Supporting Information

Synthesis and characterization of novel 4-phenyl-pyridine units based alkaline anion exchange membranes

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1. Preparation of the DIm-PSF membrane

1.1 Synthesis of the PSF copolymer

The typical procedure for the synthesis of PSF as follows. HPCH (2.1460 g, 8.0 mmol), 4,4'-biphenol (1.488g g, 8.0 mmol), FPS (4.0680 g, 16 mmol), potassium carbonate (5.528 g, 40 mmol), tetramethylene sulfone (16 mL) and toluene (20 mL) were placed into a dry 100 mL three-necked round bottom flask equipped with a Dean-Stark trap, a condenser, a mechanic stirrer and a gas inlet and outlet. The reaction mixture was carried out at 150 ^{o}C for 2 h under nitrogen flow to remove the water in the solution. Then, the temperature was raised to 210 ^{o}C

for 2 h to yield a viscous brown mixture. The mixture was poured into 300 mL of a methanol aqueous (methanol/deionized water = 1/1) to produce an off-white resin. The as-prepared copolymer PSF was washed by deionized water and methanol for several times, and then dried in vacuo at 70 ^{o}C overnight.

1.2 Bromination

The radical substitution bromination reaction of the benzyl methyl-bearing PSF was carried out in 1,1,2,2-tetrachloroethane (TCE) using NBS and benzoyl peroxide as the bromination agent and initiator, respectively. A typical procedure for the preparation of BPSF as follows. Firstly, 1.0 g PSF and 20 mL TCE were added to a 100 mL three-necked round bottomed flask and heated to 80 ^{o}C under nitrogen atmosphere. Then, NBS (1.27g, 7.13 mmol) and BPO (0.086 g, 0.36 mmol) were added to the reaction solution after the polymer completely dissolved. The reaction was kept at 80 ^{o}C for 6 h, and then, the solution was cooled to room temperature and poured into 200 mL of methanol solution to get a white fibrous precipitate. The brominated product BPSF (which B refers to brominated polymer) was collected by filtration and dried in vacuo at 70 ^{o}C overnight.

1.3 Fabrication of the DIm-PSF membrane

The typical procedure for the quaternization of BPSF as follows. BPSF (0.5 g) and DMAc (5.0 g) were placed into a 50 mL of round bottom flask to form a 9 wt% solution. After the polymer was dissolved completely at 50 ^{o}C, 1,2-dimethylimidazole (200 mg) was added to the solution and the reaction was kept at 50 ^{o}C overnight. The mixture was casted onto a clean and smooth glass plate at 60 ^{o}C for 24 h to produce the Br^{-} form AEM. Then, the as-prepared

membrane was immersed into a 1M NaOH aqueous at room temperature for 48 h to yield the desired OH^- form of DIm-PSF, in which DIm refers to 1,2-dimethylimidazolium functionalized membranes. The DIm-PSF membranes displayed tough and ductile yellow-colored transparent. The obtained OH^- form membrane was washed with deionized water for several times and kept in deionized water before use. In addition, the procedure for the preparation of imidazolium functionalized membrane was similar with DIm-PSF.

