Improving Anion Exchange Membrane Stability with Hydrophilic Polyethylene for Advanced Aqueous Organic Redox Flow Battery

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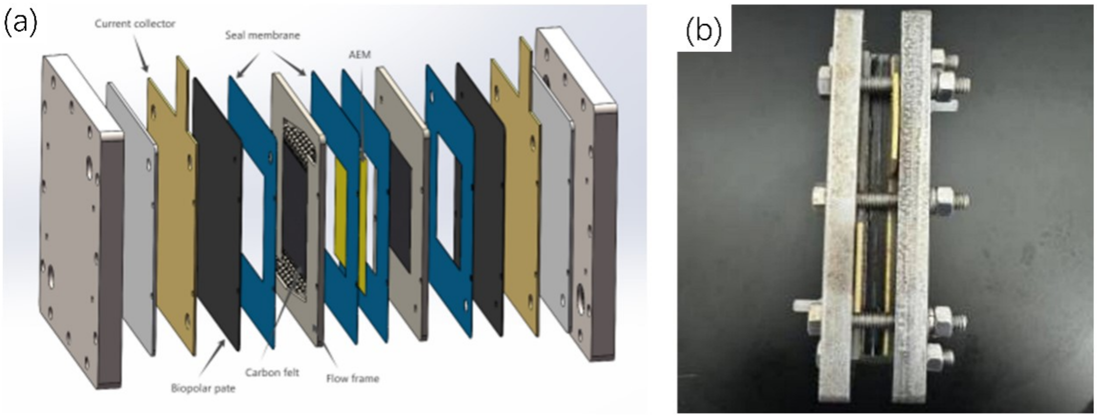

Fig. S1 The single cell. (a) Schematic and (b) physical views of a single cell.

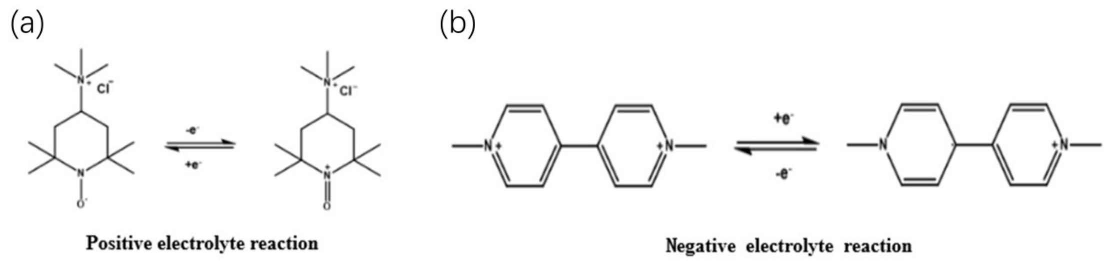

Fig. S2 Structural details and fundamental electrode reactions of compounds. (a) TEMPTMA (positive electrolyte) and (b) MV (negative electrolyte).

