

Supplementary information

Towards a stable ion-solvating polymer electrolyte for advanced alkaline water electrolysis

David Aili,^{a,*} Andrew G. Wright,^b Mikkel Rykær Kraglund,^a Katja Jankova,^a Steven Holdcroft,^b and
Jens Oluf Jensen^a

^a *Department of Energy Conversion and Storage, Technical University of Denmark, Kemitorvet 207, DK-2800*

*Kgs. Lyngby, Denmark, *Corresponding author (E-mail: larda@dtu.dk)*

^b *Department of Chemistry, Simon Fraser University, 8888 University Drive, Burnaby, British Columbia, Canada V5A 1S6*

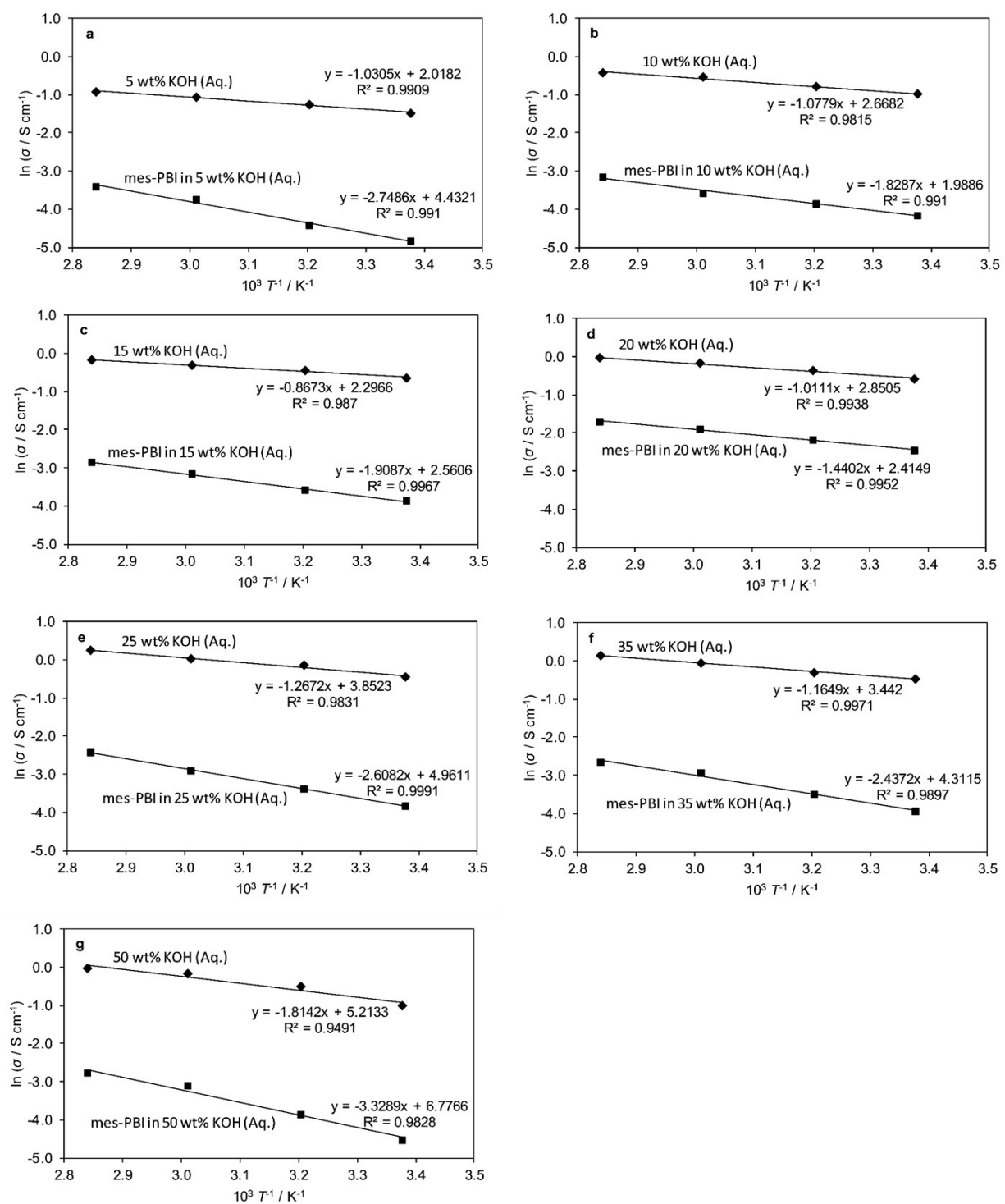


Figure S1 Fitting parameters for ion conductivity from Arrhenius relationship in the temperature range 20-80 °C.

