

Using an anion exchange membrane for effective hydroxide ion transport enables high power densities in microbial fuel cells

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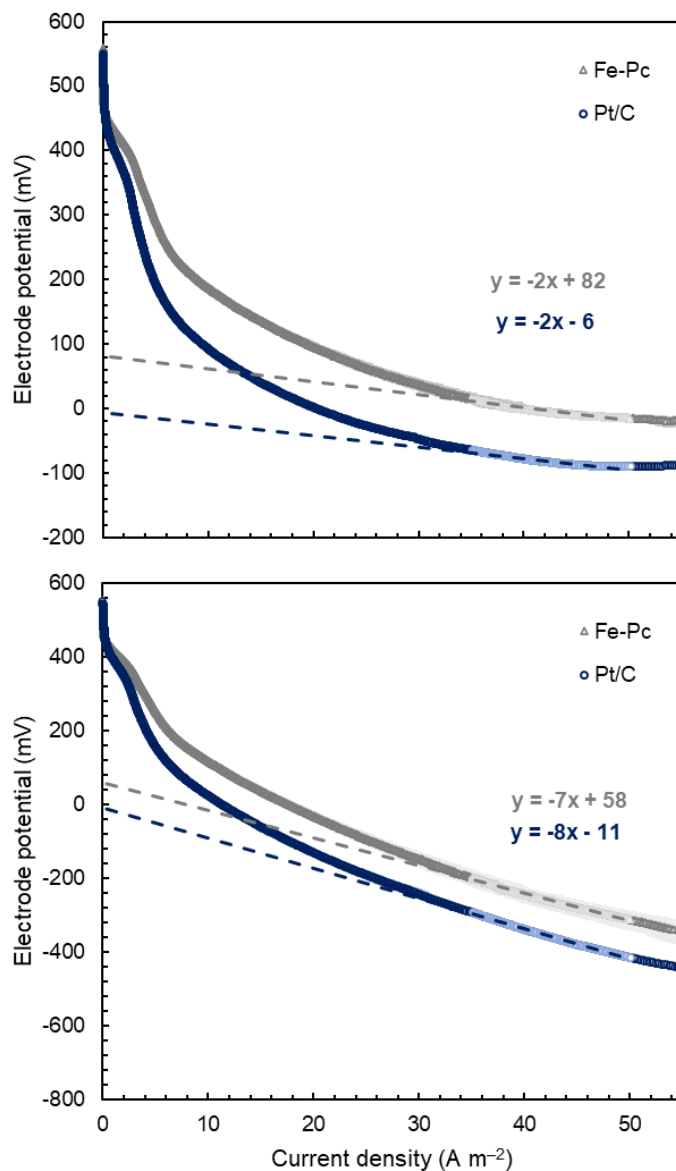


Figure S1: Iron phthalocyanine (Fe-Pc) and Pt/C cathodes performance from LSVs (A) corrected and (B) not corrected for the ohmic drop. The dashed lines represent the linearization of the data in the maximum power region (faded). The cathode resistances, calculated from the slope of the electrode potential in a current density range of 35-50 A m⁻² was similar for the Pt/C and the Fe-Pc cathodes, but the latter showed an electrode potential 88 mV in the same current range (intercept on the y-axis).