2. Characterization and spectra

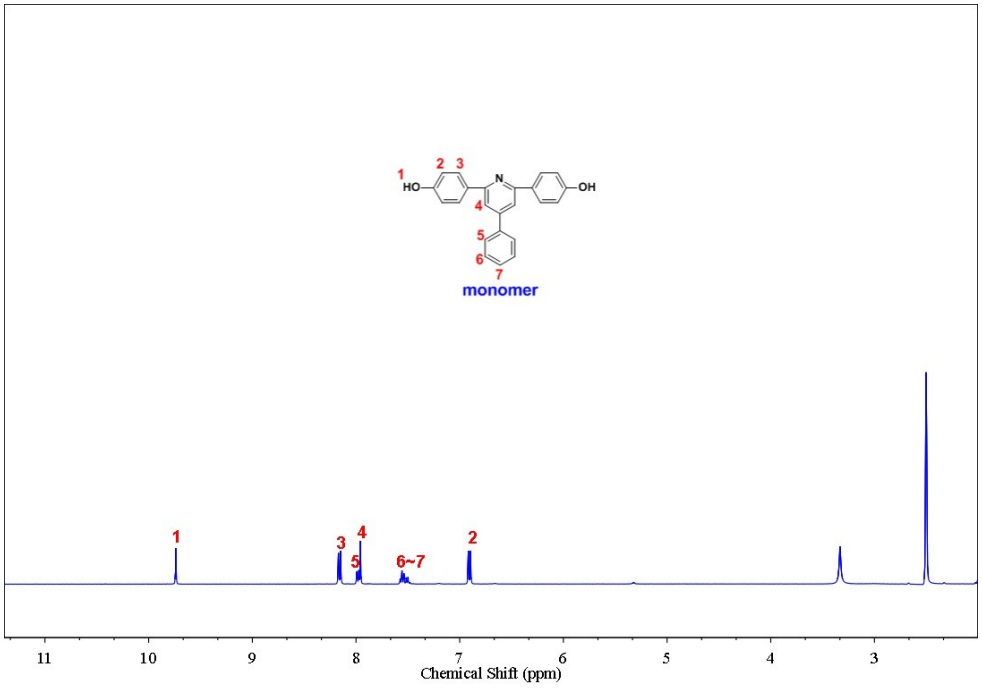


Fig. S1 ^{1}H NMR spectrum of 4-phenyl-2,6-bis(4-hydrophenyl)pyridine (PPY)

