Supplementary information

Multi-block copolymers with fluorene-containing hydrophilic segments densely functionalized by side-chain quaternary ammonium groups as anion exchange membranes

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I. Figures and tables

II. Experimental section

I. Figures and tables

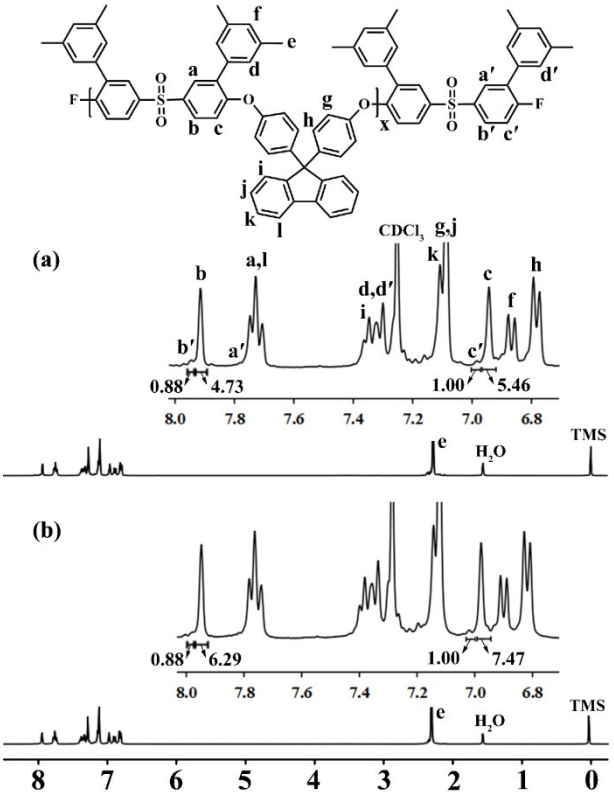
Fig. S1 ^{1}H NMR spectra of the oligomer-Fs (a) X = 5 and (b) X = 7.

Fig. S2 ^{1}H NMR spectra of oligomer-OHs (a) Y = 10, (b) Y = 13 and (c) Y = 17.

Fig. S3 ^{1}H NMR spectra of (a) BrMPAES-X5Y10, (b) BrMPAES-X5Y13, (c) BrMPAES-X5Y17, (d) BrMPAES-X7Y10, (e) BrMPAES-X7Y13 and (f) BrMPAES-X7Y17.

Fig. S4 AFM pattern of QMPAES-X5Y10

Table S1 IEC_m, $IECv_{wet}$, σ, σ/IEC_m, $\sigma/IECv_{wet}$ of the QMPAESs membranes and some reported AEMs.



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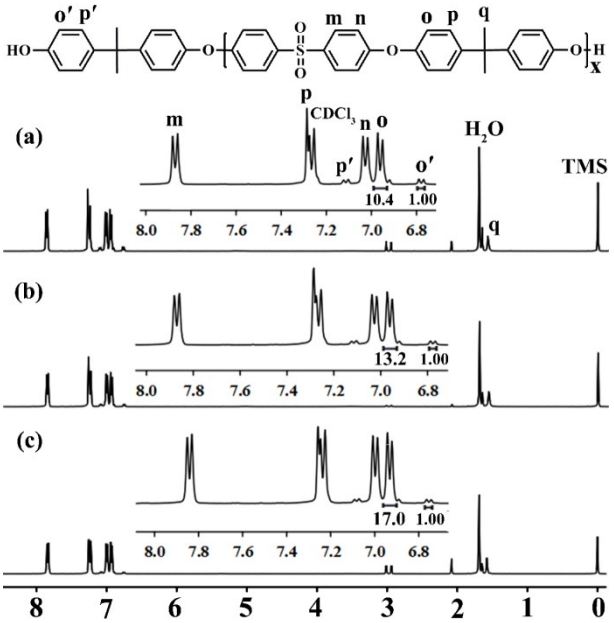

Fig. S2 ^{1}H NMR spectra of oligomer-OHs (a) Y = 10, (b) Y = 13 and (c) Y = 17.

