Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

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Adjusting perfluorinated side chain length in dual-grafted anion exchange membranes for high performance fuel cells

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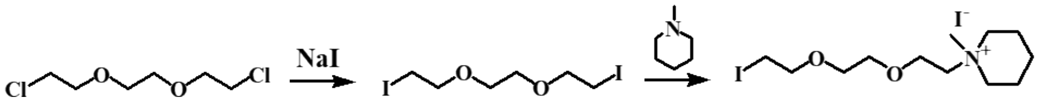
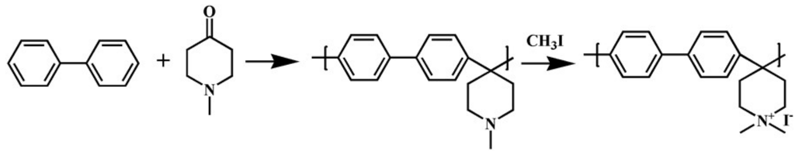
Content

1 Syntheses of I-2O-Pip and PBP.



Scheme S1 Preparation of I-2O-Pip.

For the synthesis of PBP, biphenyl (1.902 g, 10 mmol) and N-methyl-4-piperidone (1.37 mL, 12 mmol) were dissolved in 4 mL dichloromethane; then TFA (1 mL, 13.5 mmol) and TFSA (7.2 mL, 90 mmol) were added dropwise under an ice bath and reacted for 3 h. The viscous polymer solution was precipitated in deionized water, washed to neutral and vacuum dried at 60 ºC to get white solid. Above solid (1 g) was dissolved in 20 mL DMSO, 0.8 mL iodomethane and 0.8 g K_2CO_3 were added, and the mixture was stirred at 40 ºC for 24 h. The solution was then precipitated in ethyl acetate and washed repeatedly with deionized water. The product was vacuum dried at 60 ºC to obtain PBP. The synthetic route is illustrated in **Scheme S2**. A 5 wt.% DMSO solution of PBP was used as fuel cell binder.



Scheme S2 Synthesis of PBP.

2 Chemical structure

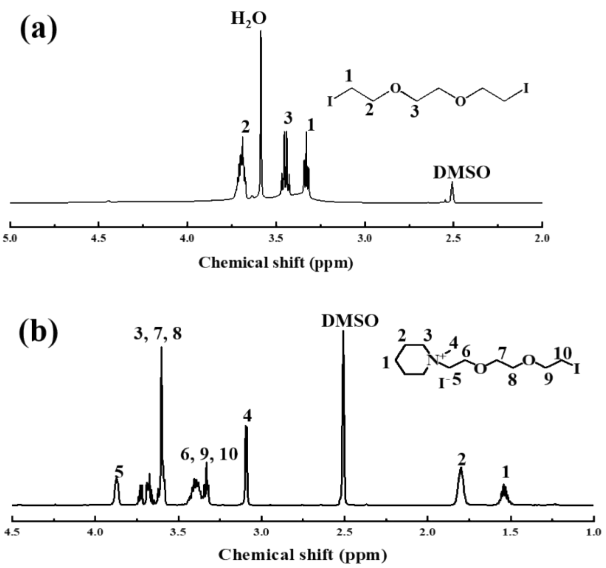


Fig. S1 ^{1}H NMR spectra of (a) I-2O and (b) I-2O-Pip.

