Investigations on Polarization Losses in Planar Solid Oxide Fuel Cells

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Abstract

In recent years, various configurations of planar Solid Oxide Fuel Cells (SOFC) have been developed for enhancing its performance. The objective of these efforts are centered on reducing polarization losses (also referred as "overpotential") by optimizing the structure and properties of three key components- anode, electrolyte and cathode. The present work was aimed at developing a model for simulating single channel using COMSOL Multiphysics® by taking electrochemical, mass transport and fluid transport aspects of SOFC modeling into account. The developed model was validated by conducting experiments using electrolyte supported SOFCs. Also, the exchange current density was deduced experimentally and was in turn used in simulations for improved accuracy. Detailed electrochemical analysis was carried out for anode, electrolyte and cathode supported SOFC with support thickness ranging from 10µm to 1mm and cathode supported SOFC was found to perform better. In order to establish this fact, the interface overpotential was derived for SOFC of different configuration and compared. For cathode supported SOFC, the activation and Ohmic overpotentials were the major contributors of polarization losses while concentration overpotential was significantly lower. For an electrolyte supported cell, ohmic overpotential dominates over activation and concentration overpotentials. However, for anode and cathode supported cells, the activation overpotential is higher compared to ohmic and concentration; with cathode supported cell having significantly lower concentration overpotential as compared to anode supported cell and thus justifying its better performance.

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Figures used in the abstract

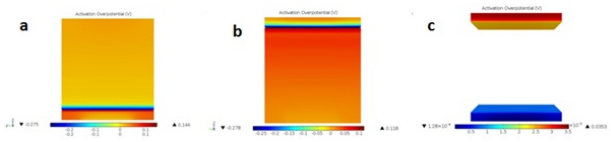

Figure 1: Distribution of Activation Polarization for (a) CSC, (b) ASC and (c) ESC at 0.7V and 800 C.

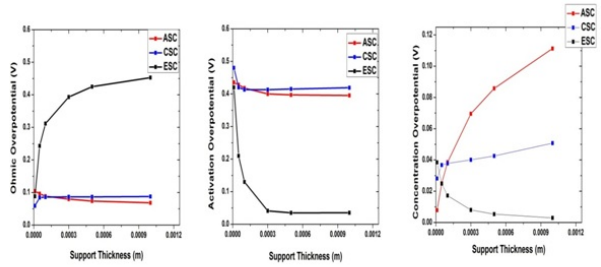

Figure 2: Variation of (a) Ohmic, (b) Activation and (c) Concentration overpotential with respective support thickness at 0.7V and 800 C.

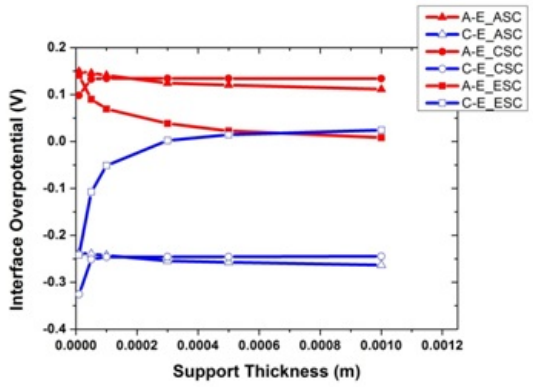

Figure 3: Variation of overpotential at electrode-electrolyte interfaces with component thickness at 0.7V and 800 C.