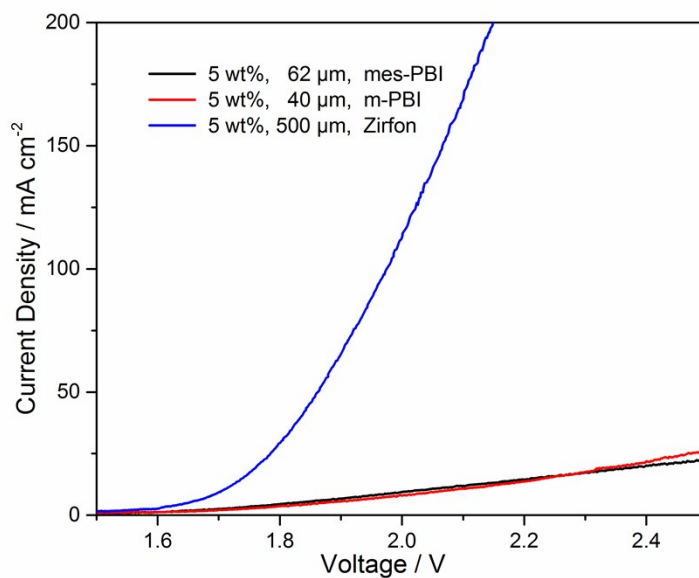


Figure S2 Polarization curves in 5 wt% KOH at 80 °C.

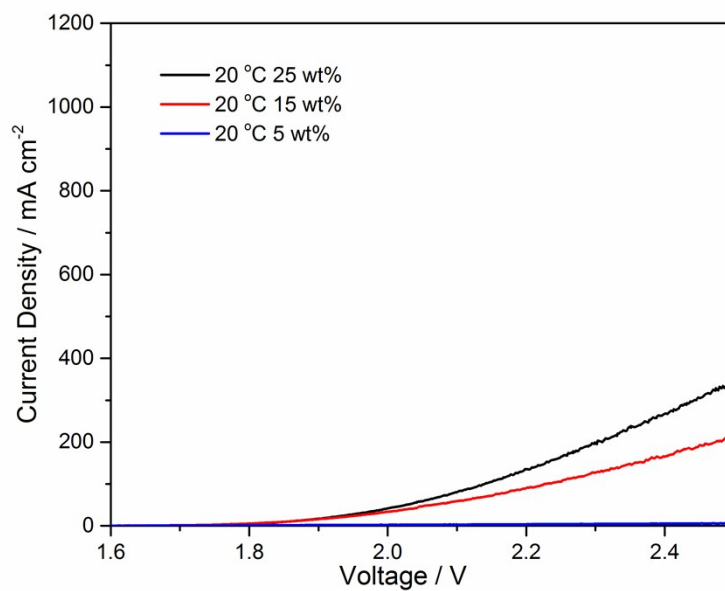


Figure S3 Polarization curves for mes-PBI in 5-25 wt% KOH at 20 °C.

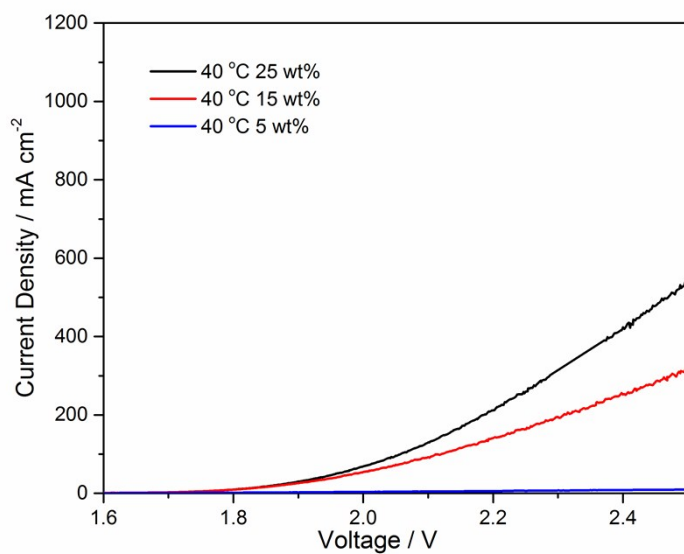


Figure S4 Polarization curves for mes-PBI in 5-25 wt% KOH at 40 °C.