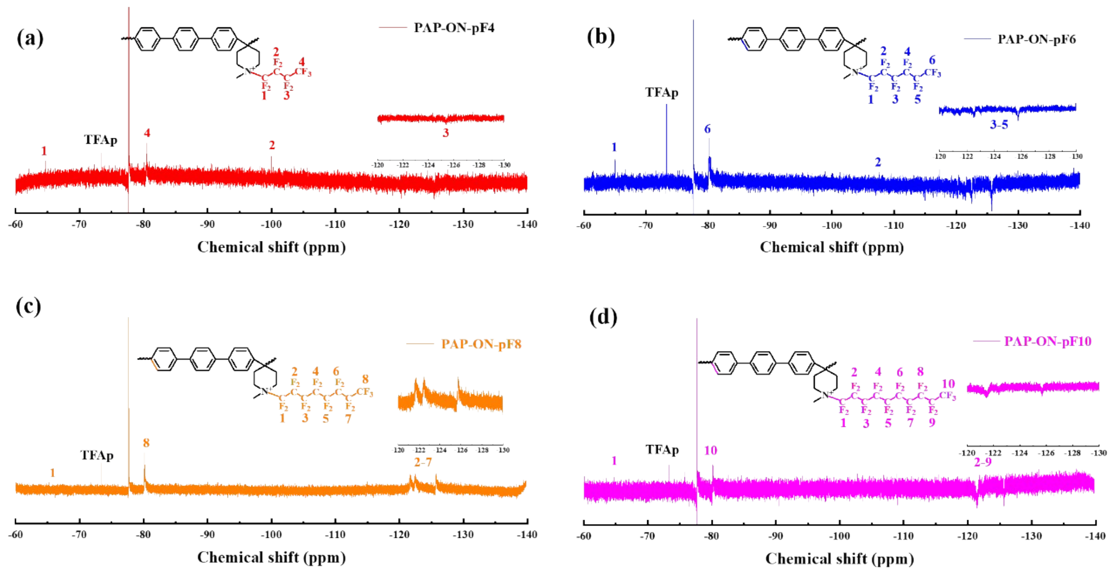


Fig. S2 ^{19}F NMR spectra of PAP-ON-pFx.

3 Thermal stability and mechanical properties

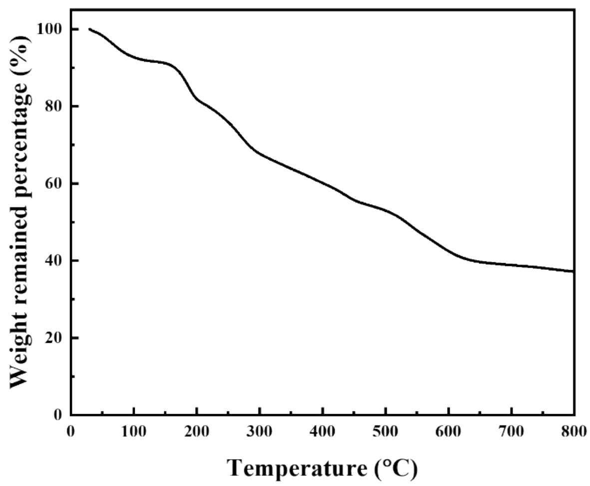


Fig. S3 TGA curve of PAP-ON-pF6 under N_2 atmosphere.

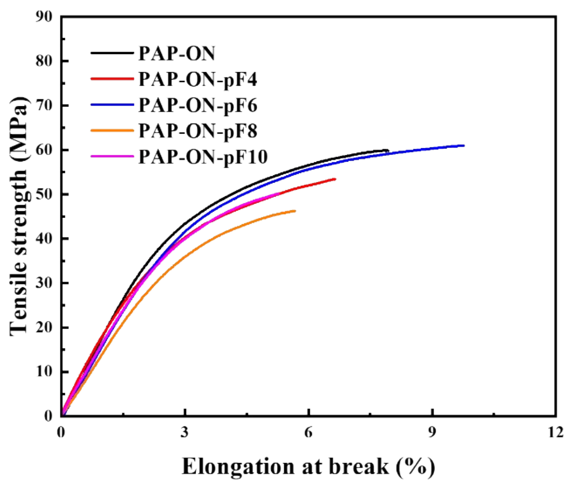


Fig. S4 Stress-strain curves of PAP-ON and PAP-ON-pFx AEMs.