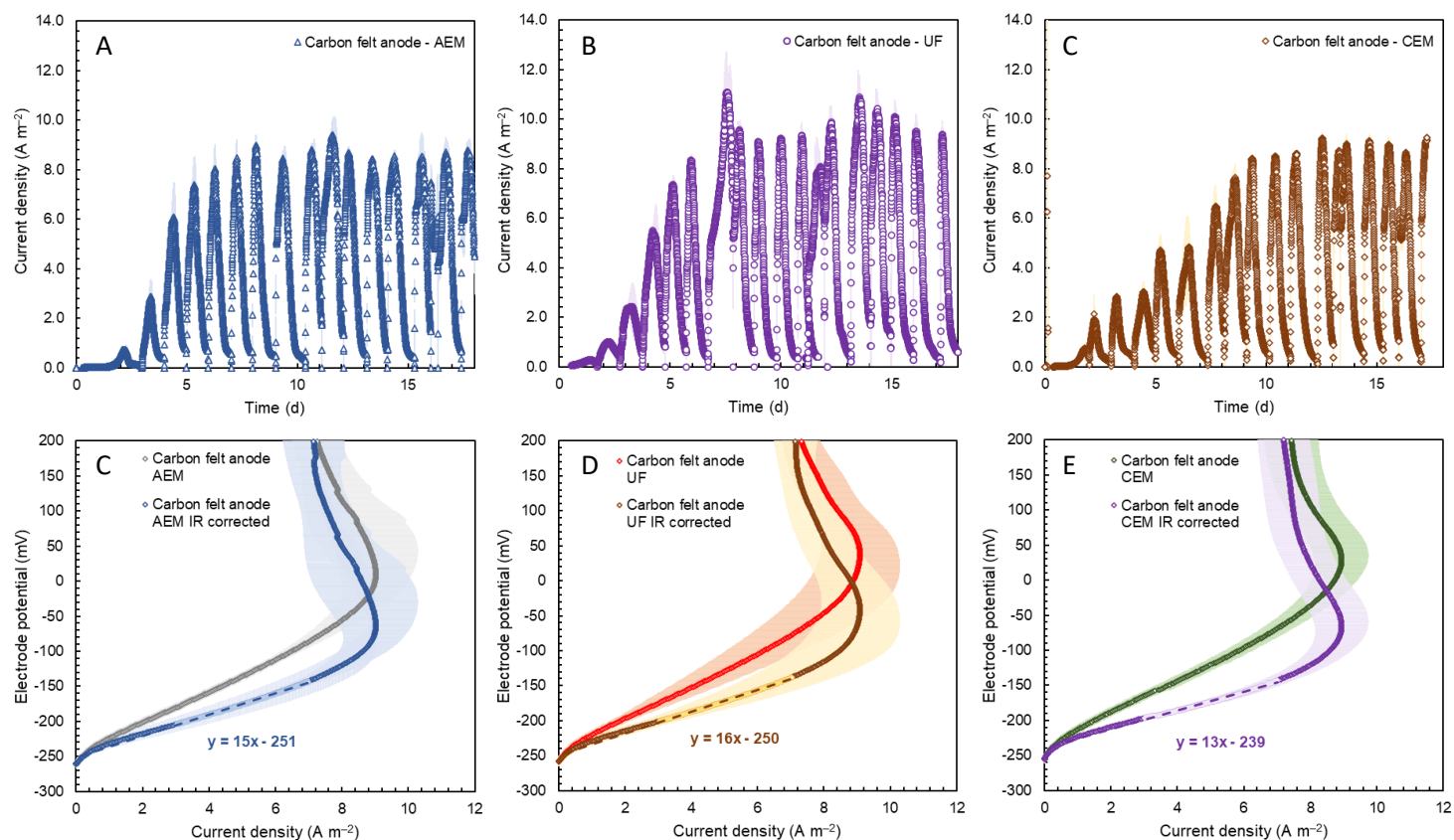


Figure S2: Felt anode (A, B, C) acclimation and (D, E, F) LSVs for the AEM-, CEM-, and UF-MFCs. The CEM- and UF- MFC performance were also tested with the AEM-MFC felt anode with no appreciable change in current and power output. The felt anodes were acclimated for more than three weeks in a cubic MFC in a three-electrode configuration to benchmark the AEM-, CEM-, and UF-MFC performance with anodes having no appreciable impacts on it. The average current density at the end of the acclimation was $8.8 \pm 0.4 \text{ A m}^{-2}$ for the AEM-MFC, $8.7 \pm 0.2 \text{ A m}^{-2}$ for the UF-MFC and $9.4 \pm 0.6 \text{ A m}^{-2}$ for the CEM-MFC. The peak current densities in LSVs were $9 \pm 1 \text{ A m}^{-2}$ for the AEM-MFC, $9 \pm 1 \text{ A m}^{-2}$ for the UF-MFC and $8.9 \pm 0.9 \text{ A m}^{-2}$ for the CEM-MFC.