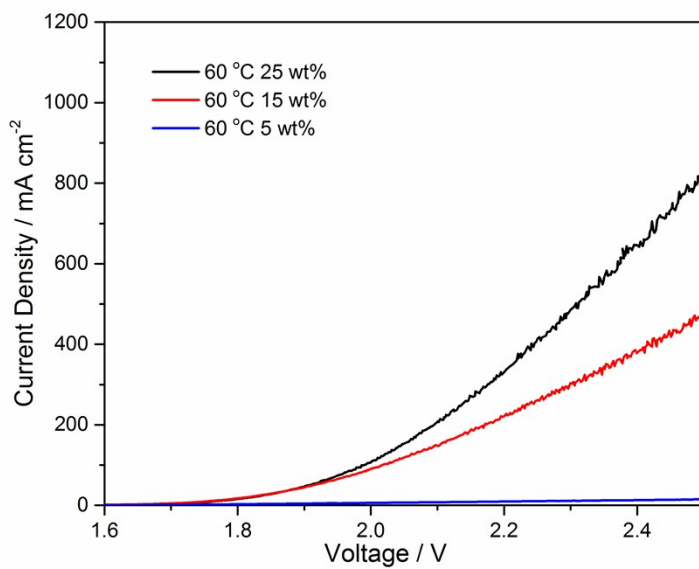


Figure S5 Polarization curves for mes-PBI in 5-25 wt% KOH at 60 °C.

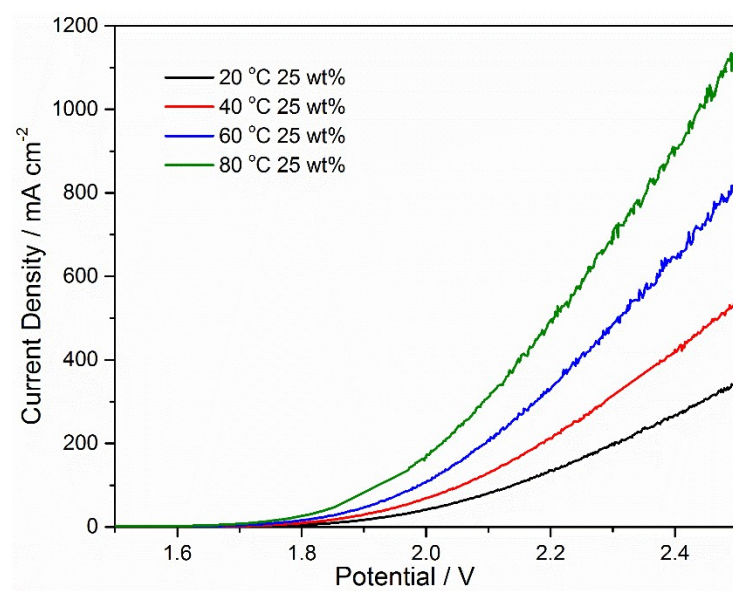


Figure S6 Polarization curves for mes-PBI in 25 wt% KOH at 20-80 °C.

