Local Current Density Prediction in a 200cm² PEMFC Semi-Segmented Electrode System

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Introduction
For PEMFC systems, experimental methods are being developed to map the current density distribution on the membrane surface. One of the best methods available to experimentalists to measure local current density is segmented electrode analysis. By electrically isolating electrode sections and measuring the current produced in each section a more accurate map of local current density can be obtained.

Another tool, besides segmented electrode experiments, that can be used to understand the physics inside fuel cells is a three dimensional electrochemical simulation based on models such as those of Shimpalee and Dutta, and Lee et al. These models can simulate a variety of operating conditions, have been experimentally verified, and predict the local current density at a much finer scale than segmented electrode experiments.

This paper seeks to compare the results for local current density obtained with the three-dimensional model of Shimpalee et al and compare these results to the semi-segmented electrode experiments demonstrated by Buechi et al, for a variety of operating conditions.

Numerical Procedure
Shimpalee and Dutta, and Lee et al. have detailed a three-dimensional, two-phase, non-isothermal model of PEMFC’s. This model has been validated against water balances and polarization curves. The model has not been used to validate local current densities measured by segmented electrode experiments. This paper seeks to compare the local current densities for similar systems obtained by segmented electrode and CFD modeling analyses.

Using STAR-HPC, a 200cm² cell was created to be representative of the geometry used by Buechi et al. (shown in Figures 1 and 2). The model will be exercised using parallel algorithms for a range of stoichiometric ratios and inlet humidity conditions. The geometry is easily decomposed into segments identical to those used in the segmented electrode experiment and the local current density profiles will be volume averaged over those segments. These results will be compared with the results of Buechi et al.

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References

