SOFC-MP – Modeling Tools for Solid Oxide Fuel Cell Stacks

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SOFC-MP is an integrated modeling tool developed at PNNL to evaluate the tightly coupled multi-physical phenomena in SOFCs. The purpose of the tool is to allow SOFC designers to numerically test changes in stack design, component materials, and operating conditions. These models will complement physical testing and aid manufacturers with design and materials development choices to achieve DOE technical targets. The SOFC-MP software tool consists of two modules (a 2D and 3D model) that aim for different purposes in the stack engineering process. The 2D model is very computationally efficient so that it can quickly compute the distributions of current, voltage, temperature, and species composition in a tall stack. The 3D model provides detailed distributions of the same physical properties in the entire 3D domain, and thermal stresses can then be computed from the temperature field with a follow-up structural analysis.

The poster will focus on advanced features of the 2D model and extensive parametric studies using the model. The enhanced 2D model capabilities which include the cell-to-cell variation feature have helped to bring greater understanding of actual experiments where uniform nominal performance is not always achieved. The results of more recent parametric studies using the enhanced 2D model on thermal uniformity in the stack are also presented. Finally, the poster also presents the proposed road map for 3D model development and improvements to provide greater accessibility and user flexibility.