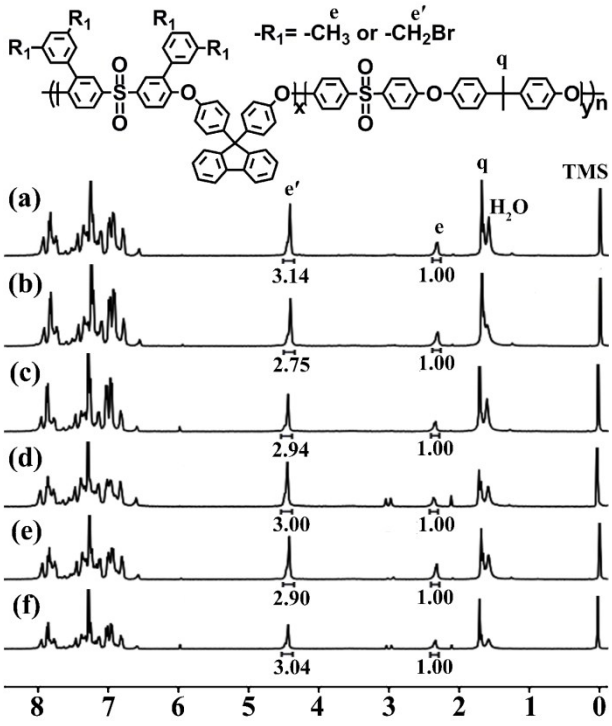

Fig. S3 ^{1}H NMR spectra of (a) BrMPAES-X5Y10, (b) BrMPAES-X5Y13, (c) BrMPAES-X5Y17, (d) BrMPAES-X7Y10, (e) BrMPAES-X7Y13 and (f) BrMPAES-X7Y17.

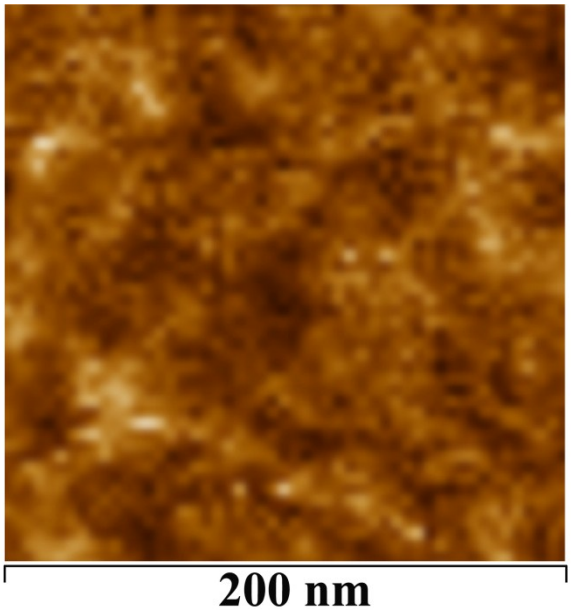

Fig. S4 AFM pattern of QMPAES-X5Y10

Table S1 IEC_m, $IECv_{wet}$, σ, $σ/IEC_m$, $σ/IECv_{wet}$ of the QMPAESs membranes and some reported AEMs

