Electronic Supplementary Material

Cross-linked sulfonated poly(ether ether ketone) electrolytes bearing pendent imidazole groups for high temperature proton exchange membrane fuel cells

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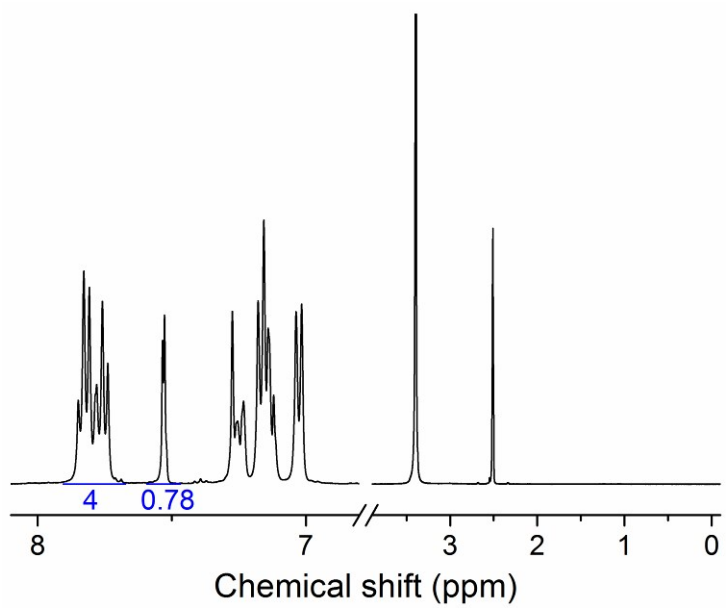


Figure S1. ^{1}HNMR spectra of SPEEK78.

