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

Electronic supplementary information (ESI)

ETFE-based anion-exchange membrane ionomer powders for alkaline membrane fuel cells: a first performance comparison of head-group chemistry

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This document provides additional data in support of the main article.

IEC = 1.84 ± 0.01 mmol g^{-1} IEC = 1.82 ± 0.02 mmol g^{-1} IEC = 1.78 ± 0.02 mmol g^{-1} IEC = 1.86 ± 0.04 mmol g^{-1}

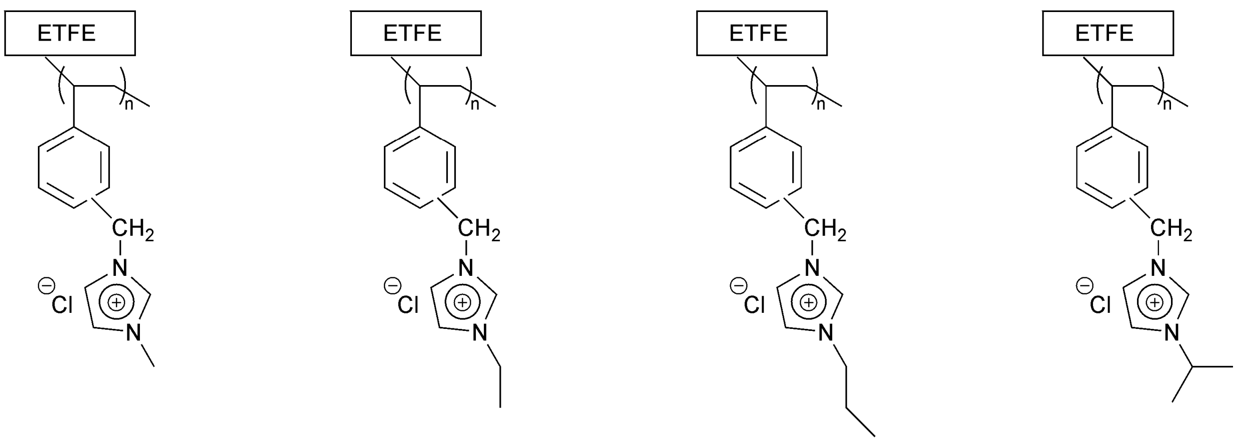


Fig. S1 A series of imidazolium-type anion-exchange membranes (AEM) that were synthesised from the same batch of radiation-grafted VBC-grafted ETFE that was then reacted with a variety of imidazole amination reagents (1-methylimidazole, 1-ethylimidazole, 1-propylimidazole, 1-isopropylimidazole, respectively). All of these AEMs exhibited a Cl^- anion conductivity ($\sigma_{Cl,hydrated}$, 4-probe, in water, room temperature) of 18 mS cm^{-1}. This data is included to demonstrate the lab-scale advantage of using the radiation-grafted technique, where AEMs with different cationic (anion-exchange group) chemistries can be synthesised with similar ion-exchange capacities (IEC) and conductivities.

