Mechanical Characterization and Modeling of Electrolyte Membranes in Electrolyte-Supported SOFCs

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Planar Solid Oxide Fuel Cells (SOFCs) are made up of repeating sequences of thin layers of energy producing ceramics, seals, and current collectors. For electro-chemical reasons it is best to keep the ceramic layers as thin as possible, which also means that the cells are more susceptible to damage during production, assembly, and operation. The latest-generation electrolyte-supported SOFC membrane, termed the FlexCell™, from NexTech Materials, have thin electrolyte layers that are supported by thicker frames and a honeycomb-type support structure. While the entire electrolyte area is electrochemically active, the thin regions comprise the “active area” of the electrolyte. Materials characterization and finite element modeling studies are underway to optimize the support sections of the electrolyte while maintaining high active areas.

FlexCell membranes, which are much smaller in thickness than they are in area, require a two-scale approach for finite element modeling; the smaller scale focuses on analyzing a representative area of the cell, while the larger scale examines the cell as a whole. To provide the material data for the models, an array of experimental techniques are needed. The small scale model requires bulk elastic properties of the electrolyte material, which are measured over a range of temperatures using a sonic resonance technique. This model then outputs “effective” properties for the large scale, which must be experimentally validated using four-point bend experiments on representative samples. Results of the modeling show where the highest stresses exist at both small and large scales and suggest ways to improve the mechanical robustness of the electrolyte membranes.