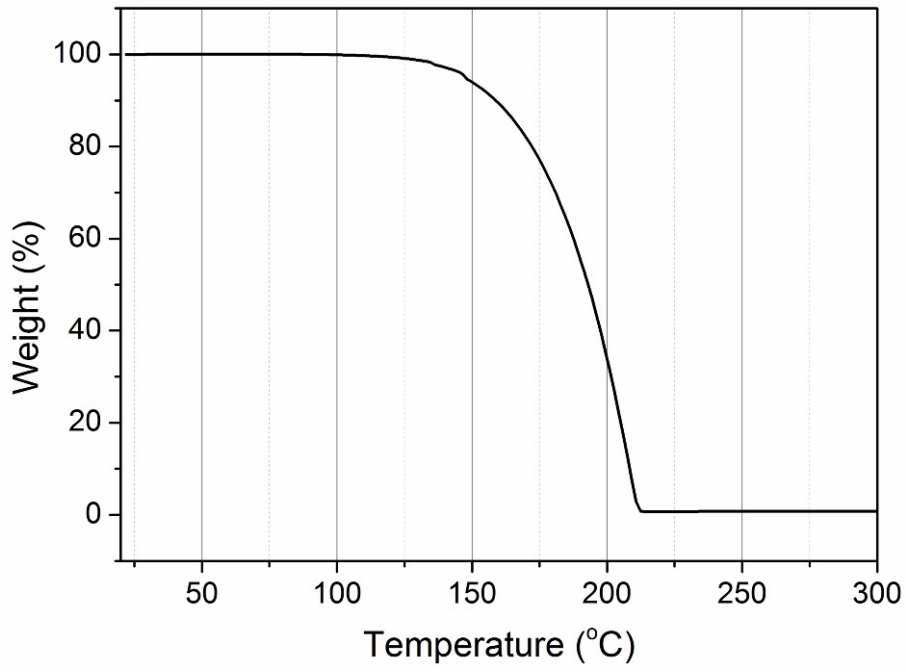
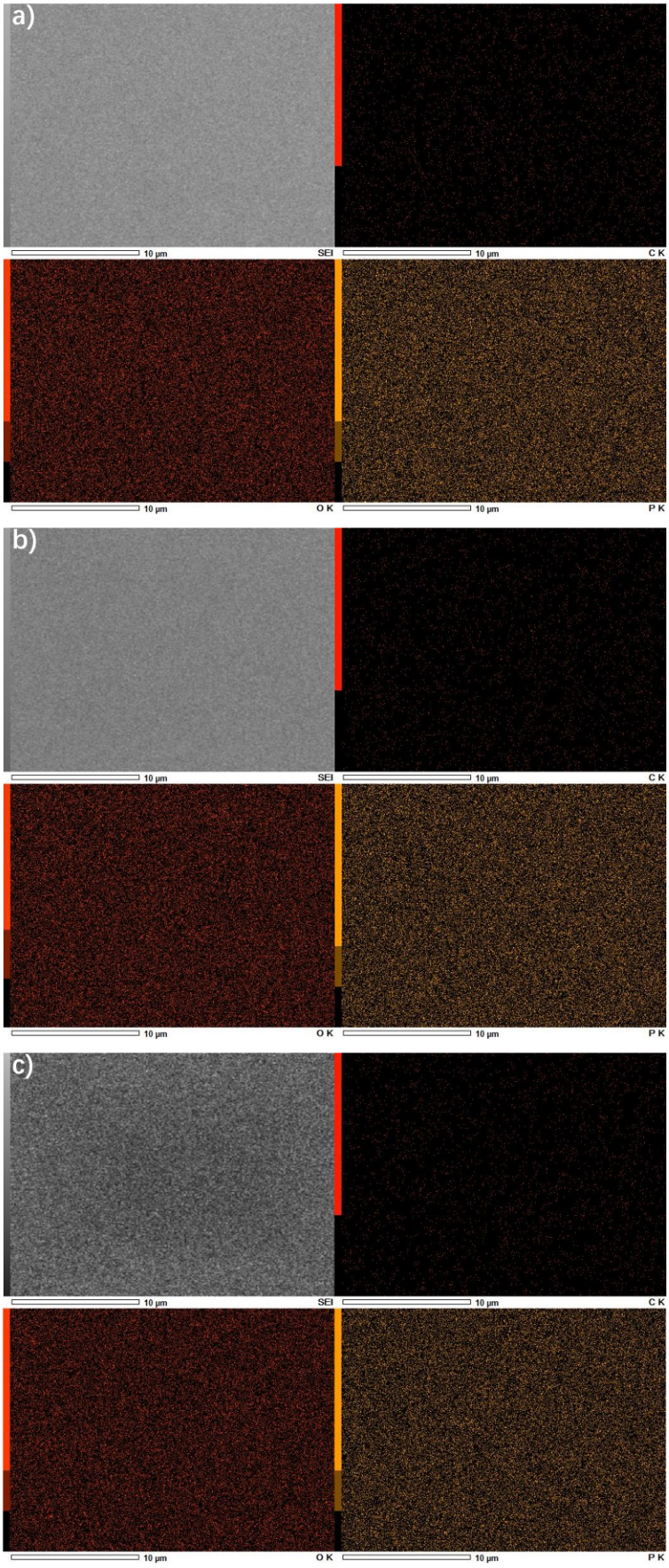


Figure S2. TGA curves of *p*-xylene dibromide under N_2 atmosphere.


a)
10 µm
SEI
10 µm
C K
10 µm
O K
10 µm
P K
b)
10 µm
SEI
10 µm
C K
10 µm
O K
10 µm
P K
c)
10 µm
SEI
10 µm
C K
10 µm
O K
10 µm
P K

