

Non-N-substituted Crosslinked Polybenzimidazole Membranes for Durable Alkaline Electrolysis

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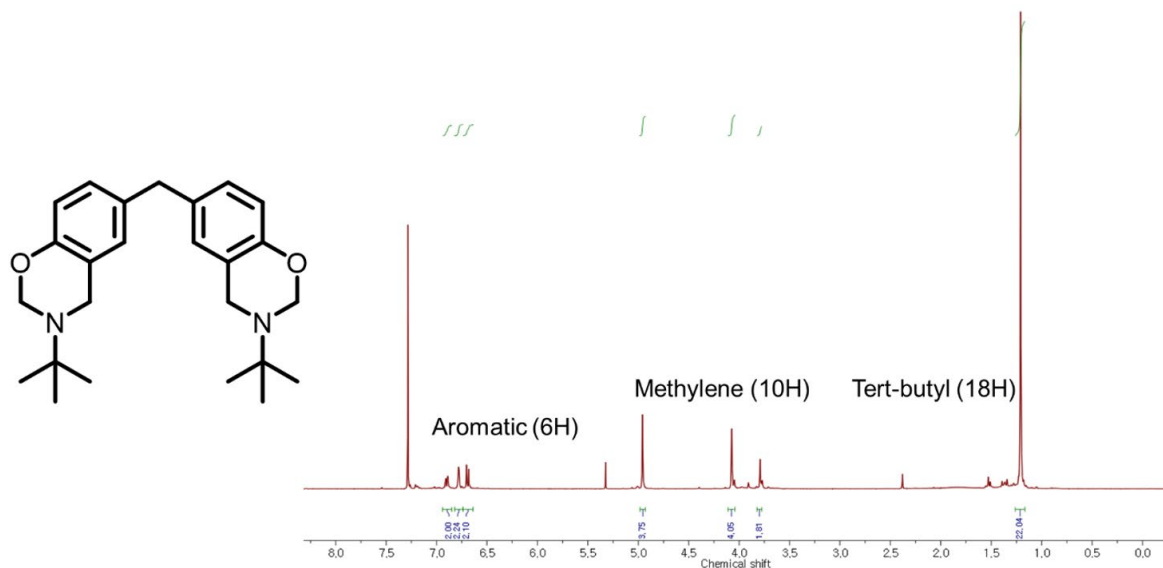


Fig. S1. ¹H NMR spectrum of benzoxazine crosslinker (*t*Bz).

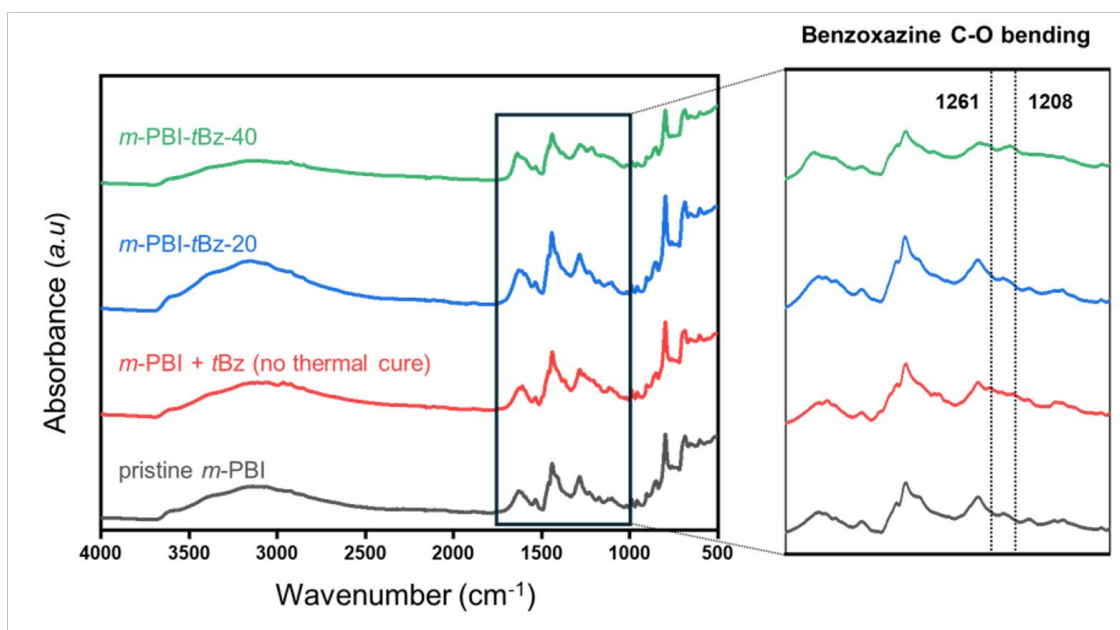


Fig. S2. FT-IR spectra of the membranes.

