

## Recoverable Performance Losses in PEM Fuel Cells

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When a PEM fuel cell is operated without interruption for an extended period of time, the performance decreases continuously. The vast majority of the observed performance loss can be recovered, generally by shutting the cell down and restarting it. These recoverable performance losses are the subject of the present investigation.

A series of diagnostic analyses were applied to ascribe performance loss observed in subscale cells to mass transport losses, Ohmic losses, or decreases in catalytic activity. *In-situ* membrane resistance measurements during constant-current holds indicated no change in membrane resistance, while performance decreased significantly, Fig. 1. Fuel cell polarization curves conducted before and after extended holds showed no change in limiting current, ruling out mass transport losses, Fig. 2. Reducing the cathode potential while keeping the anode potential constant as the cell went off-load recovered the performance. This later observation indicated that the source of performance loss was the cathode, rather than the anode. Taken together, the results indicate that the performance loss is caused by decreased cathode catalytic activity for oxygen reduction. The fuel cell polarization data (Fig. 2) also indicate activity loss.

The rate of performance loss decreased exponentially with time on load, and increased with increasing potential, Fig. 3. These trends were observed with both Pt-black and Pt/C cathode catalysts. The electrochemical surface oxidation of platinum was characterized by growth in the platinum oxide reduction feature in the cyclic voltammogram immediately following potentiostatic holds. The results were compared to previously published studies of platinum surface oxidation, e.g. [1-7]. At constant coverage, surface oxide species formed at low potential over a longer period of time were reduced at lower potential than those formed more quickly at high potential. The results obtained were all consistent with a hypothesis of platinum surface oxidation reducing cathode catalytic activity as the root cause of the observed performance loss.

## References

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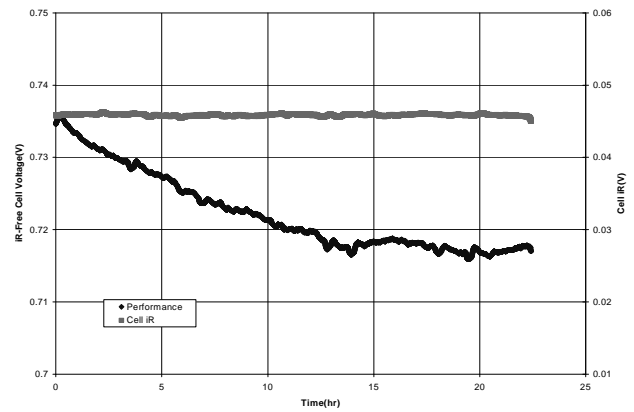


Figure 1: Comparison of changes in the performance and cell  $iR$  at  $538 \text{ mA/cm}^2$ .

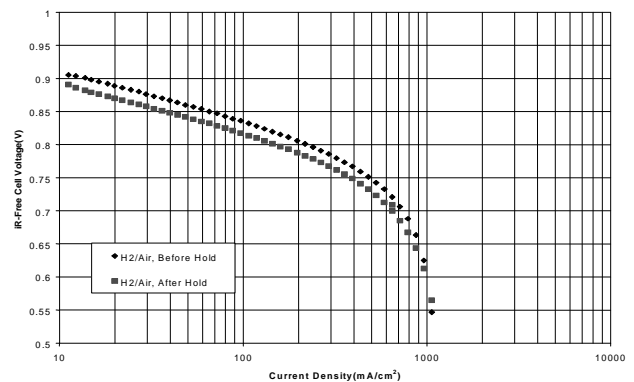


Figure 2:  $\text{H}_2/\text{Air}$  performance before and after 64 hour hold at  $646 \text{ mA/cm}^2$ .

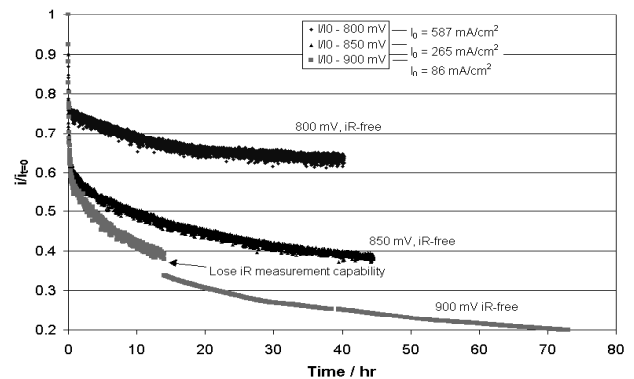


Figure 3: Normalized current density ( $i/i_{t=0}$ ) measured under  $\text{H}_2\text{-O}_2$  reactants as a function of time at 800-900 mV,  $iR$ -free, Pt-black electrodes.