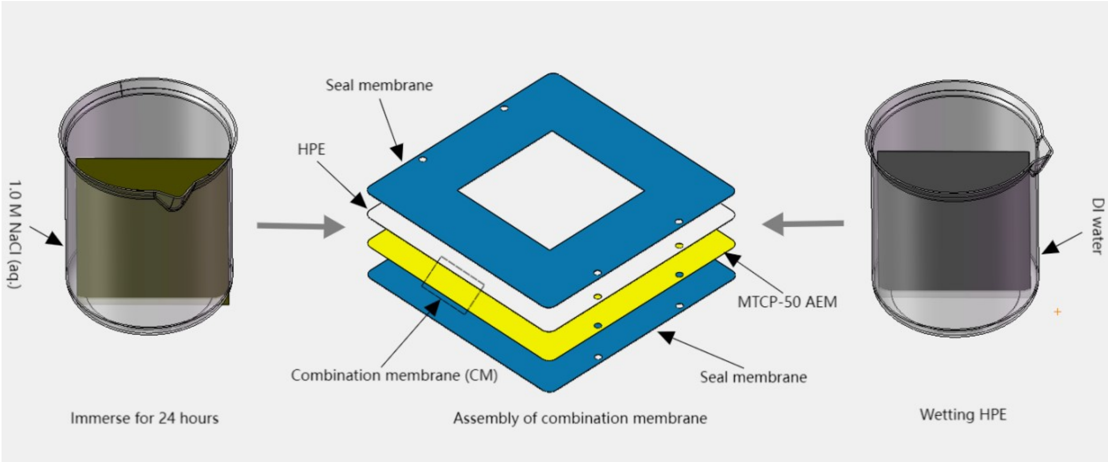

Fig. S3 Assembly process of the CM.

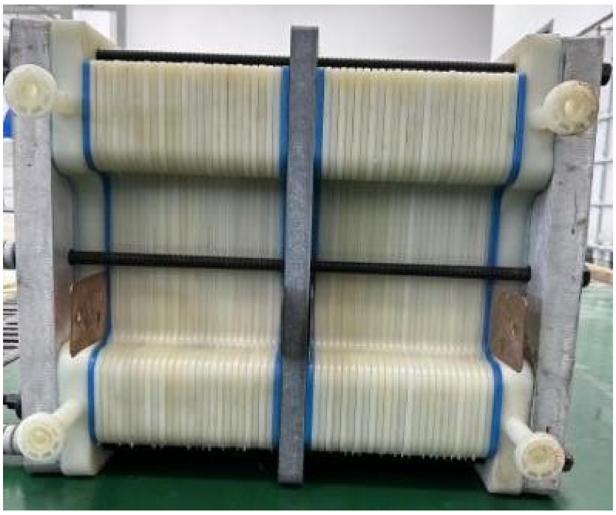

Fig. S4 Physical view of a 52-stacked cell.

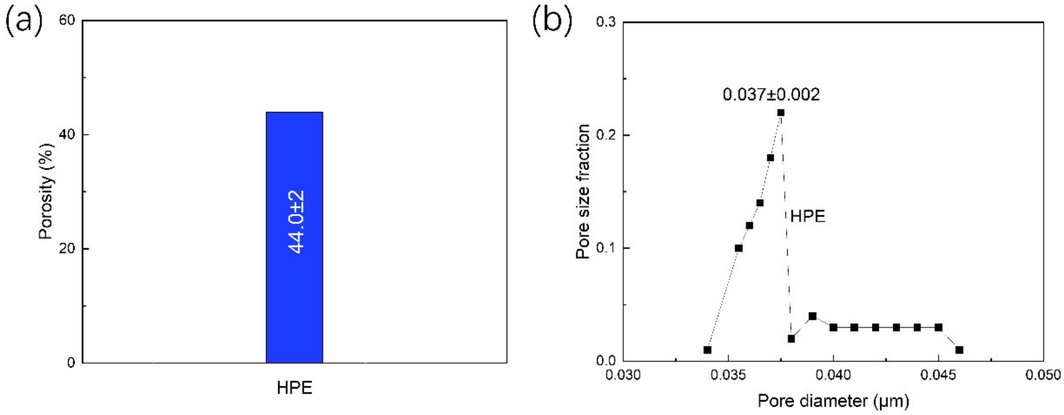

Fig. S5 Characterizations of the HPE. (a) Overall porosity and (b) pore size distribution of the HPE.

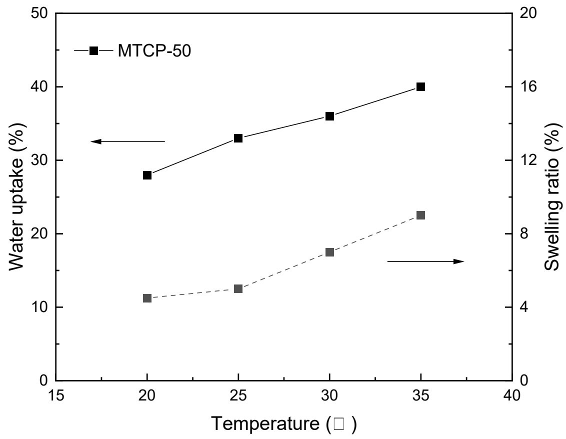

Fig. S6 Water uptake and dimensional swelling analysis of MTCP-50 AEM. Error bars indicate the standard deviation of the water uptake and swelling ratio.