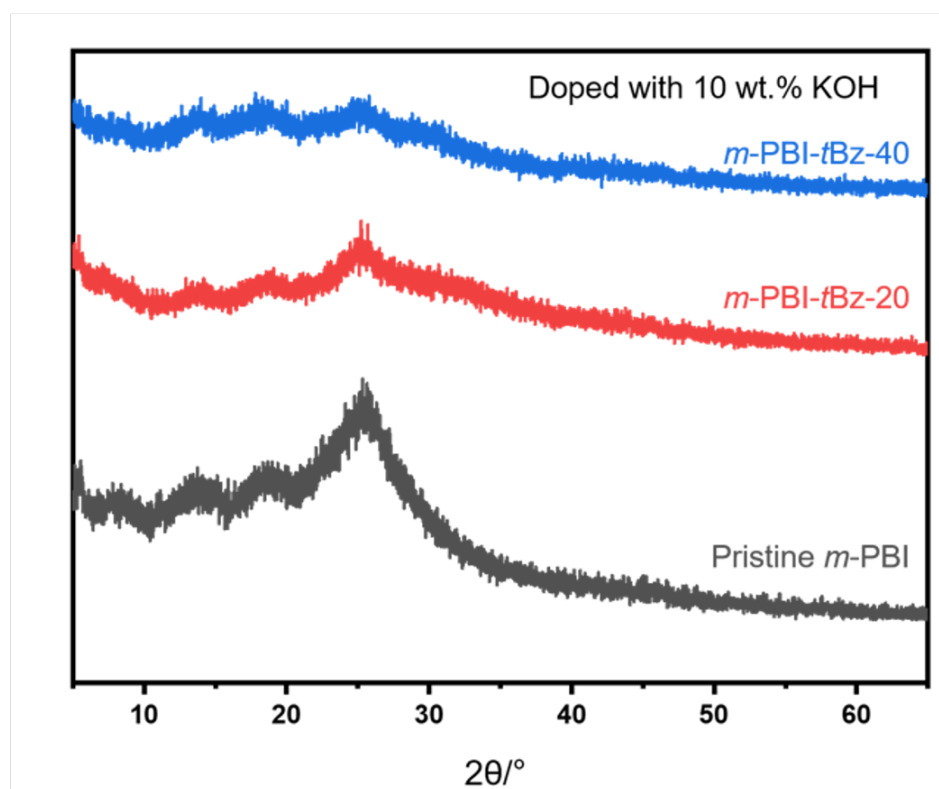


Fig. S3. XRD diffractogram of 10 wt.% KOH doped membranes.

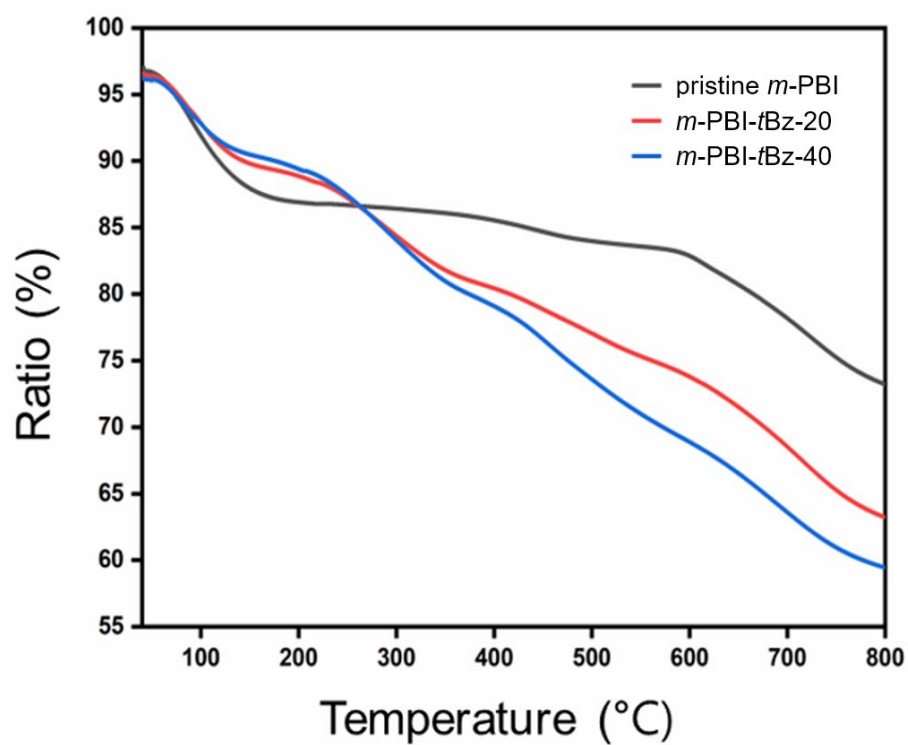


Fig. S4. TGA thermogram of the membranes.

