Supplementary information

High conductive fluorine-based anion exchange membranes with robust alkaline durability

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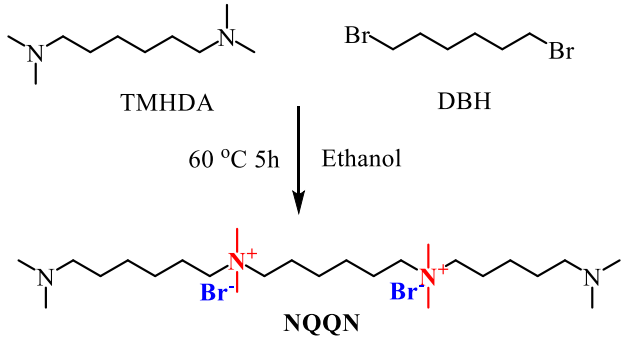
1. Synthesis of the ionic liquid1,18-(N′, N′-dimethylamino)-6,12-(N, N-dimethylammonium) octodecane bromine (NQQN)

The synthesis of NQQN is shown in Scheme S1[1]. Typically, 1.26 mL of 1,6-dibromohexane was dissolved in ethanol to form a 2% v/v solution. 15 mL of N, N, N, N-tetramethyl-1,6-hexanediamine (TMHDA) was added into a 150 mL three-necked round-bottomed flask with a magnetic stirrer. Then the 1,6-dibromohexane solution was added dropwise into the flask under stirring. The mixture was heated to 60 °C and stirred for 5 h. After that, the mixture was cooled to room temperature (RT) and transferred into 400 mL of anhydrous ether to precipitate a white powder solid. After being cooled at −18 °C for 12 h, a white precipitate was obtained via vacuum filtration. The crude product was purified with anhydrous ether for three times, followed by vacuum drying at RT for 24 h (yield 58.6%).



Scheme S1 Synthesis of the NQQN

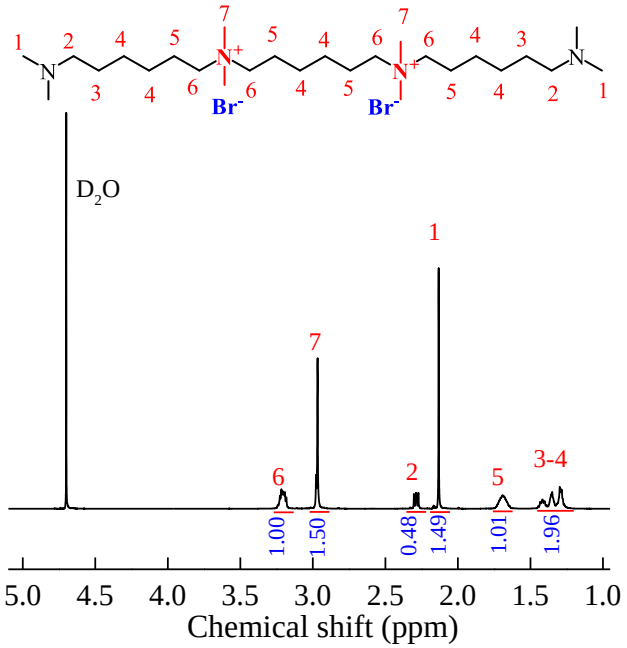


Fig. S1 ^{1}H NMR of the NQQN

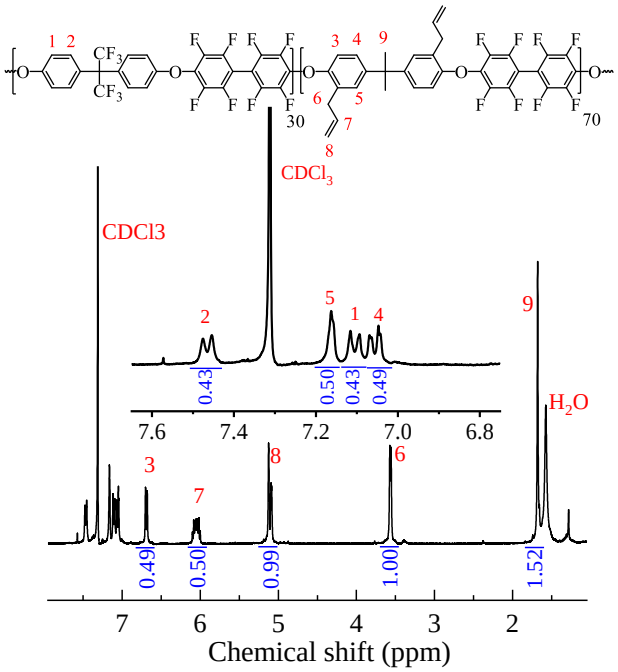


Fig. S2 ^{1}H NMR of PDBA-70%

Table S1 Molecular weight, polydispersity index (Mw/Mn) of the PDBA-X polymers

Polymers	Mn(kDa)	Mw(kDa)	Mw/Mn
PDBA-30%	75009	262147	3.49
PDBA-40%	74370	254746	3.43
PDBA-60%	63539	223180	3.51
PDBA-70%	48880	158152	3.24