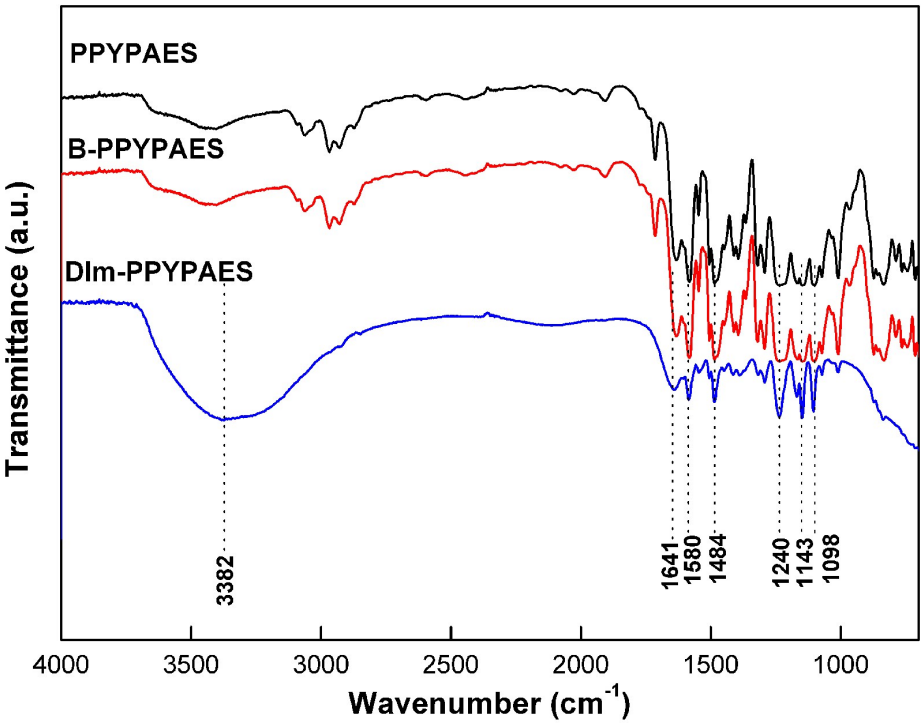


Fig. S2 FT-IR spectra of PPYPAES, B-PPYPAES and DIm-PPYPAES

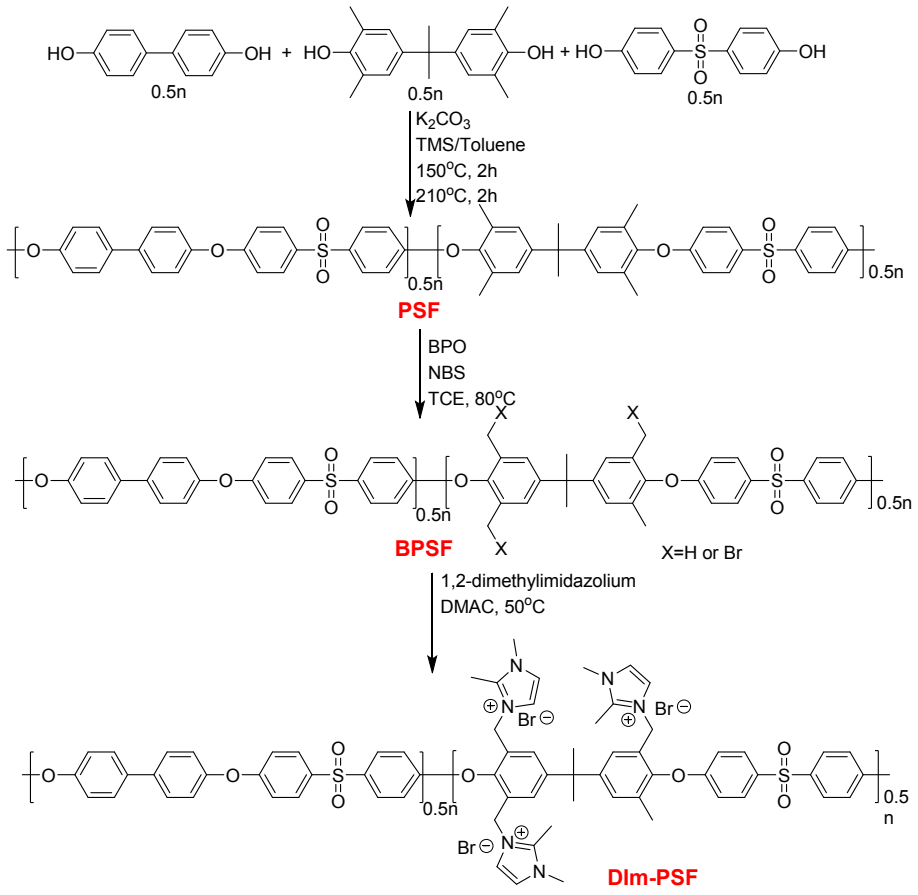


Fig. S3 Synthetic route of the preparation of the DIm-PSF membrane.