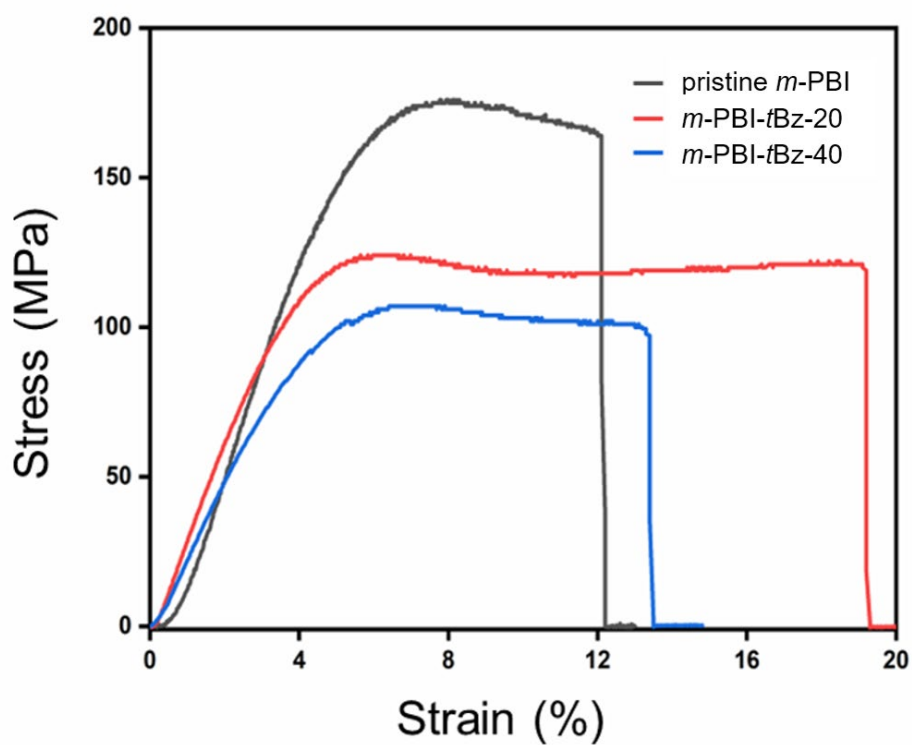


Fig. S5. Stress-strain curve of the dried membranes.

