Multi-Dimensional Micro-Scale Model for Oxygen Reduction on LSM-YSZ Cathode

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Activation of the oxygen reduction reaction at the cathode is a major source of polarization in Solid Oxide Fuel Cells (SOFCs), and a detailed understanding of the kinetics of this reaction under SOFC operating conditions is imperative for development of efficient cathode designs. In this study a multi-dimensional micro-scale model is developed to simulate the oxygen reduction on a LSM-YSZ composite cathode. The model incorporates the effects of cathode microstructural properties on the local transport phenomena and electrochemistry inside the cathode. The microstructure properties are obtained for real cathodes using analysis of cathode images from FIB-SEM experiments. A detailed reaction mechanism is used in the model which has two parallel routes for oxygen conversion into oxide ions, namely two phase boundary and three phase boundary pathways. The model predicts field distributions of local thermodynamic values, over-potential, Faradaic current and other parameters relevant to cathode performance. Electrochemical impedance simulations are performed using the model to analyze the contribution of various processes to the overall impedance. The results reveal essential details regarding contributions from the two parallel pathways to the overall reaction, and the effect of microstructure on the local distributions inside the electrode and its overall performance.