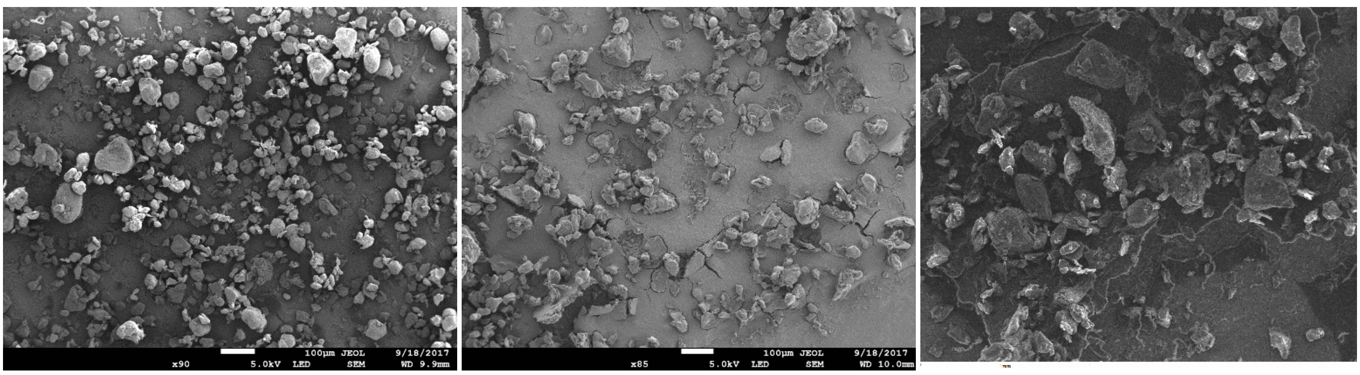


Fig. S2 (left to right) SEM micrographs of **AEI(TMA)** at ×90, **AEI(MPY)** at ×85, and **AEI(MPRD)** at ×90 magnification. Image manipulation involved contrast level adjustment only for visual clarity. Note the **AEI(MPRD)**-containing electrode was studied using a Hitachi S-3200N SEM instrument.

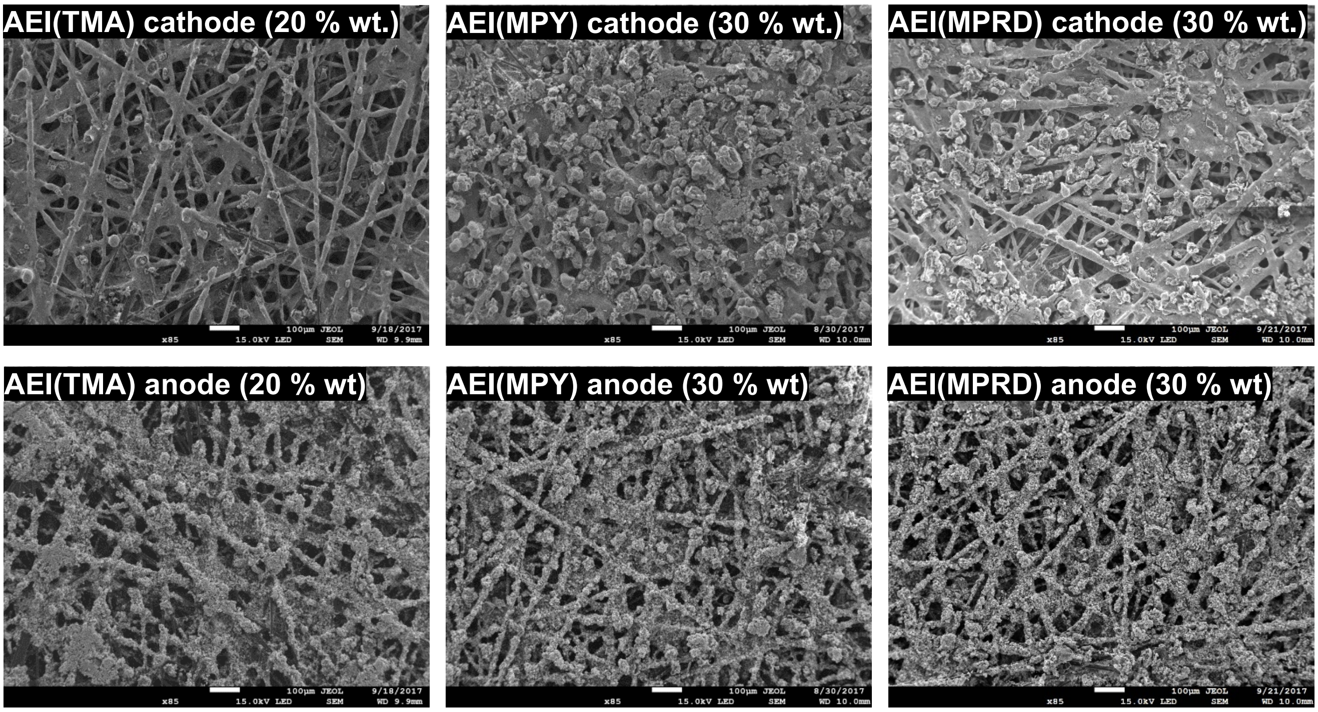
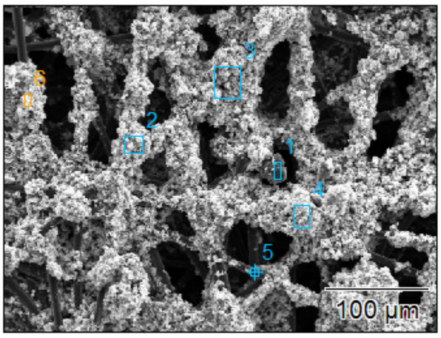
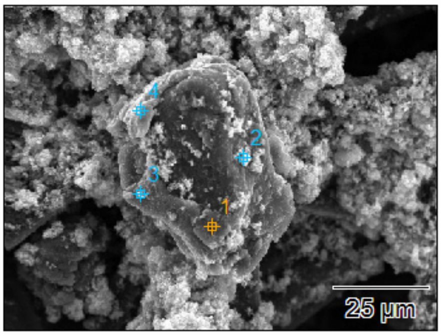


