Local Current Density Prediction in a 200cm^2 PEMFC Semi-Segmented Electrode System

S. Greenway, S. Shimpalee, and J.W. Van Zee
Department of Chemical Engineering, University of South Carolina, Columbia, South Carolina, 29208
and
Felix Buechi
Electrochemistry Laboratory
Paul Scherrer Institut
CH-5232 Villigen PSI, Switzerland

Introduction

For PEMFC systems, experimental methods are being developed to map the current density distribution on the membrane surface[1, 2]. 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.[3] and Lee et al.[4]. 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[4]. for a variety of operating conditions.

Numerical Procedure

Shimpalee and Dutta.[3] and Lee et al.[4] 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 200cm^2 cell was created to be representative of the geometry used by Buechi et al.[2] (shown in Figures 1and 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.[2]

Acknowledgements

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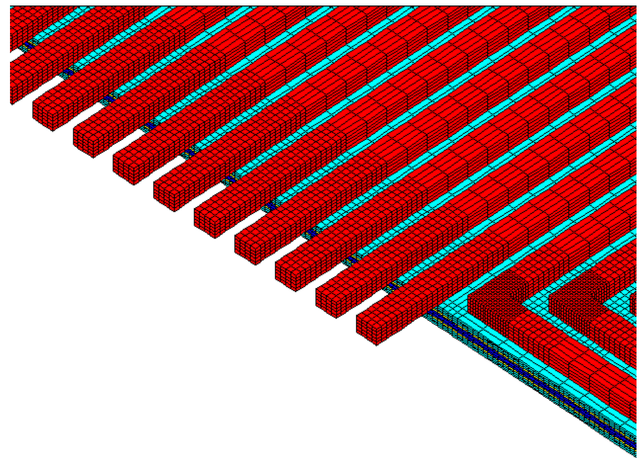

Figure 1. Section of Segmented electrode cell geometry

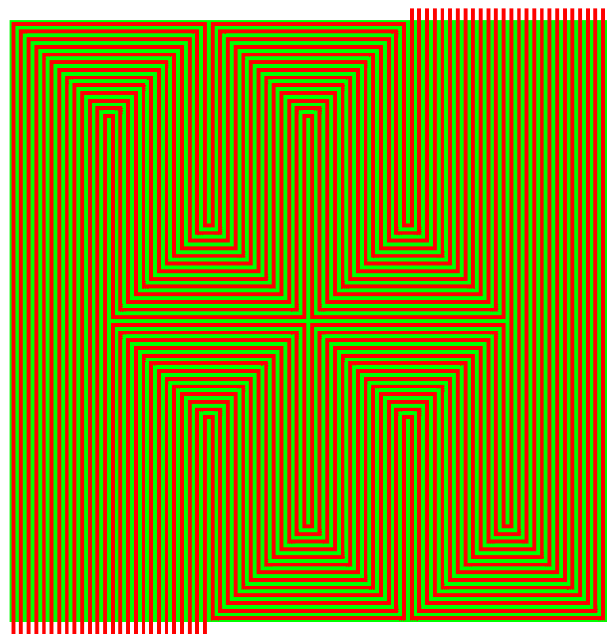

Figure 2. Flow-field pattern for the segmented electrode model at cathode side.

References

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