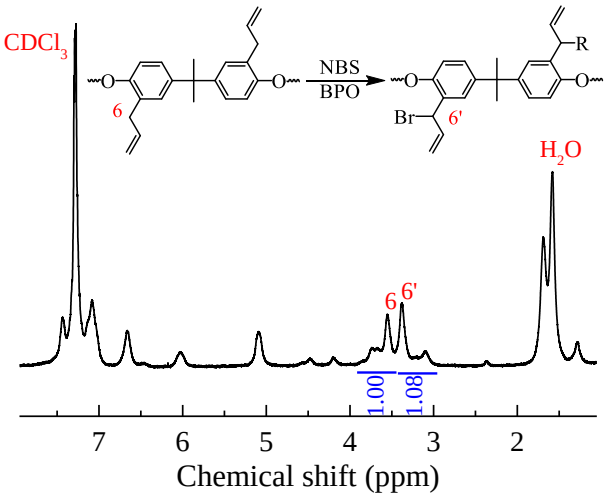


Fig. S3 ^{1}H NMR of Br-PDBA-70%

Table S2 Solubility, gel fraction (GF) and degree of bromination (DB) data of the polymers and AEMs

Sample	DMSO	DMF	THF	NMP	DMAC	$CHCl_3$	GF	DB
PDBA-X	+	+	+	+	+	+		
Br-PDBA-X	+	+	+	+	+	+		
TQ- PDBA -30%	-	-	-	-	-	-	85.9%	55.36%
TQ- PDBA -40%	-	-	-	-	-	-	89.3%	67.11%
TQ- PDBA -60%	-	-	-	-	-	-	93.2%	58.51%
TQ- PDBA -70%	-	-	-	-	-	-	96.8%	61.83%