Fig. S3 SEM micrographs (×85 magnification) of exemplar PtRu/C anodes and Pt/C cathodes containing the different powder AEIs.



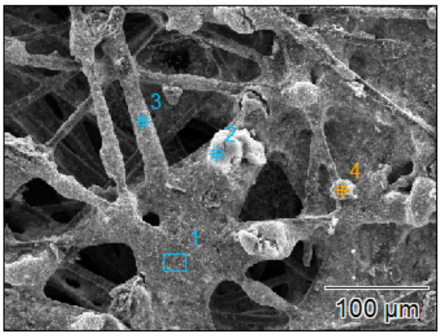
Area	C (%)	F (%)	Ru (%)	Pt (%)
1	35.3	44.7	3.3	6.5
2	4.0	0.0	29.9	61.8
3	4.7	0.1	29.0	63.1
4	4.6	0.0	31.2	61.2
5	60.5	0.2	1.6	3.5
6	10.4	0.1	29.9	55.7

Fig. S4 EDX analysis of sample points of a **AEI(TMA)**-containing PtRu/C anode. Other elements (*e.g.* N, O, Cl) were also analysed (not shown in the table). All percentages are % wt.



Area	C (%)	F (%)	Ru (%)	Pt (%)
1	69.2	7.7	-	2.4
2	9.3	1.2	37.8	51.6
3	4.4	2.3	44.8	46.7
4	72.4	7.9	-	-

Fig. S5 EDX analysis of sample points of a **AEI(MPY)**-containing PtRu/C anode. Other elements (*e.g.* N, O, Cl) were also analysed (not shown in the table). All percentages are % wt.



Area	C (%)	F (%)	Pt (%)
1	27.1	0.3	67.2
2	36.5	0.1	58.9
3	29.9	0.1	64.7
4	27.9	0.0	64.6

Fig. S6 EDX analysis of sample points of a **AEI(MPY)**-containing Pt/C cathode. Other elements (*e.g.* N, O, Cl) were also analysed (not shown in the table). This data suggests a more uniform coverage of the Pt/C catalyst (compared to the PtRu/C anodes analysed in Figs. S4 and S5 above). All percentages are % wt.

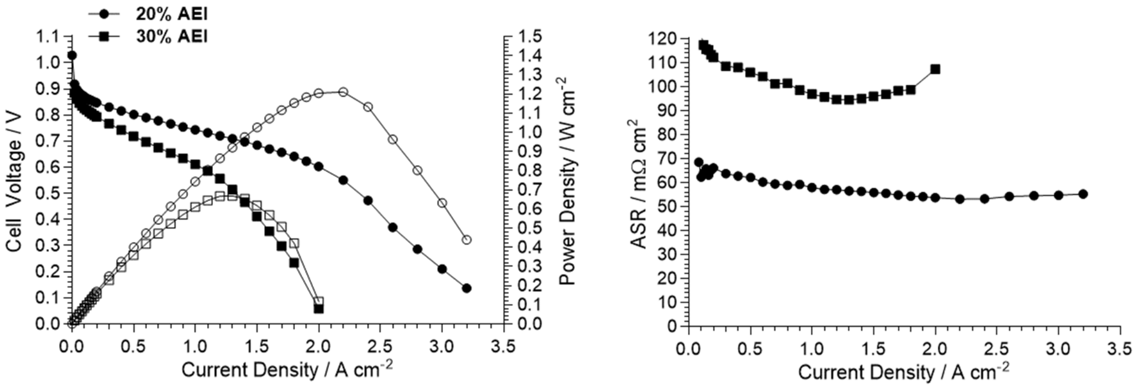


Fig. S7 AEMFC fuel cell performances at 60 °C (H_2 anode gas and O_2 cathode gas, both supplied unpressurised with dewpoint temperatures of 60 °C) with **AEI(TMA)/AEM(TMA)/AEI(TMA)**-based MEAs containing either 20 or 30 % wt. AEI loadings. PtRu/C anodes and Pt/C cathodes were used (with 0.40 ± 0.03 mg cm^{-2} Pt loadings). These two specific AEI loadings were selected in response to anecdotal evidence collected over a number of initial [unpublished] experiments.

