UNIVERSITY OF CENTRAL FLORIDA

Insight into Membrane Degradation Mechanisms Through Verification of Chemical and Mechanical Degradation Test Capabilities

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Description: The objectives of the program are to gain insight into fuel cell membrane degradation mechanisms including both chemical and mechanical degradations. In order to achieve this objective, the Membrane Electrode Assembly Durability Test System, MEADS, was verified, after which chemical degradation tests were conducted. By performing post mechanical testing and analyzing the data, the impact of accelerated degradation tests on the cell performance decay, chemical decomposition and mechanical weakening of the membranes will be revealed.

Budget: $324,000

Universities: UCF/FSEC

Progress Summary

Progress Made Toward Objectives During Reporting Period: Axial load is a critical parameter for cell assembly because components must be in intimate contact to achieve low proton and electrical resistance but too much compression will decrease porosity of the catalyst layers and the gas diffusion layers and add stress to the membrane, resulting in decreased performance and increased degradation.

To examine the effect of axial load on performance and durability, cells were built with pinches of 5-6, 8-10, and 13-14 mil. Adjusting the thickness of the gaskets around the MEAs controlled the amount of pinch each cell experienced. All cells were humidified, performance tested, durability tested and finally performance tested again.

To evaluate the level of degradation, the OCV and fluoride emission rates were monitored during the degradation test, Figure 1, and the pre- and post-test performances were compared. The initial OCV for all cells ranged from 1.028-1.045 V. The changes in OCV were very similar for all cells. The fluoride emission rate values and trends were also very similar. However, when the performance curves before and after durability testing are plotted, not only is it apparent that all cells decreased in performance after testing, but it appears that the cells with pinches of 8-10 mils decreased in performance the most, Figure 2.

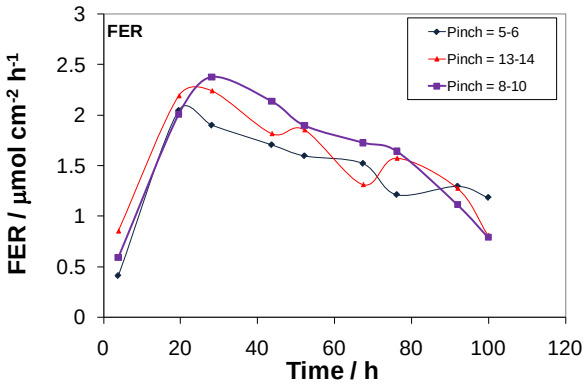

Figure 1. Average Fluoride Emission Rates.

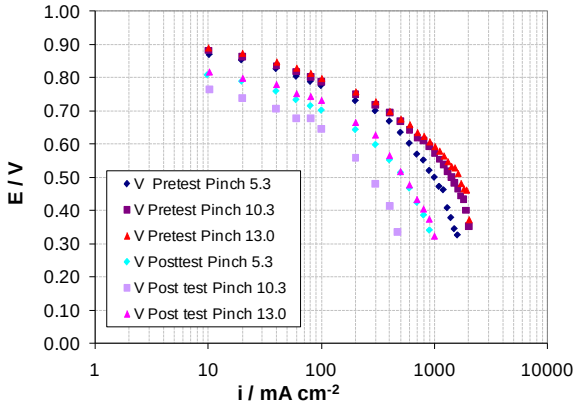

Figure 2. Performance curves of cells with varying pitch.

Additional cells were run on the MEADS in order to acquire enough data for meaningful analysis to estimate the characteristics associated with the chemical and the mechanical degradation mechanisms. Eight cells were prepared to be run simultaneously. Three of these cells contained FSEC-3; two of the cells contained FSEC-3 + 0% PTA; two of the cells contained NRE211. One cell contained an Ion Power CCM. All eight cells were assembled, and OCV tested for 100 h under 0.2 L/min H_2/Air at 90 ^oC and 30% RH. The data obtained was recorded and analyzed.

An apparatus for the testing the mechanical strength of membranes was transferred from the University to the lab at FSEC. It was installed, verified to be functioning correctly and calibrated. This apparatus will be used to determine loss of mechanical strength in samples that have been subjected to durability testing.

Additional experiments for determining the presence of pinholes in an MEA lead to the conclusion that the method developed last reporting period did not generate data that was adequately reproducible. Other methods for locating pinholes are being reviewed and will be evaluated under an alternate program.