Membrane	IEC_m (meq g^{-1})	$IECv_{wet}$ (meq cm^{-3})		σ (mS cm^{-1})		$σ/IEC_m$ (mS g/(cm mmol))		$σ/IECv_{wet}$ (mS cm^2/mmol)	
		30 °C	80 °C	30 °C	80 °C	30 °C	80 °C	30 °C	80 °C
QMPAES-X7Y10	1.28	0.52	0.51	27.4	85.0	21.4	66.4	52.7	166.7
QMPAES-X7Y13	1.02	0.70	0.64	27.2	51.9	26.7	50.9	38.9	81.1
QMPAES-X7Y17	0.90	0.72	0.68	11.6	38.7	12.9	43.0	16.1	56.9
QMPAES-X5Y10	1.06	0.78	0.74	21.4	58.0	20.2	54.7	27.4	78.4
QMPAES-X5Y13	0.83	0.56	0.56	16.5	44.1	19.9	53.1	29.5	78.8
QMPAES-X5Y17	0.81	0.64	0.61	9.7	23.0	12.0	28.4	15.2	37.7
QPAES-X8Y8[1]	1.60	1.12[a]	1.05	18.3[a]	75.8	11.4[a]	47.4	16.3[a]	72.2
QPAES-X16Y8[1]	1.24	0.62[a]	0.56	26.1[a]	51.5	21.0[a]	41.5	42.1[a]	92.0
QPAES-X16Y10[1]	1.15	0.85[a]	0.77	11.8[a]	37.8	10.3[a]	32.9	13.9[a]	49.1
	1.45	0.96[a]	0.84	15.4[a]	54.5	10.6[a]	37.6	16.0[a]	64.9
QPAES-X20Y18[1]	1.54	0.98[a]	0.87	13.3[a]	64.1	8.6[a]	41.6	13.6[a]	73.7
QPAE-X15Y8[2]	1.13	0.90[a]	0.77[c]	9.8[a]	27.6[c]	8.7[a]	24.4[c]	10.9[a]	35.8[c]
QPAE-X25Y21[2]	1.45	1.07[a]	0.86[c]	16.9[a]	37.3[c]	11.7[a]	25.7[c]	15.8[a]	43.4[c]
QPE-X16Y11[3]	0.79	—[d]	—[d]	—[d]	8.8[c]	—[d]	11.1[c]	—[d]	—[d]
	1.13	—[d]	—[d]	—[d]	47.0[c]	—[d]	41.6[c]	—[d]	—[d]
	1.38	—[d]	—[d]	—[d]	52.0[c]	—[d]	37.7[c]	—[d]	—[d]
QPE-X22Y11[3]	0.86	—[d]	—[d]	—[d]	25.0[c]	—[d]	29.1[c]	—[d]	—[d]
ds-PAES-75[4]	1.49	1.27[b]	1.03	21.9[b]	47.3	14.7[b]	31.7	17.2[b]	45.9
4(X35)[5]	1.01	1.14[a]	—[d]	15[a]	24.6	14.9[a]	24.4	13.2[a]	—[d]
4(X50)[5]	1.32	1.40[a]	—[d]	26[a]	40.0	19.7[a]	30.3	18.6[a]	—[d]
ImPES-0.55[6]	0.98	1.29	—[d]	21.9	51.7	22.3	52.8	17.0	—[d]
ImPES-0.70[6]	1.23	1.48	—[d]	32.6	69.2	26.5	56.3	22.0	—[d]
PAES-Q-12[7]	1.65	—[d]	—[d]	22.9[a]	54.0	13.9[a]	32.7	—[d]	—[d]
QA-PSf-g-PEG350[8]	1.36	—[d]	—[d]	24.9[a]	70.2	18.3[a]	51.6	—[d]	—[d]

[a] Determined at 20 °C. [b] Determined at 25 °C. [c] Determined at 60 °C. [d] Not reported in the literature.

II. Experimental section

^{1}H NMR characterization.

^{1}H NMR spectras were recorded on a Bruker AVANCE 400S with tetramethylsilane (TMS) as the standard and $CDCl_3$ or DMSO-d_6 as the solvent.

Atomic Force Microscopy (AFM) characterization.

Tapping mode Atomic Force Microscopy (AFM) was performanced on a Bruker Multimode 8 scanning probe microscopy with a probe of MPP-11100-10 (40 N/m, 300 kHz). The scanning frequency is 1 Hz. The sample was equilibrated at 60% RH for more than 24 h before test.

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