+: soluble, -: insoluble

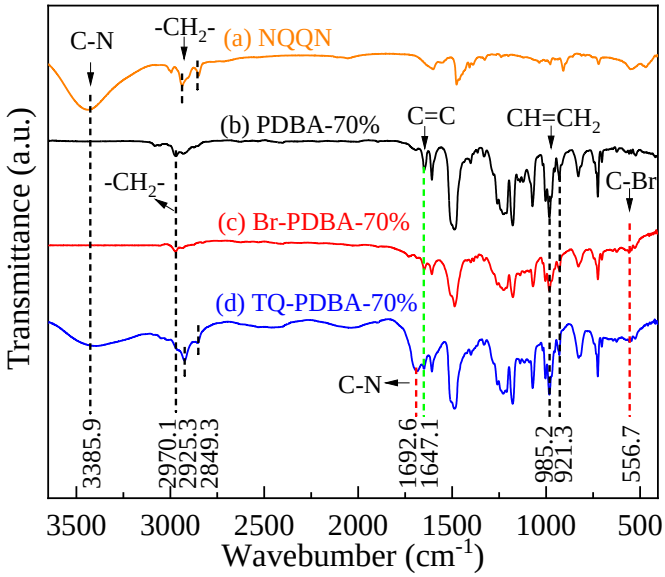


Fig.S4 FT-IR of the NQQN, PDBA-70%, Br-PDBA-70% polymers and TQ-PDBA-70% AEM

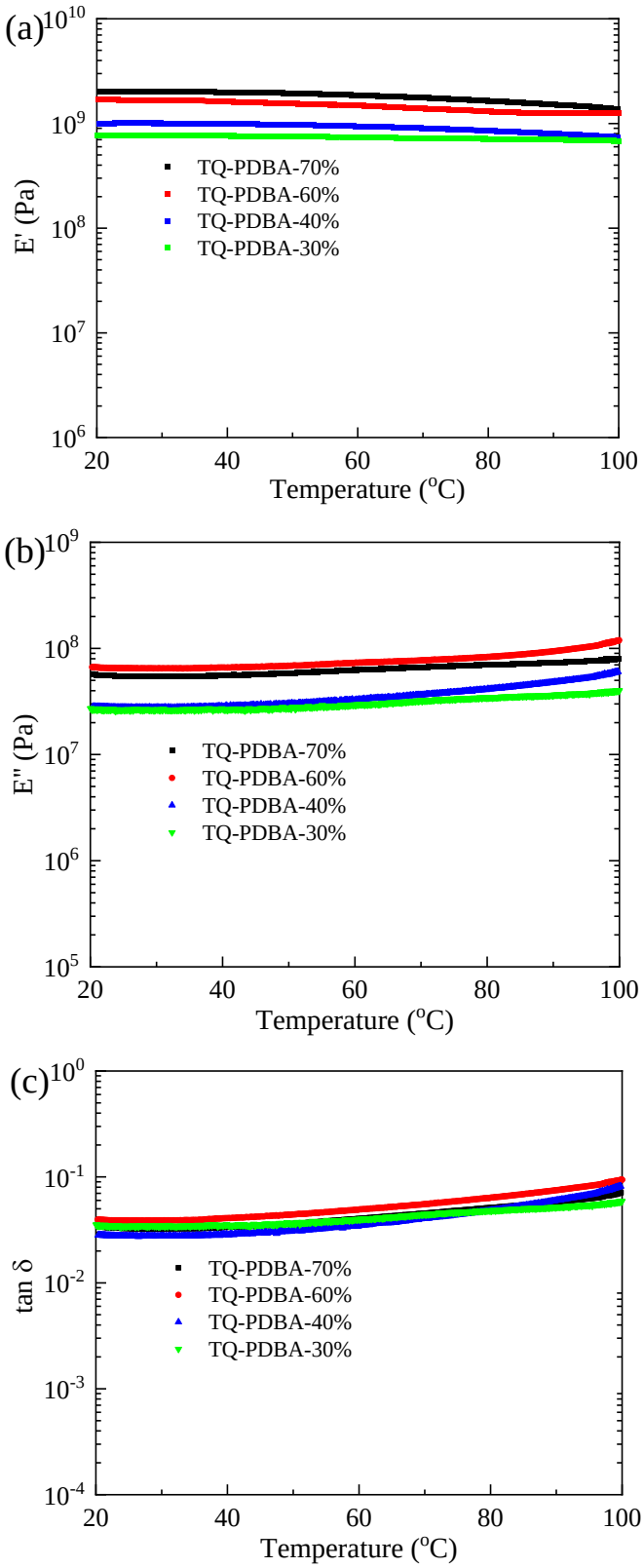


Fig.S5 DMA curves of the TQ-PDBA-X AEMs as a function of temperature at 60% RH ((a) storage modulus (E'), (b) loss modulus (E'') and (c) tan δ (δ= E'/ E''))

