The CO-Air Bleed Interaction and its Impact on Durability

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Introduction

The commercialization of fuel cells as a viable alternative to current technology for stationary and automotive requires stringent demands from the catalyst coated membrane (CCM) in terms of power density, durability and cost. Most notably the durability requirements for stationary systems range from 40,000 to 60,000 hr while automotive applications demand at least 5000 hr under dynamic load conditions.

The lack of a hydrogen economy today will continue to motivate the use of hydrocarbon fuels either directly or after conversion into a hydrogen rich stream. It is well known that reformate fuels derived from these hydrocarbons contain in addition to H_2 significant amounts of CO_2, and N_2 and trace levels of CO in the ppm range. It is also well known that trace levels of CO cause significant poisoning of the Pt-based catalyst, and that one of the common ways to mitigate the effect of CO is to chemically oxidize the CO to CO_2 with O_2 in an air-bleed. While improvements in power density in CO containing fuel streams have been a key objective of research over the years, the effects on durability has not been widely reported. A more recent review suggests potential problems in terms of H_2O_2 concentration [1].

In this work we discuss the impact of CO and air-bleed on the durability of PEM fuel cells. There exists sufficient evidence and research that suggests the formation of H_2O_2 and the subsequent generation of $OH^\bullet$ free radical is an important factor. The radical is known to chemically attack the ionomer and therefore impact the durability of the membrane. This paper will discuss in detail the key findings and some of the new technology that was developed using accelerated test protocols at Gore to mitigate this problem. Currently, lifetimes exceeding 10,000 hr in reformate (40% H_2) containing 50 ppm CO has been achieved with less than 10 μV/hr durability decay rate at high current densities.

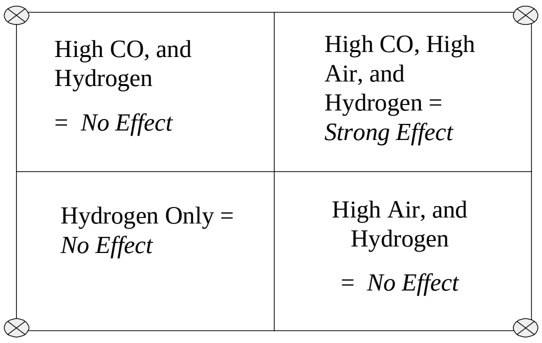
Experimental

All durability experiments were performed using PRIMEA® Series 5621 Membrane Electrode Assemblies (MEAs) with an active area of 25 cm^2. The MEAs were assembled in test fixtures with triple channel serpentine flow fields on both the anode and cathode sides. The gas diffusion media was CARBEL™ CL for all tests.

Polarization curves in reformate-air were recorded at different intervals of time. Further, for the accelerated tests additional polarization curves were recorded in H_2-air as well as in H_2-oxygen for diagnostic purposes. After the tests additional microscopy was performed on several samples to elucidate failure modes.

Results and Discussion

Figure 1 shows the scheme employed for the accelerated test. This presentation will focus on key results from the accelerated test and discuss some of the new technology that has enabled Gore to obtain long term durability over 10,000 hr under realistic operating conditions.



High CO, and Hydrogen = *No Effect*	High CO, High Air, and Hydrogen = *Strong Effect*
Hydrogen Only = *No Effect*	High Air, and Hydrogen = *No Effect*

Figure 1. Map describing the scheme for the accelerated test.

References

1. Markovic N.M., Schmidt T.J., Stamenkovic V., and Ross P.N., Fuel Cells, Vol. 1, No. 2, pp. 105 (2001).