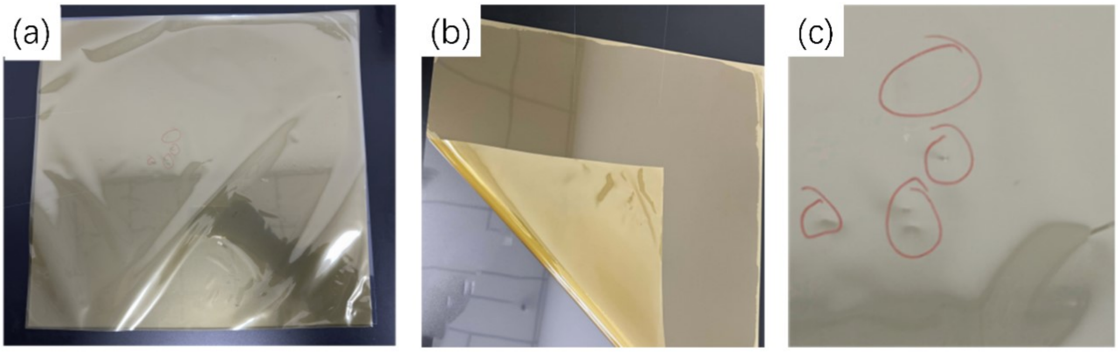

Fig. S7 Characterizations of the MTCP-50 AEM. The photograph of the (a) flaw areas is circled in red, which is produced during (b) the removal of the AEM from PET, and (c) the magnified view of the flaw areas.