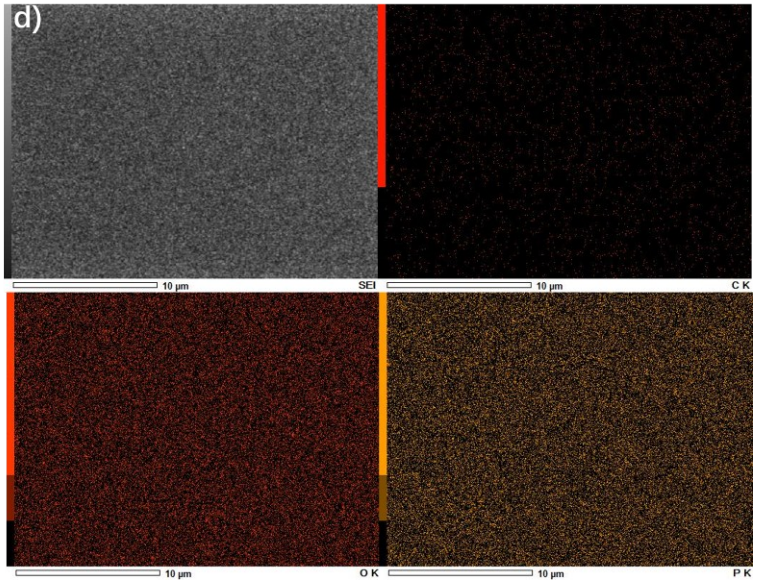


Figure S3. SEM images of the surface of PA-PEMs for a) PA-SPEEK-Im, b) PA-C-SPEEK-10, c) PA-C-SPEEK-20 and d) PA-C-SPEEK-30 and the corresponding SEM-EDX elemental mapping images for C, O, P.

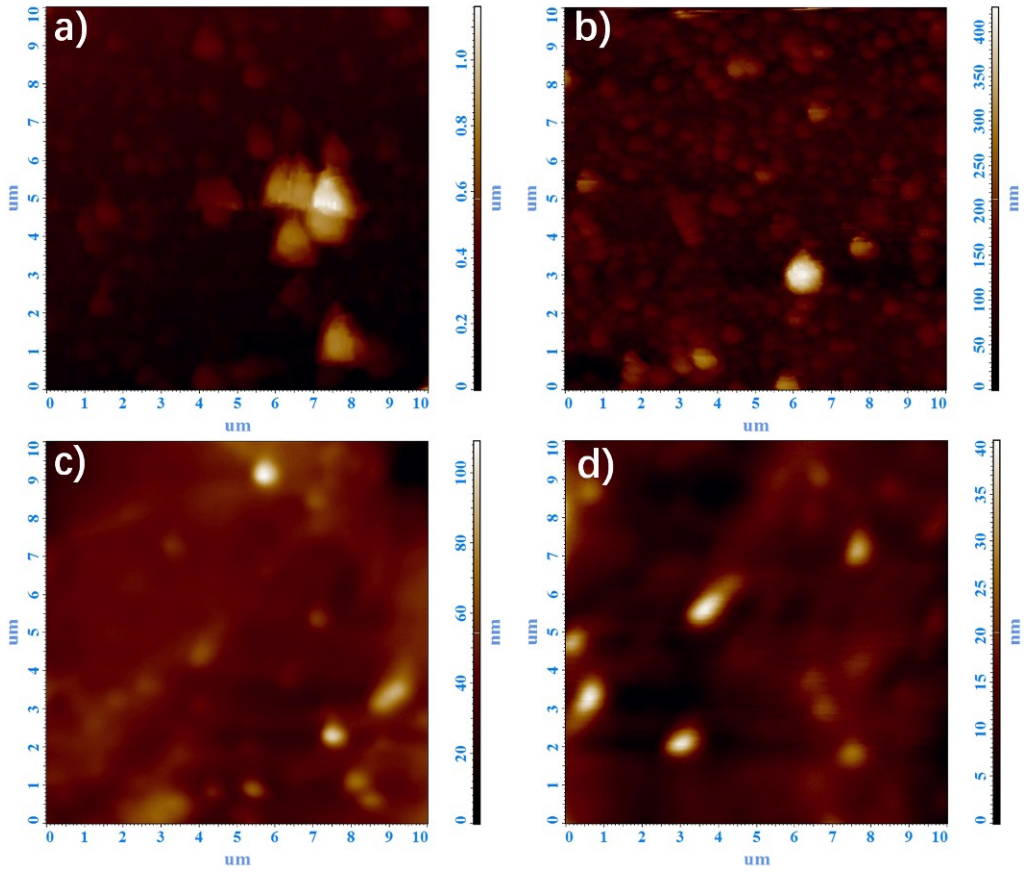


Figure S4. AFM height images of a) PA-SPEEK-Im, b) PA-C-SPEEK-10, c) PA-C-SPEEK-20 and d) PA-C-SPEEK-30.