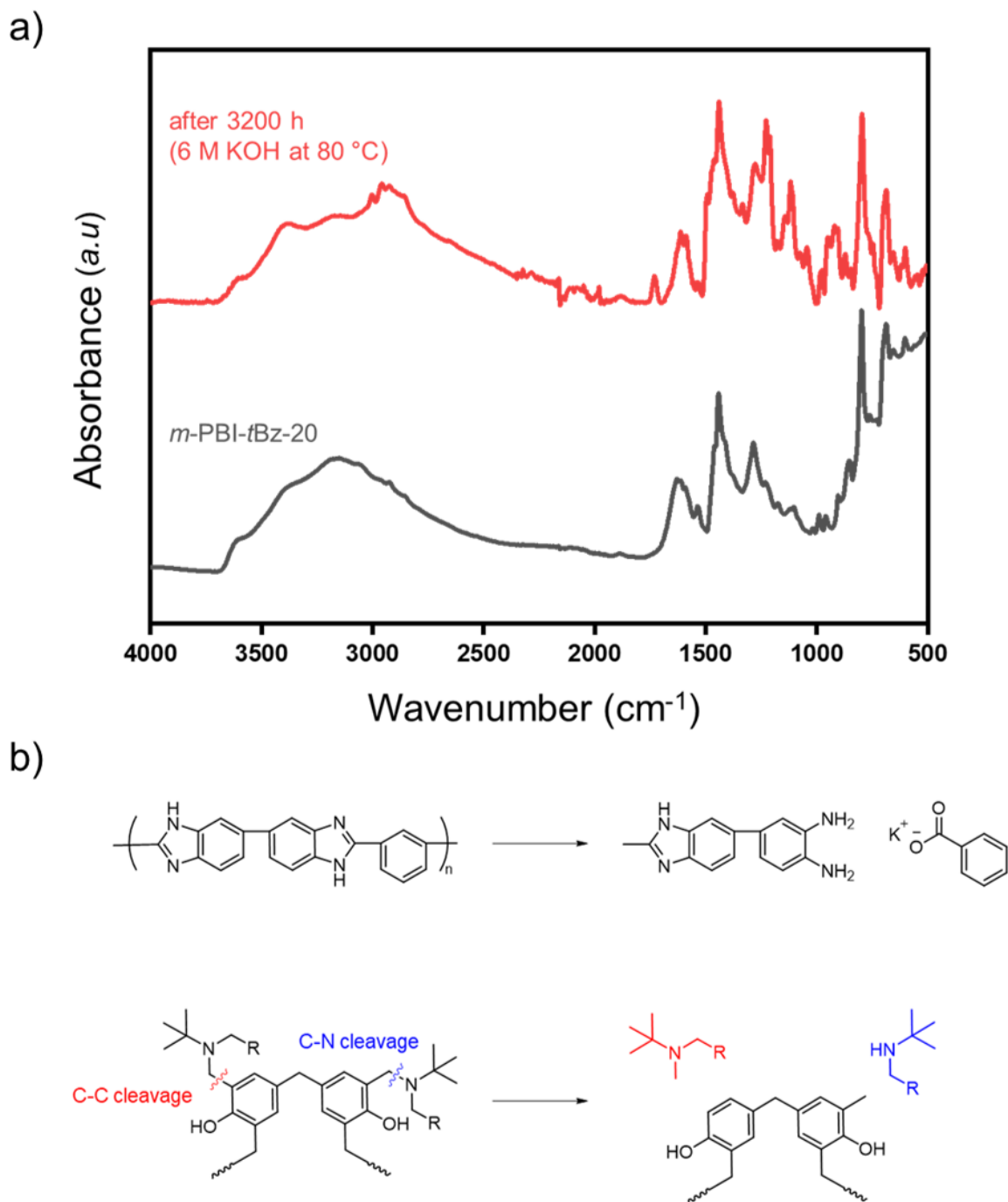


Fig. S6. a) FT-IR spectrum of *m*-PBI-*t*Bz-20 after alkaline stability test. b) Plausible degradation mechanism of polybenzimidazole and polybenzoxazine.

After 3200 h of alkaline exposure, new peaks were observed in the FT-IR spectrum of *m*-PBI-*t*Bz-20, which may suggest chemical degradation in the membrane. The bands near 2900 cm⁻¹ could be associated with sp³ C-H stretching vibrations. These signals may originate from the decomposed fragments via C-C and C-N bond cleavage of the polybenzoxazine crosslinking network¹. The bands observed in the 1700–1200 cm⁻¹ range may suggest the formation of carbonyl-containing fragments, which could be generated by a hydroxide attack at the C2 position of the PBI backbone.

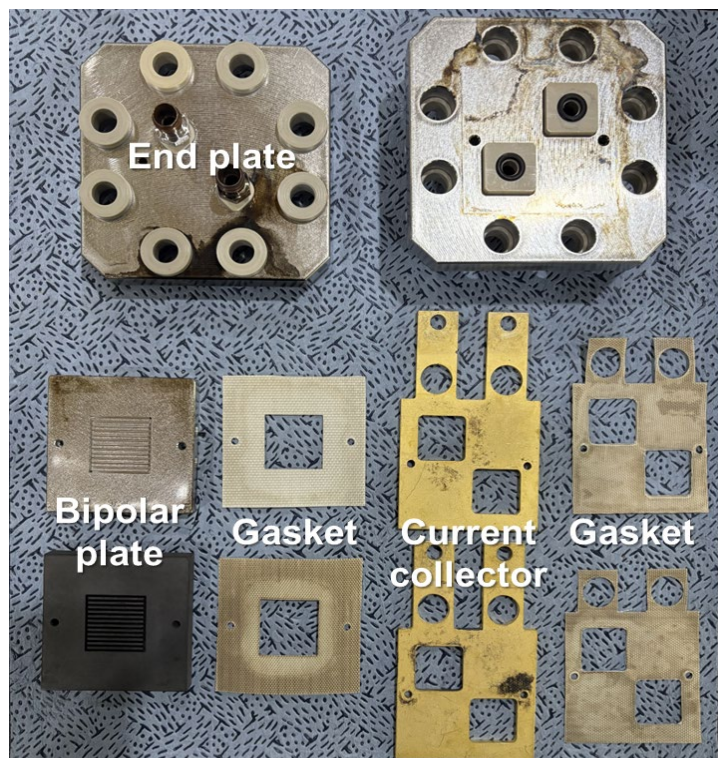


Fig. S7. MEA cell scheme.

