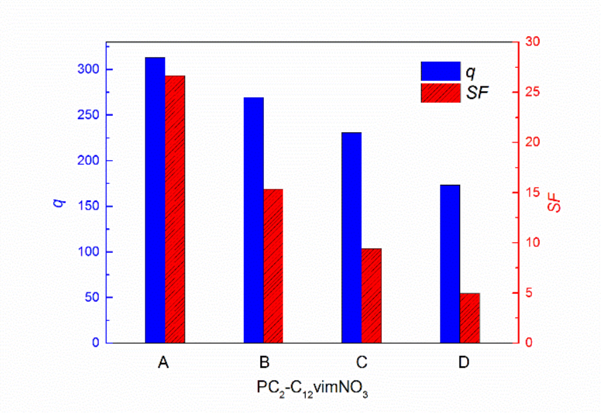

Fig. S5 *SF* of PC_2-$C_{12}vimNO_3$ gels

The c_0 was 700 ppm and HNO_3 was 0.0500 mol·kg^{-1}. Phase ratio was 1 mg gel / 1 g solution.

PC_2-$C_{12}vimNO_3$ gels were exchanged into PC_2-$C_{12}vimNO_3$ gels by HNO_3, then the *SF* were measured in a similar way as described in the paper. The *q* and *SF* decreased as the content of the hydrophobic units decreased, from PC_2-$C_{12}vimNO_3$-A to PC_2-$C_{12}vimNO_3$-D. Though the hydrophilic cation unit, C_2vim^+, has smaller molecular weight, the *q* still decreased as its content increased. So it was illustrated that the hydrophobic cation unit, $C_{12}vim^+$, would bring a higher adsorption selectivity towards ReO_4^- against NO_3^-.

References:

1. D. Han, X. Li, J. Peng, L. Xu, J. Li, H. Li and M. Zhai, *Rsc Advances*, 2016, **6**, 69052-69059.
2. I. J. Villar-Garcia, E. F. Smith, A. W. Taylor, F. L. Qiu, K. R. J. Lovelock, R. G. Jones and P. Licence, *Physical Chemistry Chemical Physics*, 2011, **13**, 2797-2808.