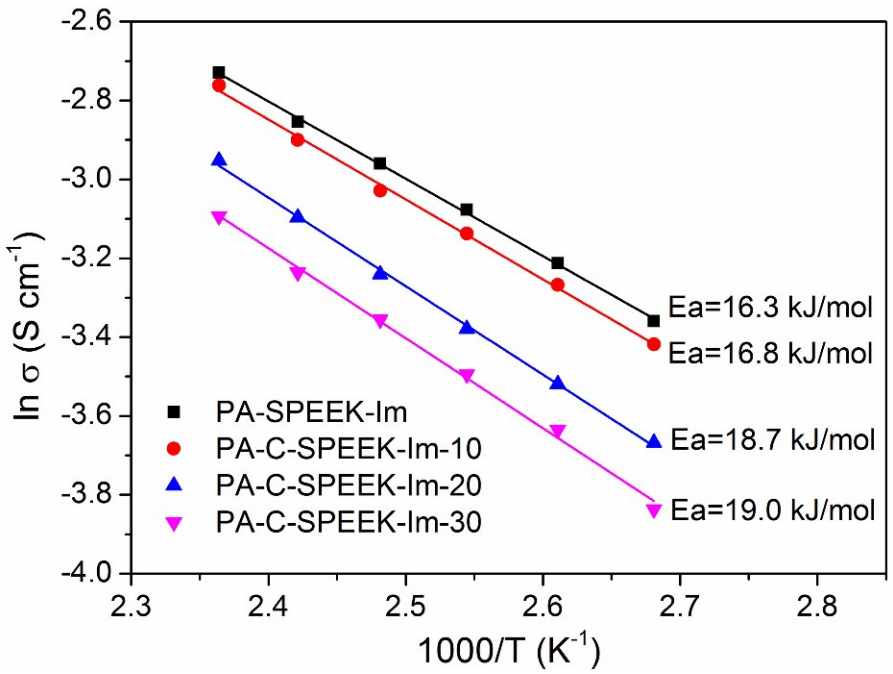


Figure S5. Arrhenius plot of proton conductivity.

