Hawaiʻi Natural Energy Institute Research Highlights

Electrochemical Power Systems

Anion Exchange Membrane Fuel Cell

OBJECTIVE AND SIGNIFICANCE: Interest in anion exchange membrane fuel cells (AEMFCs) is driven by the potential for lower cost and increased durability. The goals of this project are to: 1) evaluate the performance of AEMFCs with platinum group metal (PGM) content and PGM-free cathode catalysts under various operating conditions, 2) study effects of membrane electrode assemblies (MEAs) components on mass transport, water management, and durability, and 3) develop electrochemical diagnostic and analysis methods applicable for AEMFC evaluation.

BACKGROUND: Interest in AEMFCs technology (Figure 1) has been driven by possible substitution of Pt electrocatalysts by platinum metal group (PGM)-free materials, since their performance in hydrogen oxidation and oxygen reduction in alkaline media is comparable or even higher than Pt. Moreover, operation in an alkaline environment is less corrosive and can improve durability.

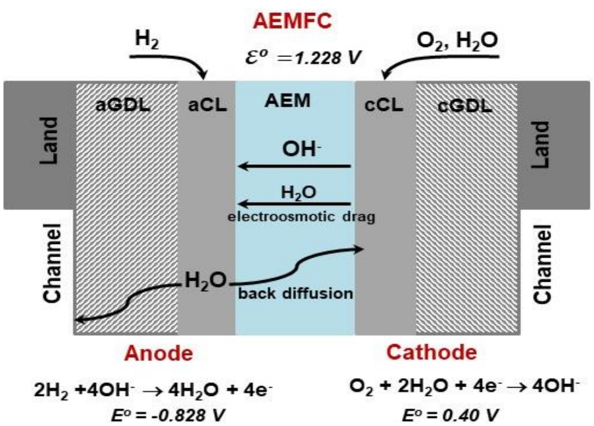

Figure 1. Schematic representation of AEMFC.

The design of MEAs for alkaline fuel cells is still in its infancy. Moreover, operation of AEMFC requires O_2 and water at the cathode, while water production happens at the anode; the situation is completely opposite compared to PEMFCs, which brings additional complexity and requirements to the MEA structure for the alkaline system.

The main approach to improve AEMFC performance and durability is to design catalyst layers with optimal porosity, hydroxide ion conductivity and thickness to ensure development of three phase boundaries, and sufficient reagents transport, as well as adequate choice of gas diffusion layers (GDLs) for better water management. In addition, there is a lack of harmonized testing protocols and procedures, and development of electrochemical diagnostics and approaches are critical for AEMFC.

PROJECT STATUS/RESULTS: Under this effort, HNEI has achieved the following results. To address the observed performance discrepancy in AEMFCs, suppliers of anion exchange membranes and ionomers were consulted to discuss potential causes. Based on these discussions, it was recommended to re-evaluate the conditions for ink formulation, preparation, and deposition to ensure consistency and optimal performance. For electrode production, it was suggested to deposit the catalyst ink onto a heated substrate or membrane (T=40-50°C). Following these recommendations, several series of MEAs were manufactured, utilizing Pt/C on both electrodes and PtRu/C and Pt/C for the anode and cathode, respectively. The effects of compression ratio on the integrity of membrane electrode assemblies (MEAs) were studied, revealing an optimal compression range of 20-25%. Based on these findings, recommendations were developed for selecting suitable gasket materials to maintain MEA durability and performance. An evaluation of MEAs with Pt and PtRu anode electrodes demonstrated that the use of PtRu significantly improved MEA performance (Figure 2).

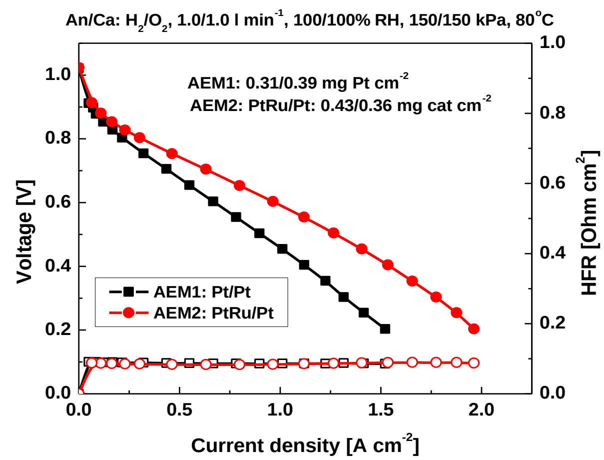

Figure 2. Polarization curves and high frequency resistance (HFR) for Pt and PtRu AEMFCs.

Future work will include a continuation of electrochemical studies of AEMFCs with a focus on MEAs reproducibility, durability, and performance.

Funding Source: Office of Naval Research

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Last Updated: November 2024