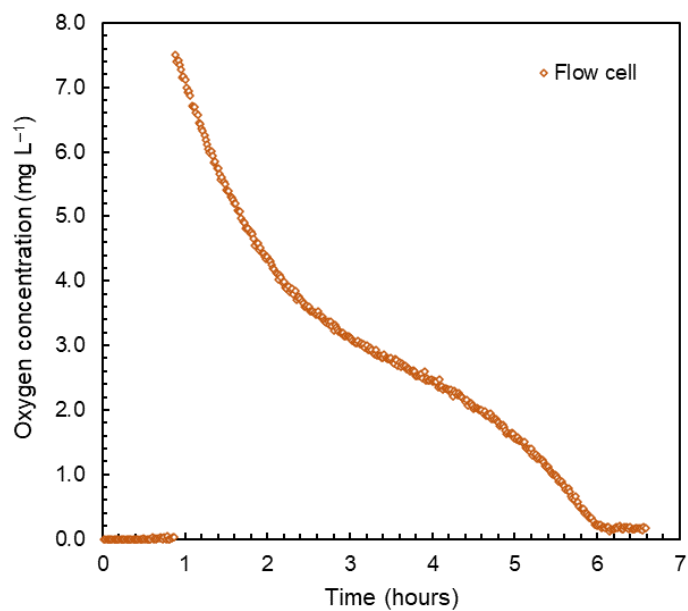


Figure S3: Oxygen depletion after replacement of the media during normal operation of the AEM-MFC. The oxygen concentration in solution was monitored and peaked after replacing the solution (1 h), then completely depleted after 5 h of operation, with no decrease in the MFC performance during that time.

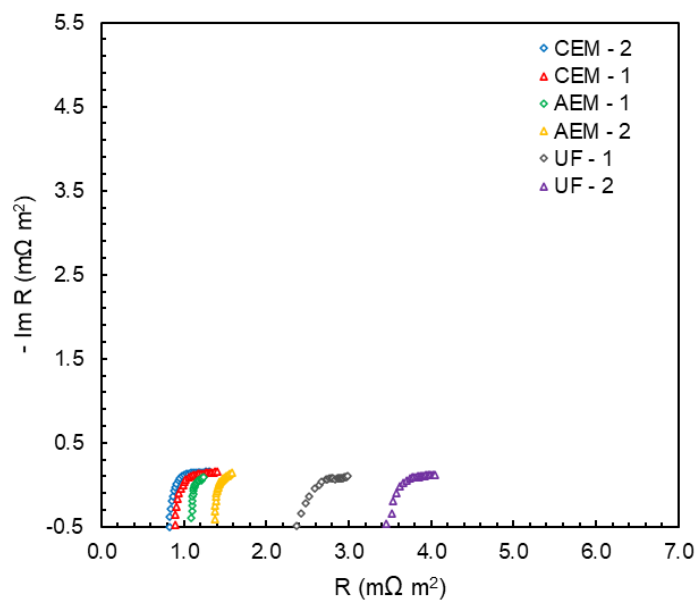


Figure S4: EIS spectra of the AEM-, CEM-, and UF-MFC configurations. The solution resistance (R_{Ω}) was assumed to be the intercept of the spectrum with the x-axis. The CEM-MFC solution resistance ($0.95 \pm 0.04 \text{ m}\Omega \text{ m}^2$) was lower than that of the AEM-MFC ($1.3 \pm 0.1 \text{ m}\Omega \text{ m}^2$), indicating that the higher performance of the AEM-MFC were not due to a lower solution resistance. The UF-MFC showed slightly larger solution resistances ($3.1 \pm 0.5 \text{ m}\Omega \text{ m}^2$).