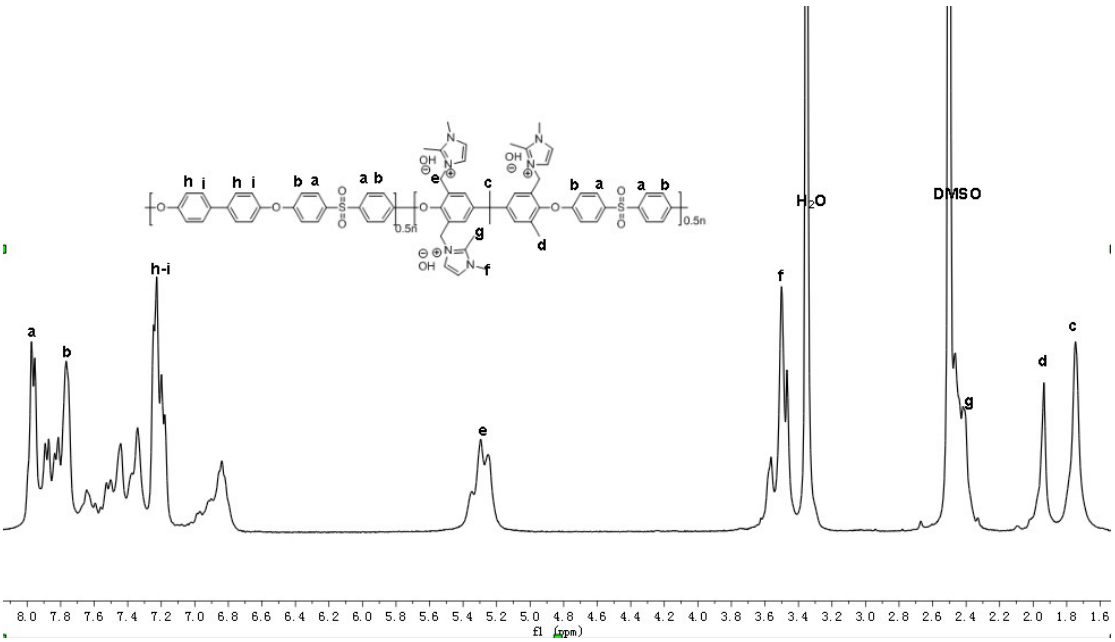
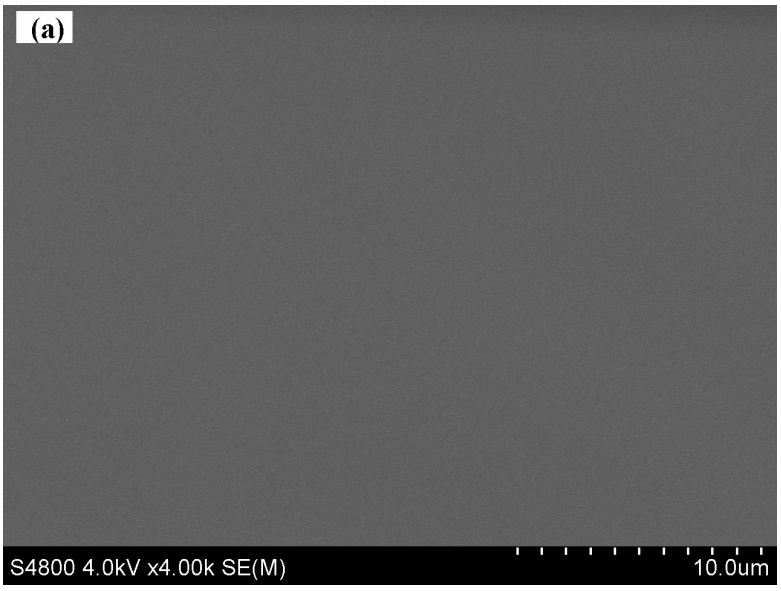


Fig. S4 ^{1}H NMR spectrum of the DIm-PSF membrane



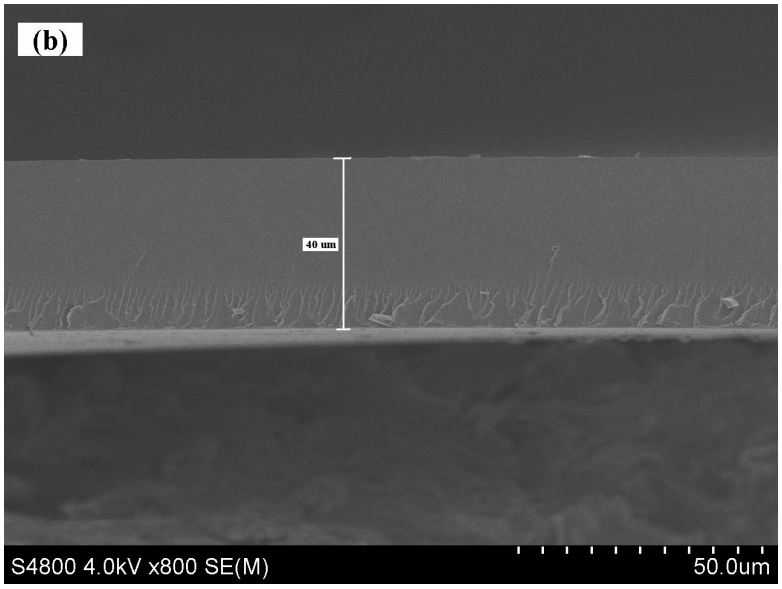


Fig. S5 SEM images (a) surface image and (b) cross-section image of the DIm-PPYPAES-1 membrane