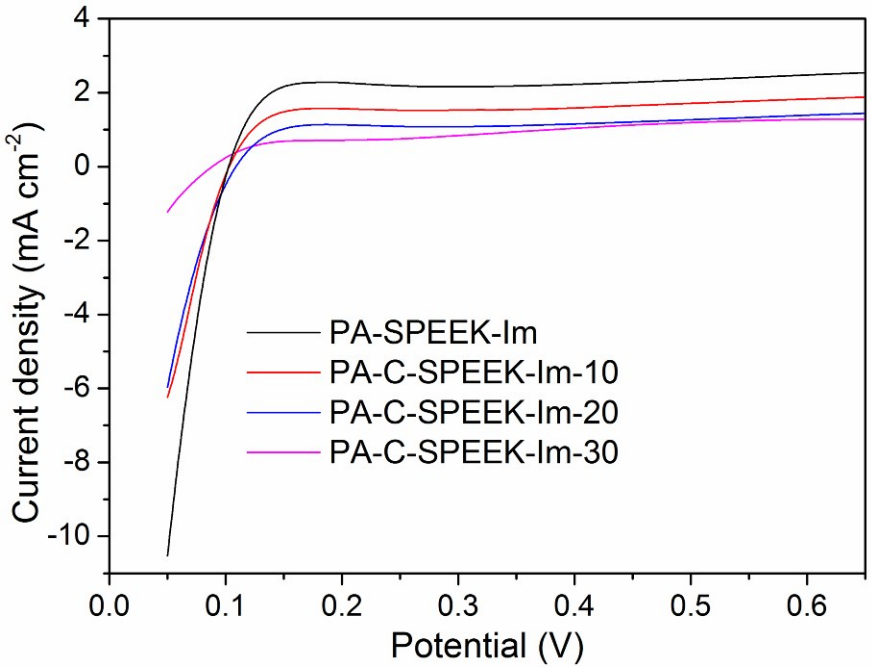


Figure S6. Measurement of the hydrogen crossover: linear sweep voltammograms for the PA doped membranes with dry H_2 and N_2 at ambient pressure. The scan rate is 10 mV s^{-1}.

Table S1. Mechanical properties and proton conductivity at 130 °C the membranes under Fenton treatment at 80 °C after 4 h.

Sample	Tensile strength (MPa)	Young's modulus (MPa)	Elongation at break (%)	Proton conductivity at 130 °C (S cm^{-1})
SPEEK-Im	14.7	341.8	184	0.049
C-SPEEK-Im-10	16.5	593.1	75	0.046
C-SPEEK-Im-20	18.2	637.0	69	0.038
C-SPEEK-Im-30	29.4	780.6	63	0.035

Table S2. Comparison of the proton conductivity and peak power density of alternative PEMs

Sample	Proton conductivity (S cm^{-1})	Peak power density (W cm^{-2})	Reference
PA-C-SPEEK-Im-20	0.039 (130 °C, 30% RH)	0.209 (130 °C)	This work
ABPBI/2S-Sep	0.020 (130 °C, 0 RH)	0.18 (120 °C)	J. Membr. Sci. 2019, 574, 282
SPEEK/2#-PA	0.026 (130 °C, 0 RH)	0.177 (120 °C)	J. Membr. Sci. 2018, 545, 88
PA-MTZPAEK(2.15)	0.028 (130 °C, 0 RH)	0.055 (140 °C)	J. Membr. Sci. 2018, 545, 167
PECH-50SiIm-50MeIm /PTFE/PA	0.040 (133 °C, 0 RH)	0.128 (120 °C)	RSC Adv., 2016, 6, 61029
M-5#/13.0PA	0.031 (130 °C, 0 RH)	0.175 (140 °C)	J. Membr. Sci. 2015, 493, 80
TZ-PEEN	0.027 (140 °C, 0 RH)	0.287 (160 °C)	J. Mater. Chem. A, 2015, 3, 14389
PA/PVDF-PVP80	0.055 (130 °C, 0 RH)	0.37 (130 °C)	J. Mater. Chem. A, 2015, 3, 148
EtPSU/10.7PA	0.016 (130 °C, 15mol% water vapor)	0.172 (130 °C)	J. Power Sources 2012, 205, 114

Table S3. Proton conductivity and H_2 cross-over current density of PEMs.

Sample	Proton conductivity at 130 ^oC (S cm^{-1})	H_2 cross-over current density at 0.55 V (mA cm^{-2})
PA-SPEEK-Im	0.052	2.41
PA-C-SPEEK-Im-10	0.048	1.77
PA-C-SPEEK-Im-20	0.039	1.33
PA-C-SPEEK-Im-30	0.035	1.24

Table S4. Pure gas permeability of PA doped membranes at 50 psi and 35 ^oC.

Sample	Thickness (μm)	P(O_2) (Barrer)	P(H_2) (Barrer)
PA-SPEEK-Im	73	0.19	1.64
PA-C-SPEEK-Im-10	75	0.10	0.83
PA-C-SPEEK-Im-20	76	0.07	0.61
PA-C-SPEEK-Im-30	72	0.06	0.57

P is permeability coefficient. 1 Barrer = 10^{-10} cm^3 (STP) cm/(cm^2 s cmHg).