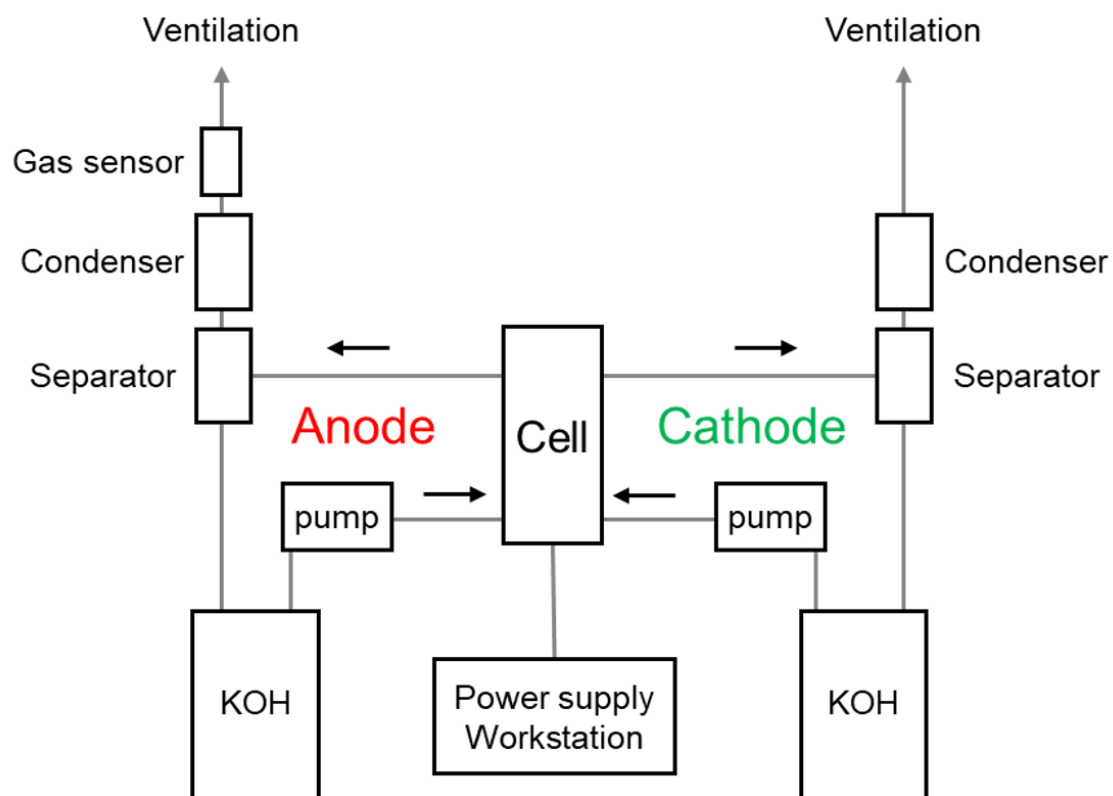


Fig. S8. Illustration of a water electrolyzer test station.

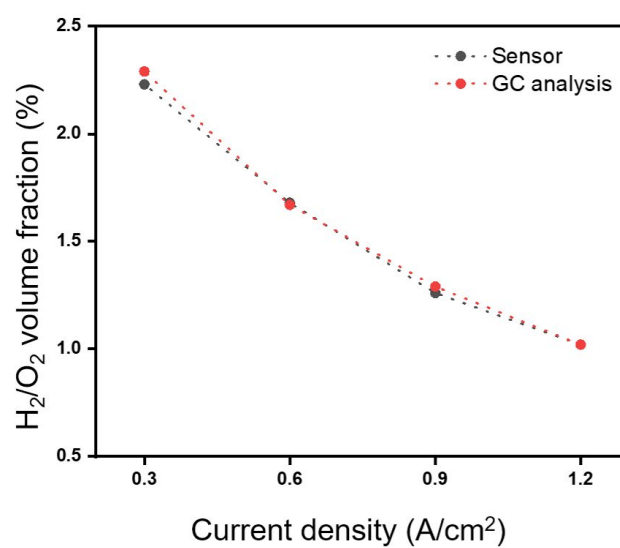
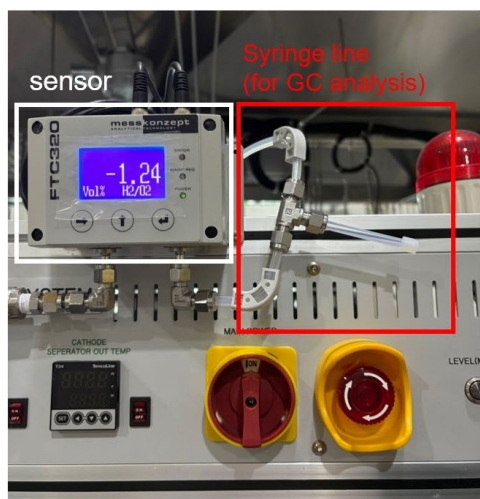


Fig. S9. Validation of H₂ in O₂ volume fraction measured by gas sensor and gas chromatography.