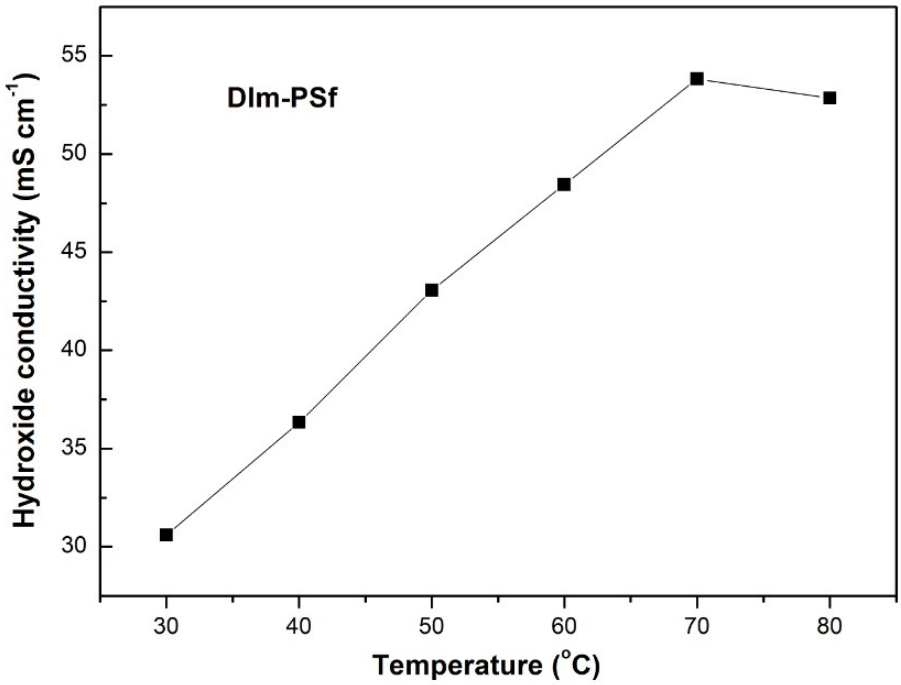
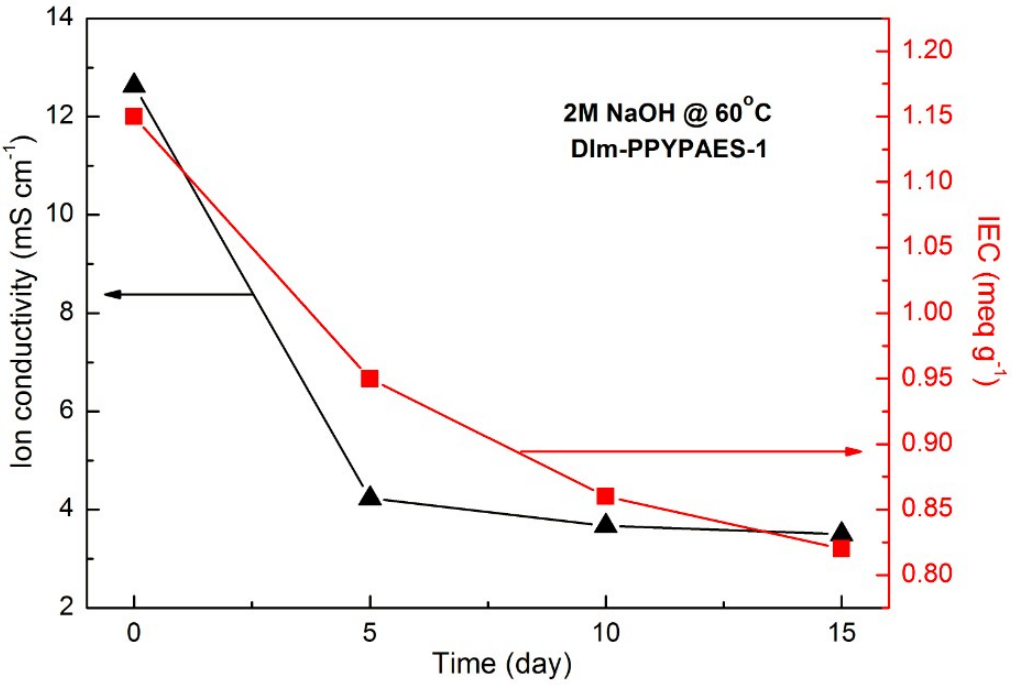