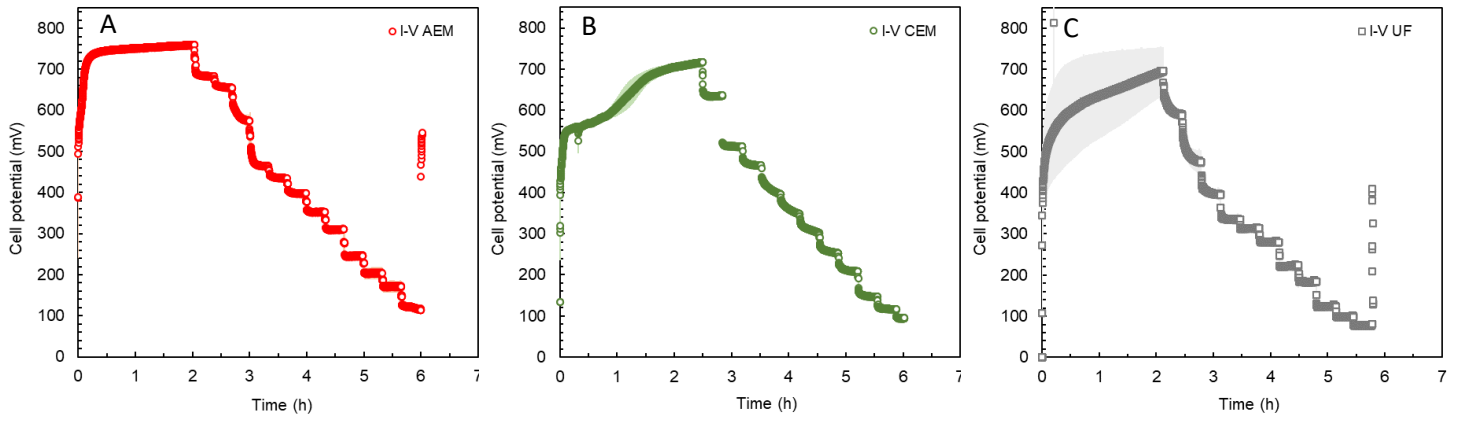


Figure S5: AEM-, CEM-, and UF-MFC whole cell potential measured over time during polarization tests. The external resistance was decreased every 20 minutes and the cell potential was stable during that time