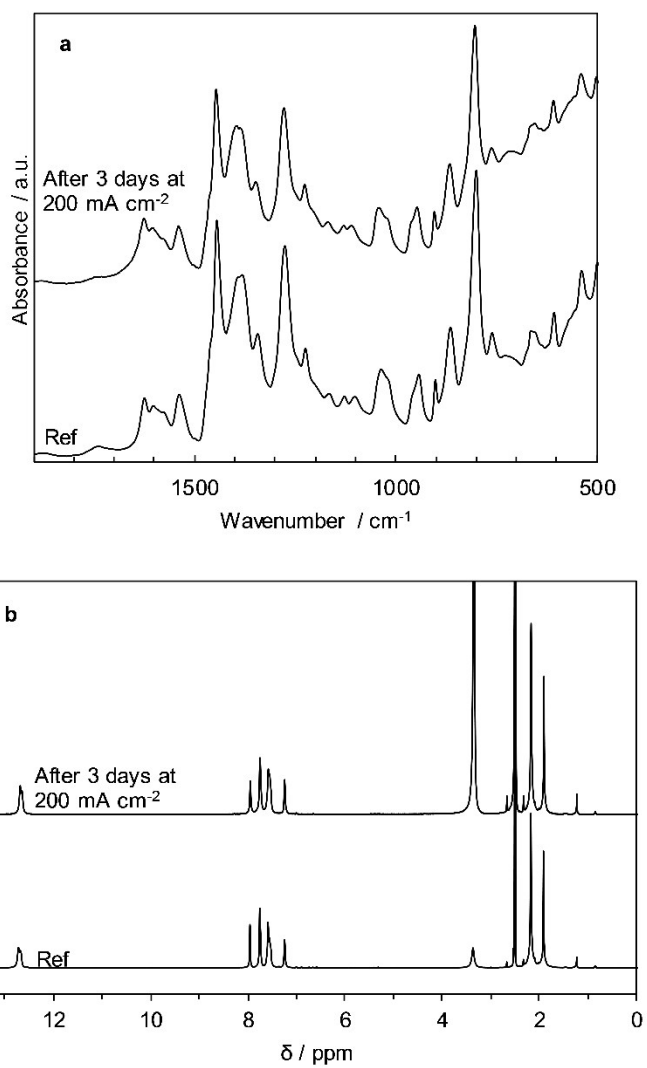


Figure S7 FTIR (a) and ^1H NMR (b) spectra of mes-PBI after 3 days of electrolysis at 200 mA cm^{-2} in 25 wt% KOH at 80 $^{\circ}\text{C}$.

Table S1 Activation energy for ion conductivity obtained by fitting the data to the Arrhenius equation in the temperature range 20-80 °C. The Arrhenius plots and the corresponding fitting parameters are shown in Figure S1. Predicted data for aqueous KOH from the model developed by Gilliam et al.¹ (in parenthesis) are presented for comparison.

[KOH] / wt%	E_a (aqueous KOH) / kJ mol ⁻¹	E_a (mes-PBI) / kJ mol ⁻¹
5	8.6 (9.1)	22.9
10	9.0 (9.6)	15.2
15	7.2 (10.3)	15.9
20	8.4 (11.0)	17.8
25	10.5 (11.9)	21.7
35	9.7 (14.0)	20.3
50	15.0 (13.4)	27.7

1 R. J. Gilliam, J. W. Graydon, D. W. Kirk, S. J. Thorpe, *Int. J. Hydrogen Energy* 2007, **32**, 359.

Table S2 Summary of molecular weight data of mes-PBI after 0-207 days in 0-50 wt% aqueous KOH at 88 C obtained from SEC and as calculated from the PMMA calibration curve. Eluent: DMAc + 0.25% LiCl.

Days	[KOH] / wt%	M_p / kg mol ⁻¹	M_n / kg mol ⁻¹	M_w / kg mol ⁻¹	M_w / M_n
0 (ref)	-	197	84.6	191.2	2.26
2	0	205	65.7	203.7	3.10
2	5	214	84.8	204.4	2.41
2	10	193.6	66.7	188.8	2.83
2	25	168.3	70.4	168.3	2.39
2	50	176	84.0	168.0	2.00
14	0	204.5	74.8	206.4	2.76
14	5	175	74.0	174.6	2.36
14	10	170	68.8	173.4	2.52
14	25	162.6	69.5	162.0	2.08
14	50	122.6	61.5	127.9	2.48
28	0	195	75.7	187.8	2.39
28	5	177	74.9	179.0	2.27
28	10	150	70.2	159.4	2.11
28	25	161	84.5	179.1	1.98
28	50	84	44.3	87.7	2.25
59	0	192	79.2	178.5	2.71
59	5	170.6	61.2	165.9	1.98
59	10	169.3	75.2	148.0	2.25
59	25	127.9	63.8	128.7	2.71
59	50	82.4	48.2	107.5	1.97
99	0	215	52.9	188.3	3.56
99	5	176	77.8	185.2	2.38
99	10	173.5	76.3	180.1	2.36
99	25	113.5	57.4	141.8	2.47
99	50	77	44.9	79.5	1.77
149	0	209.1	85.3	204.7	2.40
149	5	175	78.2	176.0	2.25
149	10	210.5	76.0	119.0	1.57
149	25	130.3	48.7	83.6	1.72
149	50	47	27.7	45.2	1.63
207	0	189	47.1	148.8	3.16
207	5	137	41.1	122.1	2.97
207	10	152	47.5	172	3.62
207	25	64.6	26.2	99.0	3.78
207	50	42.5	16.9	56.8	3.36