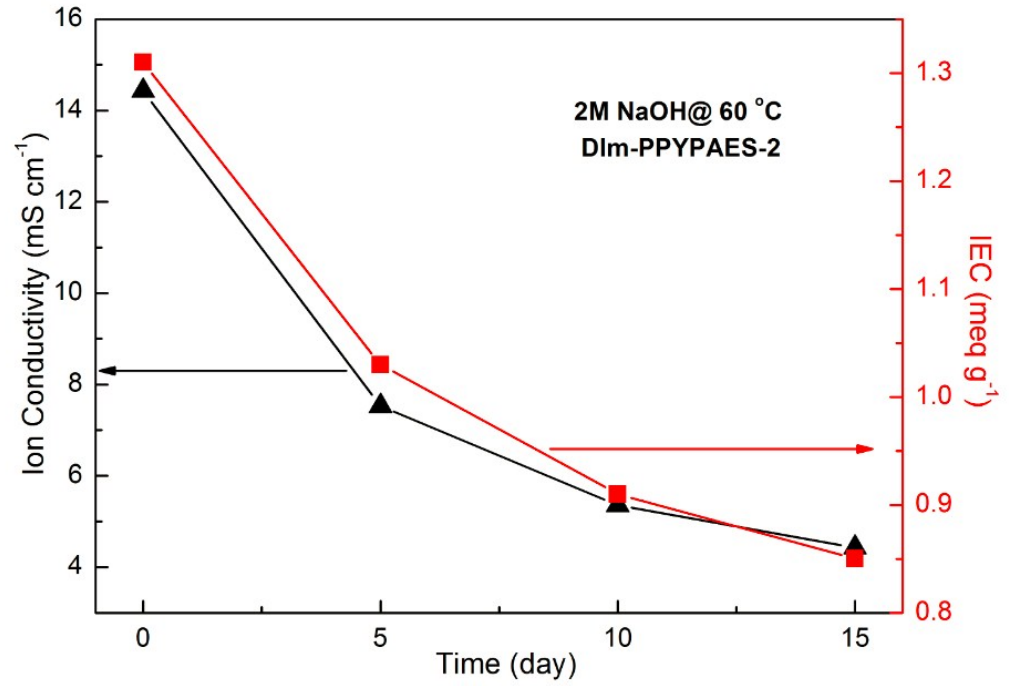


