Impact of Membrane-Electrode Assembly Fabrication Technique on PEM Fuel Cell Performance

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INTRODUCTION

PEM fuel cell performance is limited by three main sources of polarization losses: activation, ohmic and mass transport. Relative magnitudes of these differ depending upon the type of catalyst, membrane and substrate used in the fuel cell. More importantly there can also be a large variation in these losses between different cells having the same component due to the different fabrication techniques used in making the Membrane-Electrode Assembly (MEA). For a particular technique like screen-printing the processing conditions alter the performance due to the different polarization losses[1]. These differences become more significant at higher operating cell temperature and lower relative humidity operation.

EXPERIMENTAL

Baseline MEAs were made by first screen-printing the catalyst slurry onto a Teflon® Blank to fabricate the electrode decals. Next the anode and cathode decals were hot pressed onto each side of the membrane. Electrodes were transferred to the membrane by peeling off the Teflon®. Gas Diffusion Layers (SGL Technologies) were then pressed against the Catalyst Coated Membrane and assembled in fuel cell hardware.

Fuel cell performance was obtained using a fuel cell test station (Scribner Associates, model 890C) and a flow loop built in house. *In situ* ohmic resistance was obtained using a combination of current interruption technique and a milliohm meter. Catalyst utilization was obtained by doing cyclic voltammetry. In combination with the above-mentioned experiments, current ratio, oxygen gain and limiting current were calculated from the H_2/air and H_2/O_2 performance curves to decouple the different sources of polarization losses.

RESULTS

Fig 1. shows performance curves for two cells operating at 120°C cell temperature, atmospheric pressure and 35% relative humidity (RH). 25µm thick Nafion®-Teflon®-phosphotungstic acid membranes from Ionomem Corp. were used in the cells. B752 was made without adding propylene glycol to the catalyst ink and the drying temperature for the catalyst was 65°C, whereas catalyst ink for B744 had propylene glycol as a solvent and was dried at 130°C because of the high boiling point of propylene glycol. The lower drying temperature for B752 resulted in a lowering of the ohmic loss in the catalyst by about 125 mohm-cm^2, but at the same time its oxygen gain increased by 35mV compared to B744. Propylene glycol acts as a poreformer and improves the oxygen diffusion in the catalyst.
Further results on the effect of MEA fabrication and performance based on the optimized fabrication technique will be discussed in the presentation.

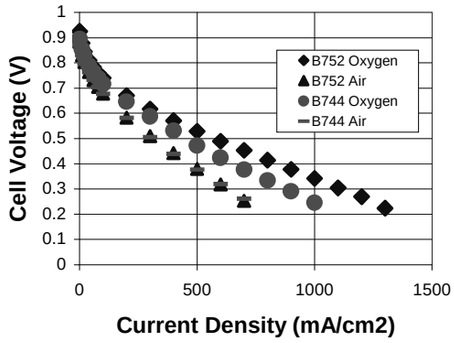

Fig 1. Active Area = 6.25 cm^2, Cell Temp. 120°C, 35%RH, ambient pressure, catalyst loading: cathode 0.45mg/cm^2 Pt/C (Tanaka Kikinzoku Kogyo, Japan), anode 0.3 mg/cm^2 Pt-Ru/C(Tanaka Kikinzoku Kogyo, Japan).

REFERENCES

1. R. Zaffou, V. Mittal, H. R. Kunz, J. M. Fenton, Abstracts of the 205th Meeting of the Electrochemical Society, San Antonio, May 2004 (Abstract No. 310)

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