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Characterizing the Impact of Electrode Fabrication and Microstructure Upon SOFC Multi-Physics Transport

The performance and reliability of a solid oxide fuel cell (SOFC) is sensitive not only to the components' chemical composition, but also the topology/microstructure of the material components that are made, as well as the operating conditions. Prior studies in this regard have been primarily restricted to electrochemical characterization, with a focus upon air-based oxidant streams. Performance and reliability, however, are also strongly related to the temperature fields that result along application-scale SOFCs. Additionally, of particular interest in this research, oxidant streams aside from air may be the emphasis. The presently proposed study thus expands experimental and computational characterization to include coordinated measurements of electrochemical and thermal properties as functions of electrode microstructure. This study will leverage these findings into higher fidelity models and simulations of cell performance and reliability, under conditions and environments relevant to Land based Power Generating Sources (LPGS). The thrusts are to measure and resolve the explicit dependencies of these multi-physics properties upon microstructure, and subsequently characterize the coupled nature of electrochemical and thermal transport via full cell simulations. The central approach is to implement a Design of Experiments wherein SOFC components and cells of variable electrode microstructures are produced and tested for multi-physics transport functionality. Primarily, the cells will be fabricated, and then electrochemically tested at representative reactant stream compositions. Again a focal point will be to assess the impact of alternative oxidants upon cell performance, as a function of cell fabrication/microstructure. Subsequently, the test cells will also be tested for characterization of thermal transport (e.g., thermal conductivity) and response (e.g., thermal diffusivity), likewise as functions of cell fabrication/microstructure. Simultaneously, prior SOFC multi-physics modeling developments will be leveraged and enhanced for higher fidelity simulations and design insights, given these properties.