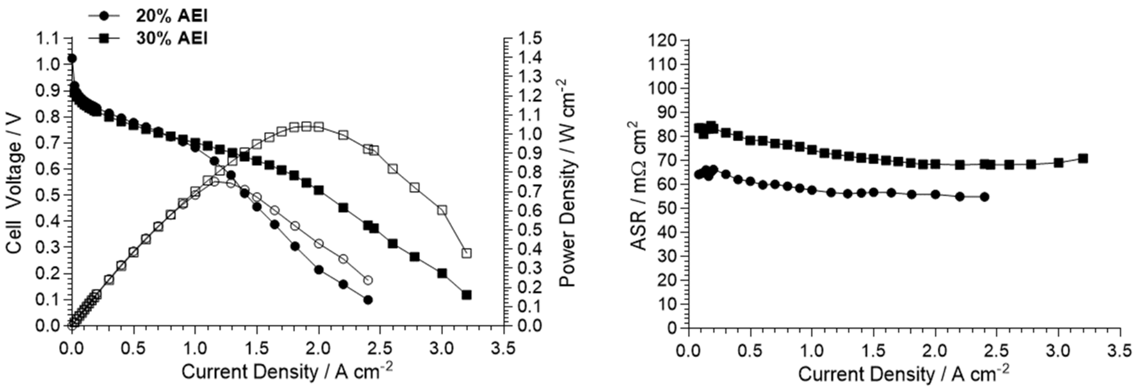


Fig. S8 AEMFC fuel cell performances at 60 °C (H_2 anode gas and O_2 cathode gas, both supplied unpressurised with dewpoint temperatures of 60 °C) with **AEI(MPY)/AEM(TMA)/AEI(MPY)**-based MEAs containing either 20 or 30 % wt. AEI loadings. PtRu/C anodes and Pt/C cathodes were used (with 0.40 ± 0.03 mg cm^{-2} Pt loadings).

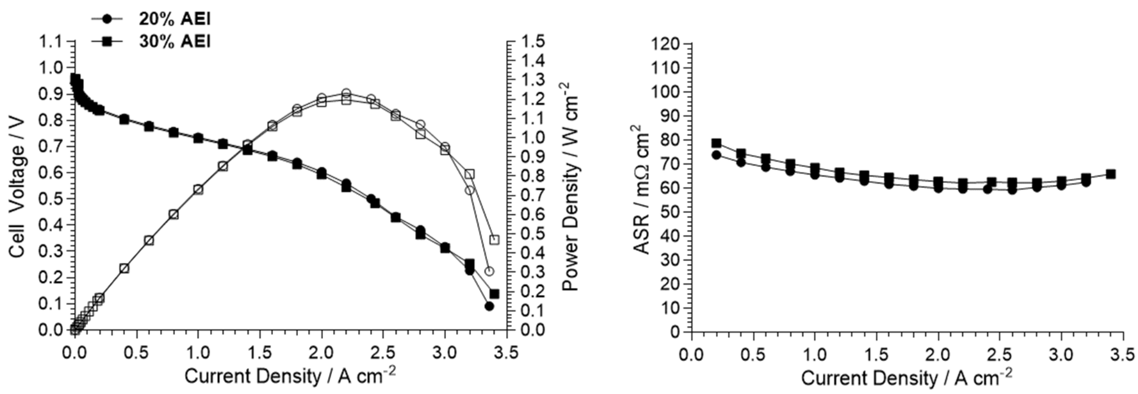


Fig. S9 AEMFC fuel cell performances at 60 °C (H_2 anode gas and O_2 cathode gas, both supplied unpressurised with dewpoint temperatures of 60 °C) with **AEI(MPRD)**/**AEM(TMA)**/**AEI(MPRD)**-based MEAs containing either 20 or 30 % wt. AEI loadings. PtRu/C anodes and Pt/C cathodes were used (with 0.40 ± 0.03 mg cm^{-2} Pt loadings).