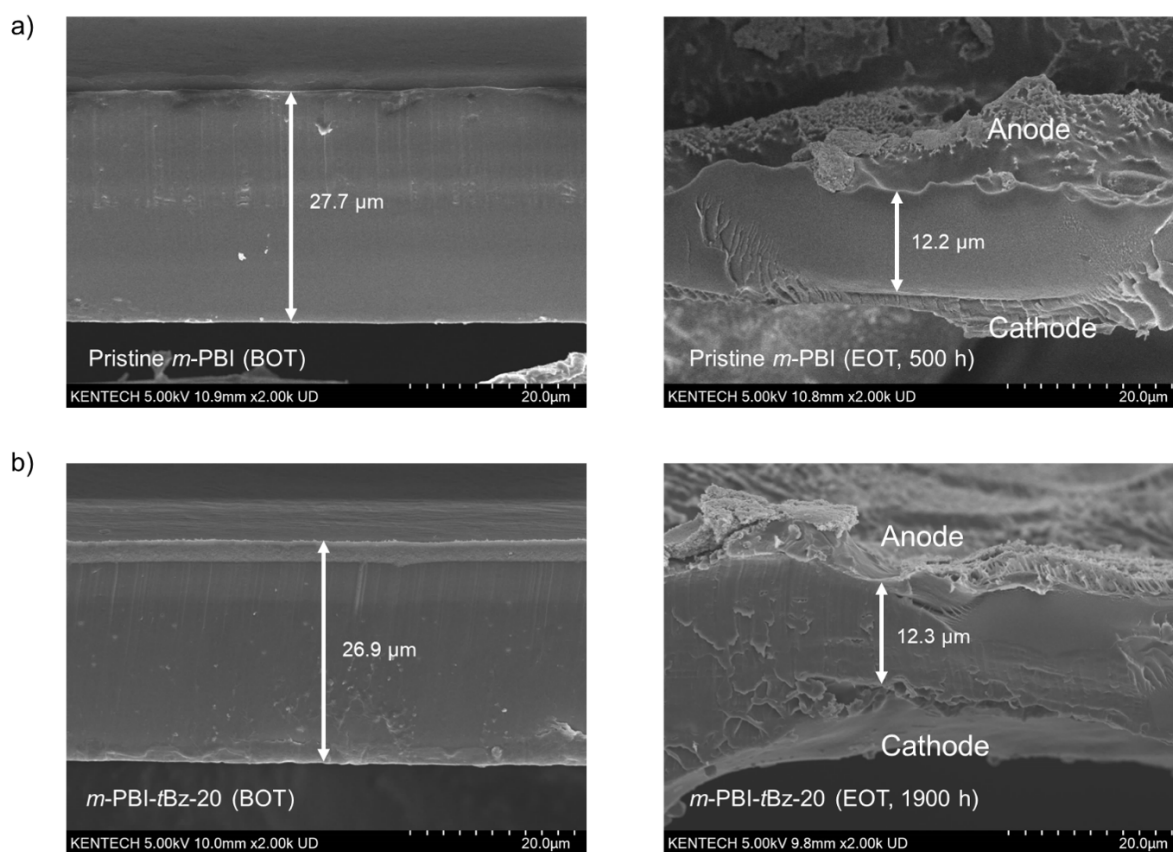


Fig. S10. SEM image of the membranes after durability test. a Pristine *m*-PBI, b *m*-PBI-*t*Bz-20.