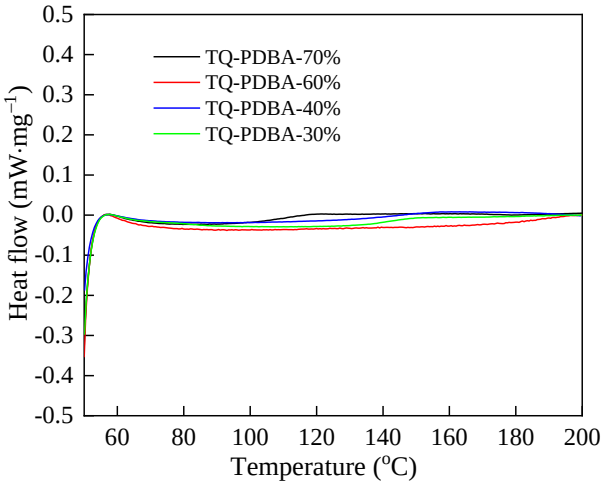
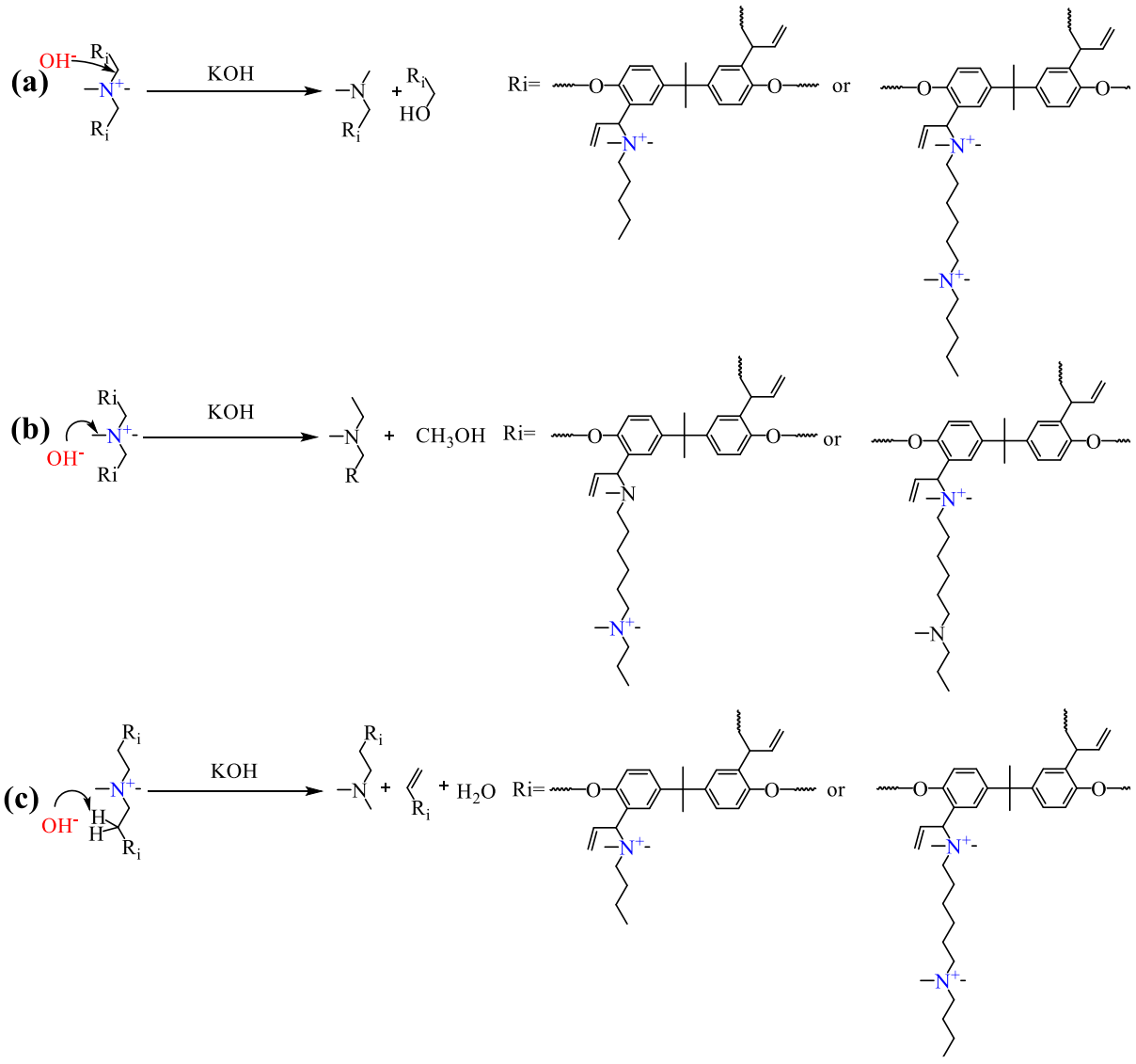


Fig.S6 DSC curves of the TQ-PDBA-X AEMs as a function of temperature



Scheme S2 Possible degradation mechanism of QA groups in the TQ-PDBA-70% AEM after alkaline treatment (a-b) nucleophilic substitution, and (c) Hofmann elimination

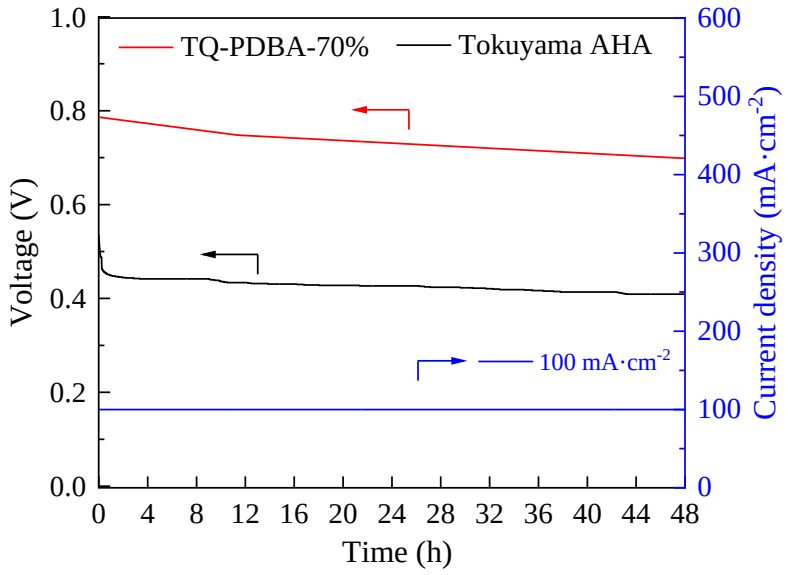


Fig.S7 Durability test of the single cell assembled with the TQ-PDBA-70% and commercial Tokuyama AHA AEM

Reference

1. Han, J., et al., Elastic long-chain multication crosslinked anion exchange membranes. *Macromolecules*, 2017, **50**(8):3323-3332.