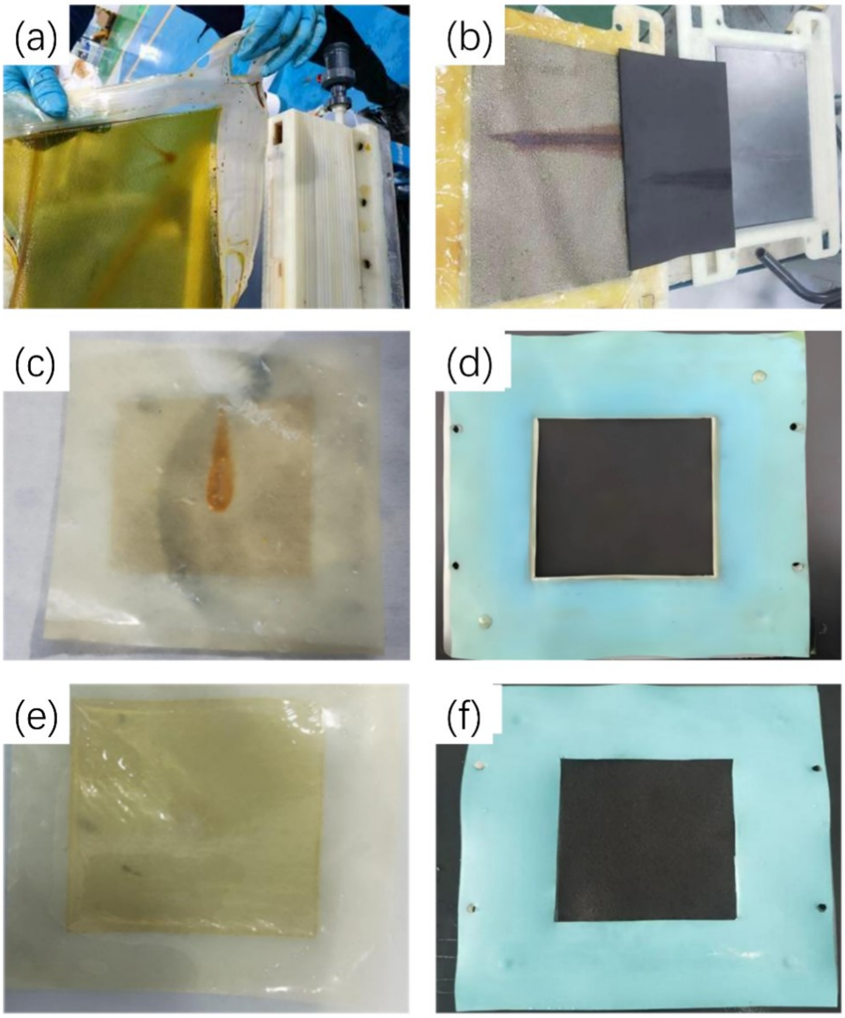

Fig. S8 Photographs of disassembled MTCP-50 AEM. (a) Mildly corroded MTCP-50 AEM, (b) severely corroded MTCP-50 AEM with breakage, (c) MTCP-50 AEM from a single cell with a 0.5 mm round hole after approximately 15 hours of operation, and (d) the corresponding bleached blue seal membrane (inside view). (e) Dismantled CM (MTCP-50 AEM with a 0.5 mm round hole) after approximately 90 hours of operation, and (f) the blue seal membrane without bleaching.

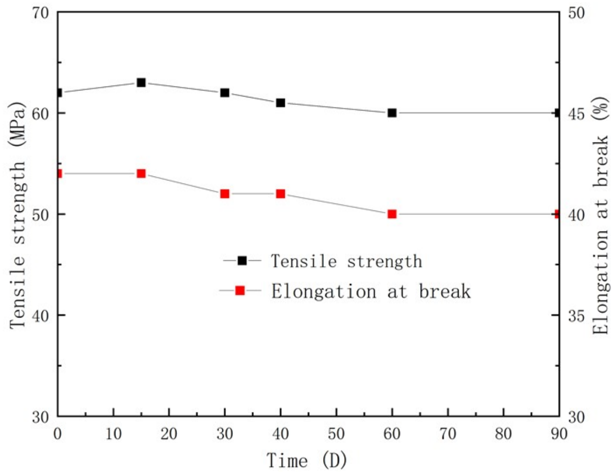

Fig. S9 The mechanical properties of the MTCP-50 AEM with different soaking times in TEMPTMA catholyte (1.5 M, 50°C, under a 100% state of charge).

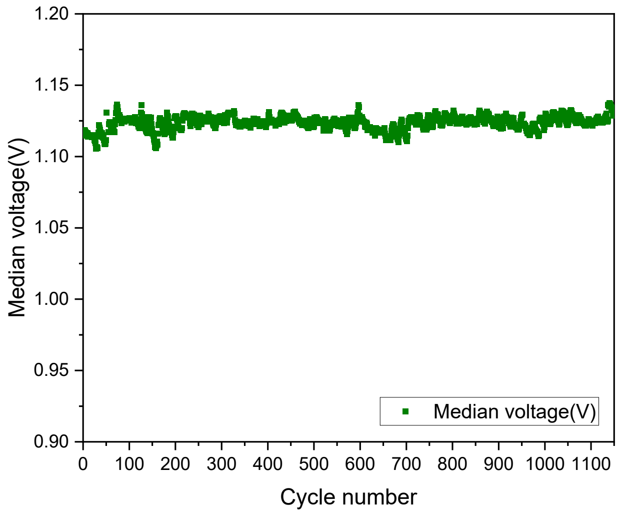

Fig. S10 The discharge median voltage of the single cell during a 1500-hour cycling test.

Fig. S11 Hydrophilic stability of HPE in the single cell. Photograph of HPE immersed in water after a 1500-hour single cell cycling test.