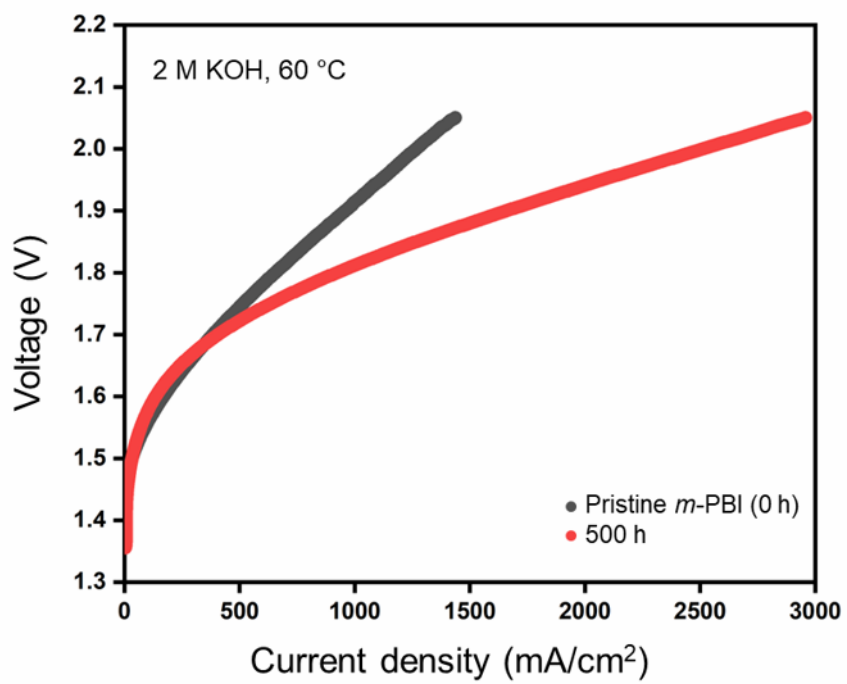
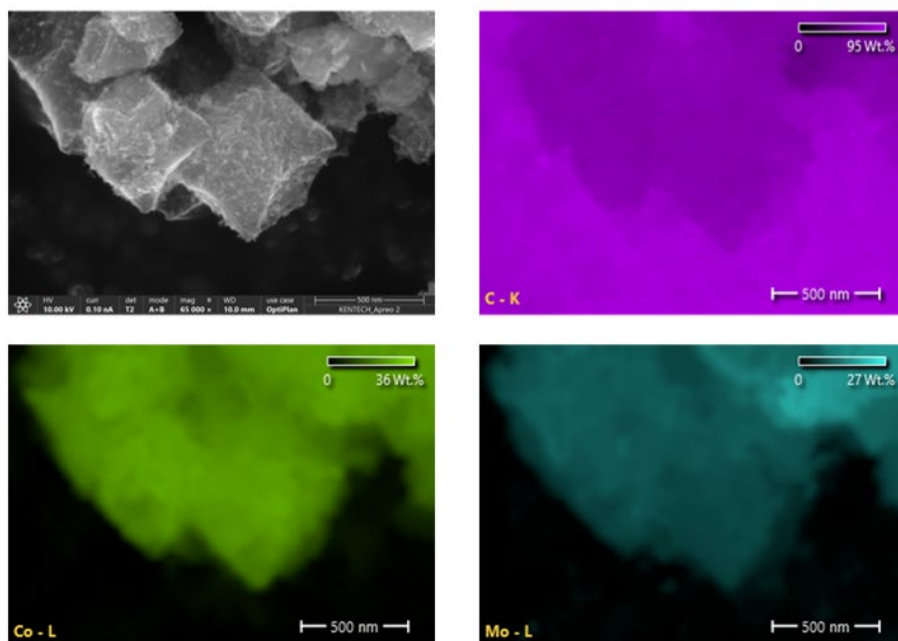


Fig. S11. Polarization curve of *m*-PBI-based electrolyzer cell after long-term durability testing.

a)



b)