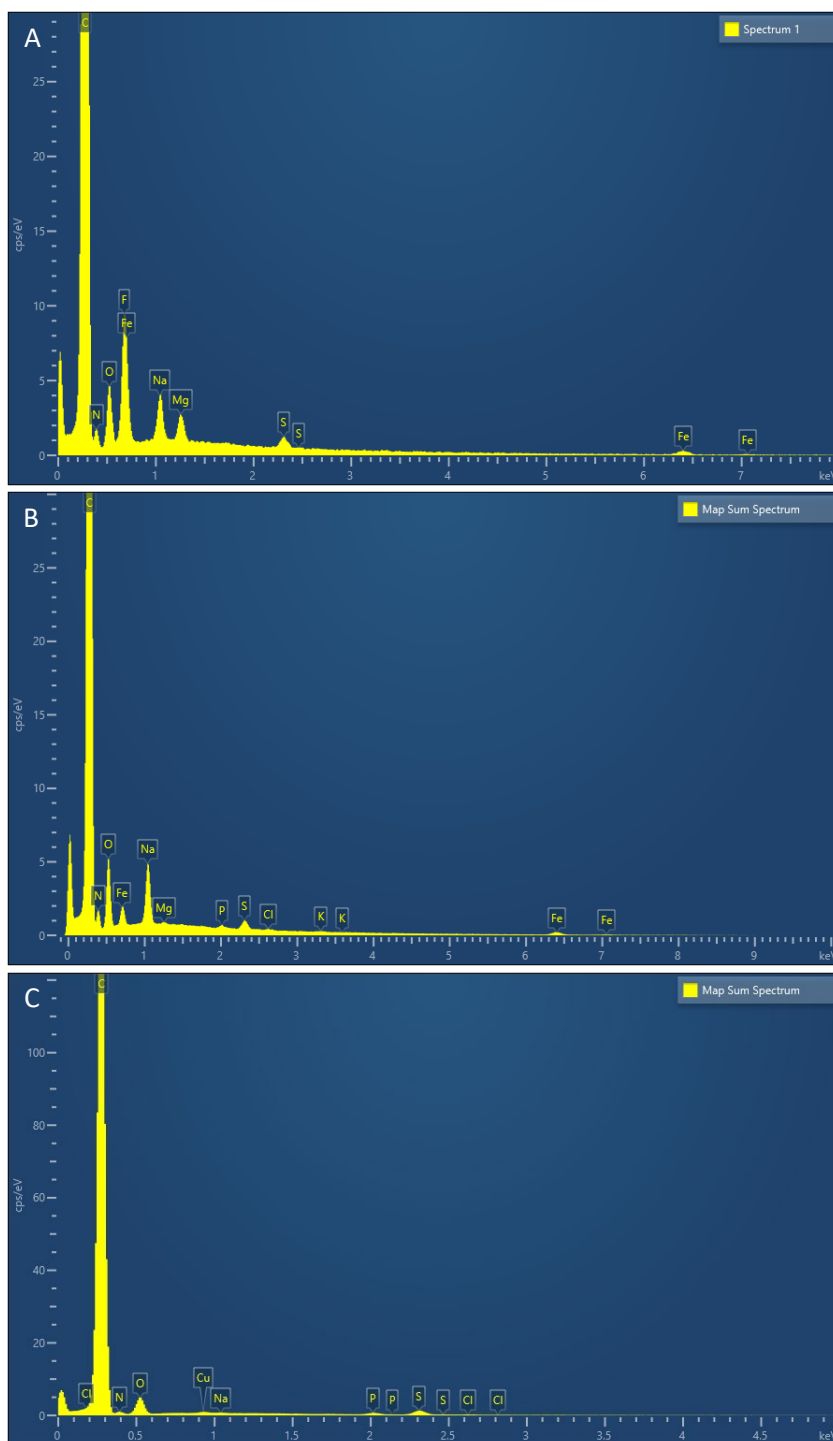


Figure S6: EDX elemental analysis spectra of the membrane side of the MEA cathode of the (A) CEM-, (B) UF-, and (D) AEM-MFC. The cathode and the membrane were peeled off and the membrane side was analyzed. The analysis of the CEM spectrum revealed that mainly positive ions such as Na (1.22% wt.) and Mg (0.72% wt.) were transported through the membrane while the UF spectrum showed presence of positive (Na, 1.54% wt.; Mg, 0.05% wt.) and negative ions (P, 0.12% wt.; likely transported with the buffer). The AEM spectrum did not reveal any positive ion but small amounts of P (0.42% wt.) and Cl (0.11% wt.) were identified. This analysis revealed that CEM and UF membranes mainly transport positive ions to the cathode to balance the electron flow from anode to cathode. The AEM, instead, did

not transport any positive ions and the electron flow is primarily balanced by the transport of OH^- from the cathode to the anode, as no other ions are present in the cathode chambers.