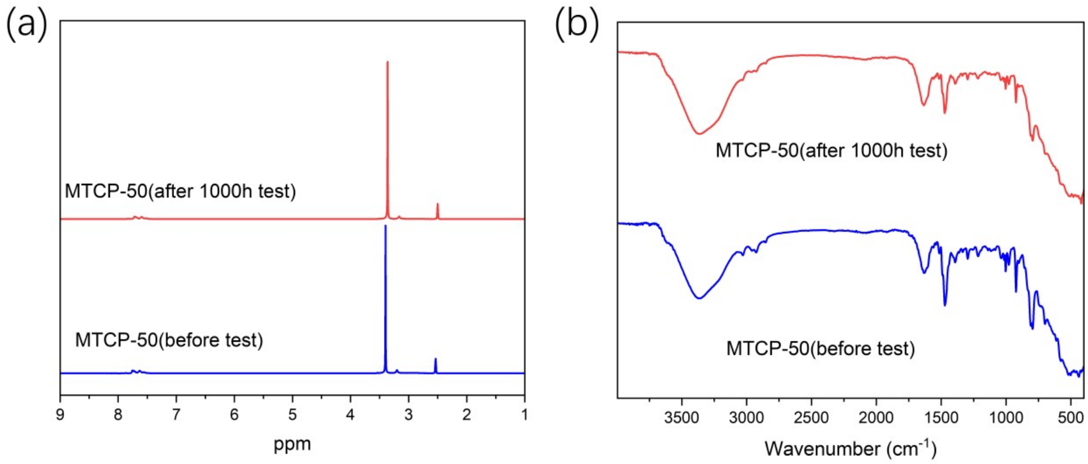

Fig. S12 The structural integrity of AEM post post-cycling. (a) The ^1H NMR spectra and (b) FT-IR spectra of the MTCP-50 AEM before and after 1000-hour cycles.

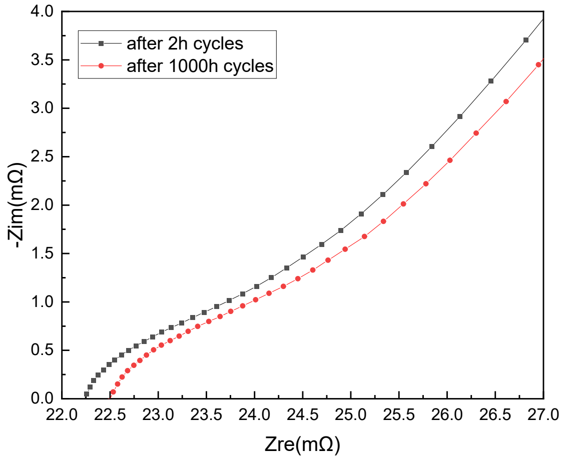

Fig. S13 EIS measurements of the single cell with CM after 2-hour cycles and 1000-hour cycles under 50% state of charge.

Table S1 Various membranes test in TEMPO and MV-based AORFB system. Physicochemical properties and battery performance of various commercial membranes and the MTCP-50 membrane in TEMPO and MV-based all-organic redox flow battery (AORFB) systems.

Membrane	Redox couple	Thickness (μm)	Cl^- conductivity ($mS\ cm^{-1}$)	Energy Efficiency	Capacity fade rate
DSV	TEMPT MA/MV	90	12.05 (±0.2)	77% @88 $mW\ cm^{-2}$	0.62 (±0.08) per day
AMV		95	6.57 (±0.12)	70% @88 $mW\ cm^{-2}$	4.0 (±0.5) per day
FAA-3-50		50	2.09 (±0.04)	76% @55 $mW\ cm^{-2}$	0.4 (±0.05) per day
MTCP-50		60	10.96 (±0.15)	79% @88 $mW\ cm^{-2}$	0.065 (±0.003) per day

Note of Table S1: The ionic conductivity of the membranes test in the 3.0 M NaCl (aq.) at room temperature (25±0.5°C).