Fig. S6 Temperature dependence of ionic conductivity of the DIm-PSF membrane.


2M NaOH @ 60°C
DIm-PPYPAES-1
Ion conductivity (mS cm-1)
IEC (meq g-1)
Time (day)
14
12
10
8
6
4
2
0
5
10
15
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80


2M NaOH@ 60 °C
DIm-PPYPAES-2
Ion Conductivity (mS cm-1)
IEC (meq g-1)
Time (day)
16
14
12
10
8
6
4
0
5
10
15
1.3
1.2
1.1
1.0
0.9
0.8

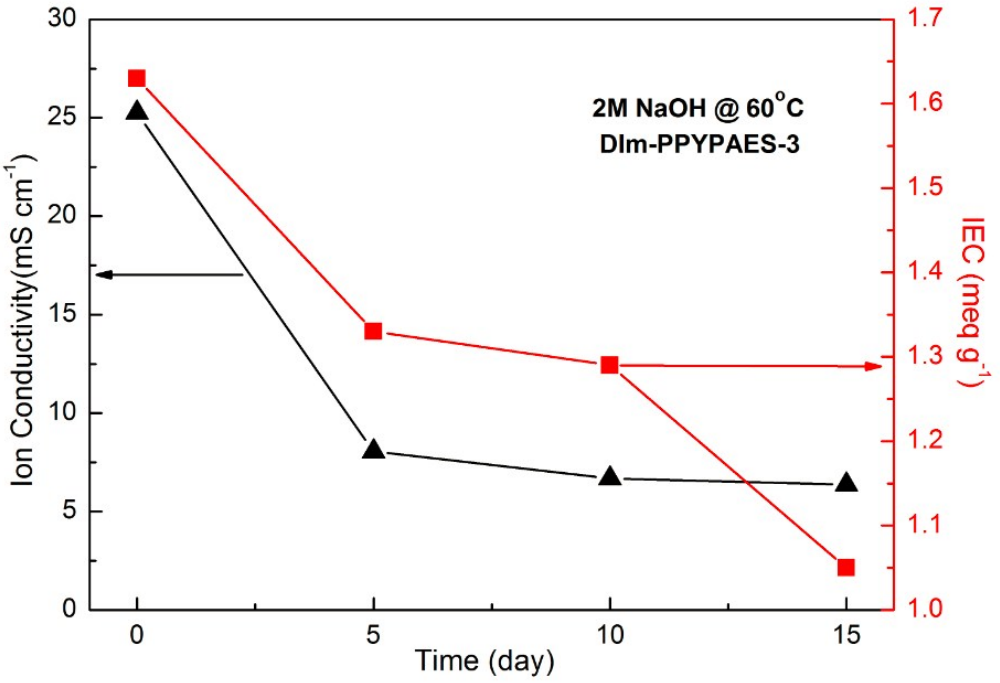


Fig. S7 The changes of hydroxide conductivity and IEC of the DIm-PPYPAES-1/2/3 membranes before and after treatment with 2M NaOH solution at 60 °C.

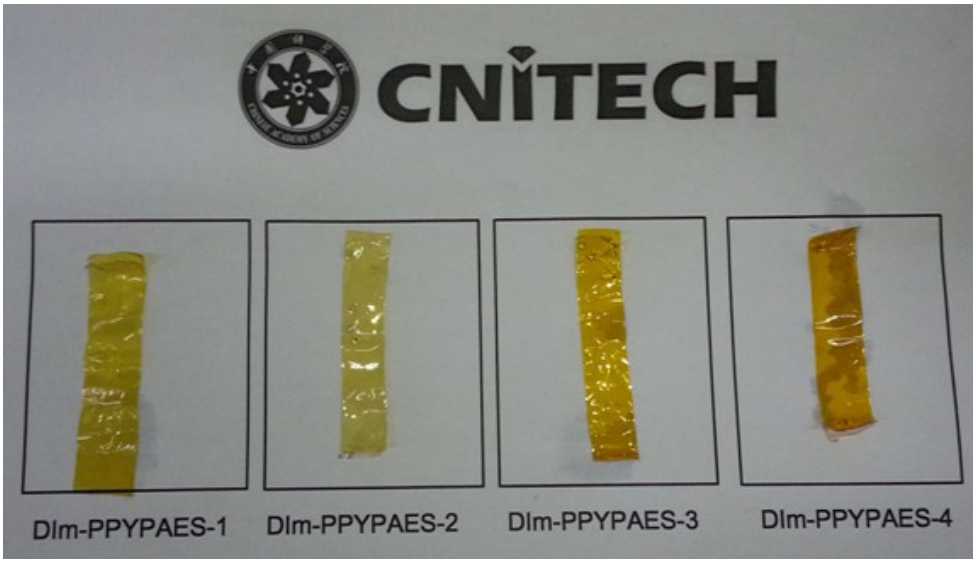


Fig. S8 Photograph of the DIm-PPYPAES membranes after immersion in 2M NaOH aqueous solution at 60 °C for 15 days.