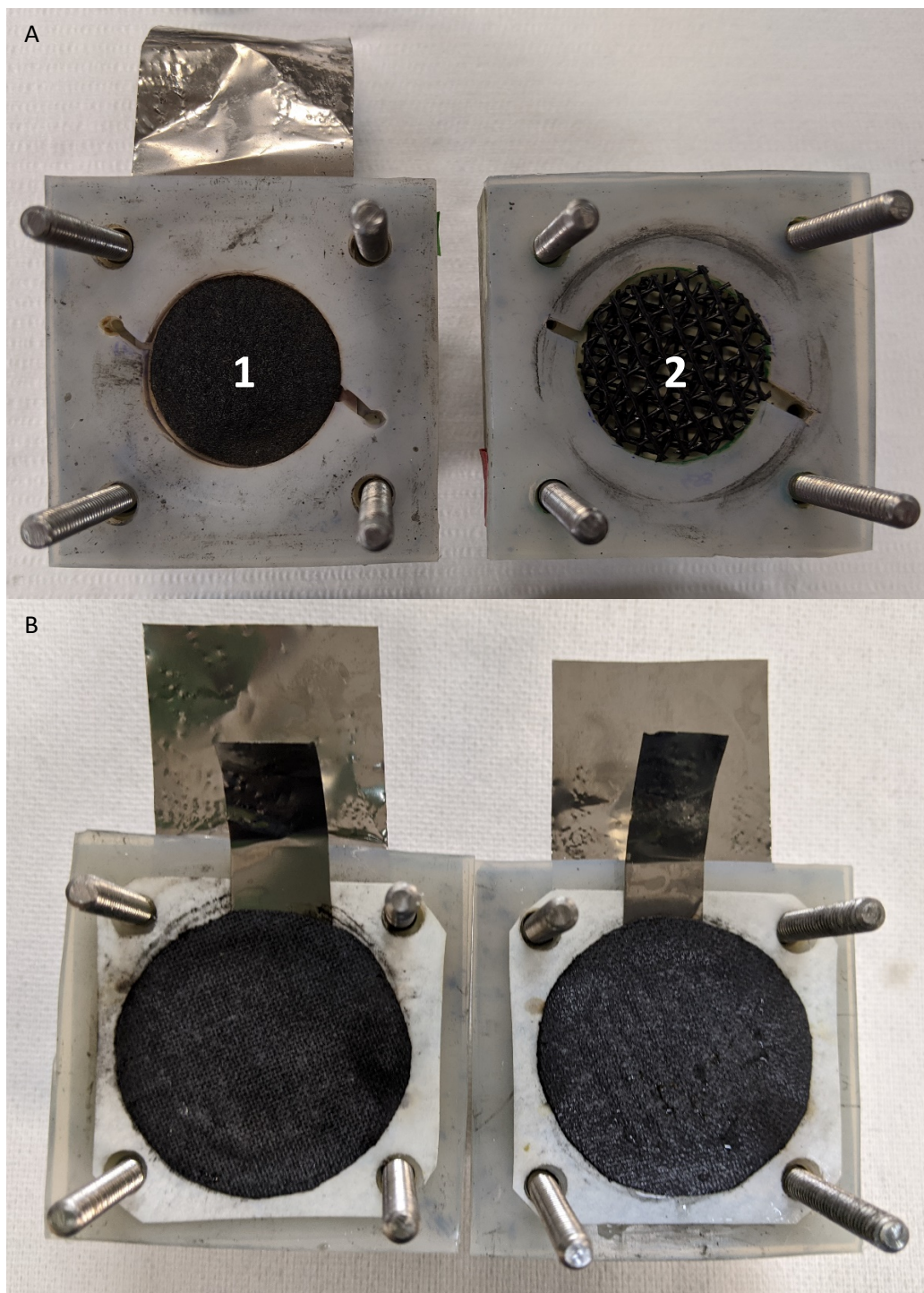


Figure S7: Photographs of the MFC used in this study. (A) (1) Carbon felt anode and (2) gas cathode chamber. (B) Photo of the cathode MEAs with UFM.

Table S1: Concentration of the main cations in solution (concentration > 0.01 mM).

Cation	Concentration (mM)
Sodium (Na ⁺)	106.89
Ammonium (NH ₄ ⁺)	5.79
Potassium (K ⁺)	1.74
Magnesium (Mg ²⁺)	0.15
Manganese (Mn ²⁺)	0.03