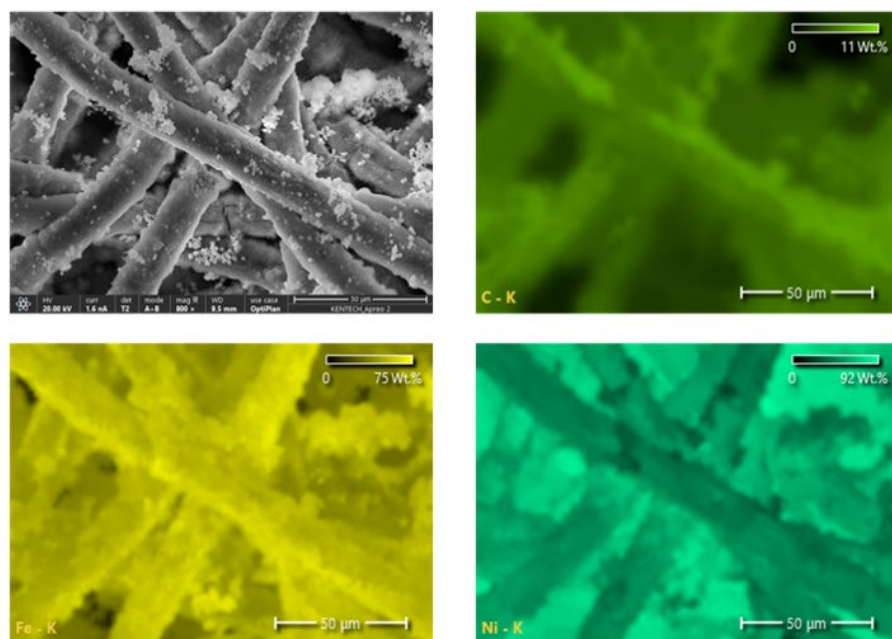


Fig. S12. SEM-EDS image of non-PGM catalysts. a Mo/Co@CNT, b NiFe-LDH.

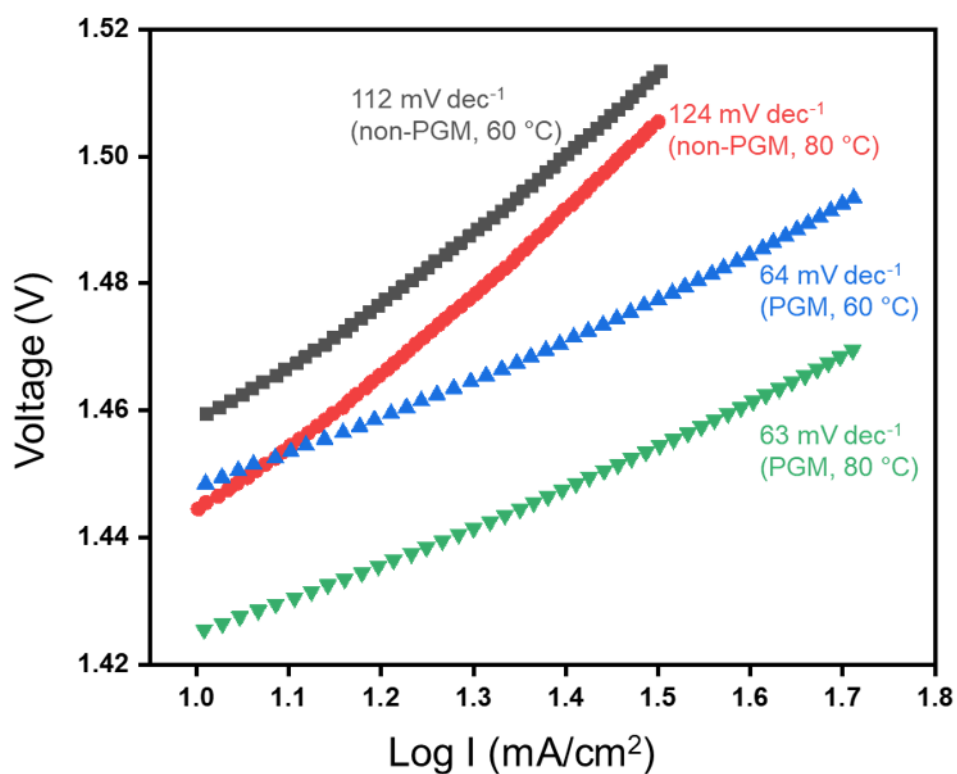


Fig. S13. Tafel slope of PGM and non-PGM catalyst based electrolyzer cell.

Table 1. Reference cell performance with non-PGM catalysts.

Membrane	Anode	Cathode	KOH concentration (wt%)	Temperature (°C)	Current density @ 2.0 V (A cm ⁻²)	Ref.
<i>m</i> -PBI- <i>t</i> Bz-20	NiFe-LDH	Mo/Co@CNT	10	80	0.57	This work
gel BN-PBI	Ni foam	Ni foam	10	80	0.25	²
cMS-PBI	Ni foam	Ni foam	10	80	0.85	³
cMS-PBI	NiFe	Raney Ni	10	80	3.52	³
gel NPBI	Ni foam	Ni foam	10	80	0.5	⁴
FAA-3-PK-75	Ni foam	Ni foam	10	80	0.53	³
50SOPBI-act	Ni-Al/Mo	Ni-Al	10	80	1.91	⁵
<i>m</i> -PBI	Ni foam	Ni foam	24	80	0.4	⁶
<i>m</i> -PBI	Raney Ni	Raney Ni	24	80	2.9	⁶
<i>fe-p</i> -PBI	NiFe-LDH	Ni-Al	20	80	1.0	⁷
Asy-PBI	Raney Ni-Fe	Raney Ni-Fe	20	80	3.0	⁸
POBP-ISM	Ni foam	Ni foam	30	80	0.25	⁹

References

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