4 Performance of PBP

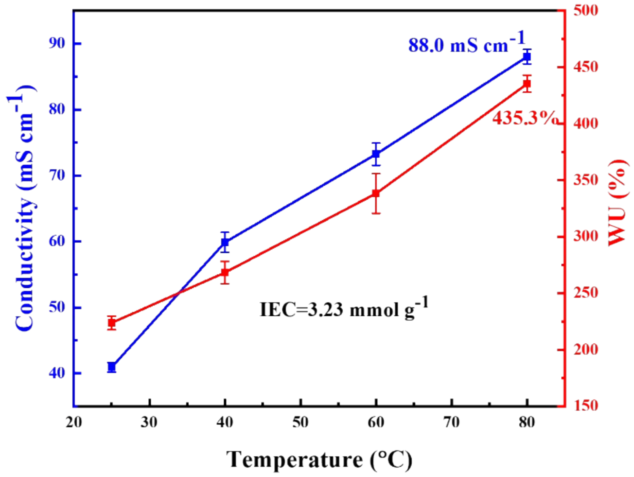


Fig. S5 The conductivity, water uptake (WU) and ion exchange capacity (IEC) of PBP.

5 Performance comparison

Table S1 Comparison of alkali stability between PAP-ON-pF6 and other membranes.

AEMs	Temperature (ºC)	NaOH or KOH concentration (M)	Test time (h)	Conductivity retention (%)	Ref.
PAP-ON-pF6	80	1	1000	95.0	This work
		2		87.0	
		1	1600	90.1	
		2		80.8	
BD_3/50EVOH	70	1	310	>96.0	1
QAPCE-16C	80	1	960	95.8	2
PBPA-6-QA	80	1	1000	97.0	3
s-PDTP-54	80	1	1000	89.2	4
QABP-2	80	1	1000	88.0	5
qPBN-CA_{40}	80	1	1008	90.0	6
x-PFTP-DP-C5-10	80	1	1200	90.0	7
C-IL-100	50	1	1200	97.8	8
PITP-C10Q85	80	1	1200	80.0	9
QPIT-$CE_{0.5}$	80	1	1200	85.0	10
PQP-100	80	1	1334	75.0	11
PDTP-10	80	1	1500	81.0	12

QPEPTpi-35	80	1	2000	85.0	13
P(VCP$_{10}$-TP$_{90}$)	80	1	5000	93.8	14
PHPFP-QA	80	2	720	83.0	15
Tec-PBI-50	60	2	672	78.0	16
BOC-DMI	80	2	1080	82.3	17
QABNP	80	2	1080	90.0	18

Table S2 Comparison between PAP-ON-pF6 and recently reported AEMs in terms of IEC, conductivity (σ), normalized conductivity (σ/IEC) and fuel cell performance.

AEMs	IEC (mmol g^{-1})	Conductivity (σ) at 80 ºC (mS cm^{-1})	σ/IEC	PPD (mW cm^{-2})	Fuel cell durability			Ref.
					Current density (mA cm^{-2})	Temperature (ºC)	Time (h)	
PAP-ON-pF6	2.17	134.2	61.8	1066	200	60	140	This work
QPEPTpi-35	2.91	140	48.1	1200	200	60	20	13
TPTP-Pip-OH-20%	2.71	143.2	52.8	405	200	60	32	19
PBP-6-Pip	3.78	117.1	31.0	307	200	60	40	20
PQP-100	2.3	118.7	51.6	496	200	60	85	11
PB2Pip-5C8F	2.42	168.5	69.6	718	100	80	70	21
O-PDQA-3	1.97	106	53.8	1180	400	70	16	22
PDTP-10	2.57	110	42.8	621	300	60	18	12
PPTDF-QA-2.5	2.78	161.5	58.1	778	200	80	60	23
QABNP	2.6	135.3	52.0	1160	400	60	30	18
QBNTP-MP11	2.85	145	50.9	1410	200	80	100	24
40%-PPT-c-PmpP	2.19	148.6	67.9	1210	400	60	110	25
PTF6-QAPTP	2.54	142.7	56.2	849	300	80	80	26
OHPTP-10TBB	2.01	136	67.7	639	300	60	26	27
P(4PA-co2PA)-47	2.07	87	42.0	400	200	50	100	28
BOC-TMA	2.21	151.3	68.5	546	100	60	110	17
qPBN-CA40	1.81	122	67.4	603	200	60	30	6
Cr-QPPV-2.51	2.51	135.5	54.0	1270	400	60	100	29

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