Introduction

- Simultaneous calibration of polarization curves and impedance behavior is necessary for SOFCs model developments, but was largely neglected in the literature.
- Tens of parameters are nonlinearly coupled in the multi-physics model of SOFCs, so that large number of datasets are needed for model calibration.
- The accurate prediction of cell performance at different air/fuel utilization conditions, as well as different working loads, should also be considered for model developments.
- The present study aims to find the way of determining the essential properties of fuel cells via efficient combination of experiments and numerical simulations.

Model Description

- Physics-based SOFC Analysis Procedure
  - Governing Equations
    - Charge conservation
    - Electrode phase
    - Electrolyte phase
    - Dense electrolyte
    - Species transportation
    - Butler-Volmer type equations
    - Diffusion coefficients
    - Effective conductivity
  - Microstructure Properties
    - Length of triple phase boundary
    - Interface area between ion-conducting and electron-conducting phase
    - Tortuosity

Results

- Calibration Procedures for Button Cell
  - Simultaneous calibration of polarization curves and impedance behavior

- Detailed Analysis of Processes Inside Electrodes
  - Air/fuel fraction distribution within electrode
  - Performances with different working loads and impedance of electrodes

Acknowledgements

- As part of the National Energy Technology Laboratory’s Regional University Alliance (NETL-RUA), a collaborative initiative of the NETL, this technical effort was performed under the RES contract DE-FE0004000.2.621.248.001.
- The authors also wish to explicitly thank the group of Dr. Shiwoo Lee of NETL for providing the datasets of several baseline and Co-infiltrated cells.
- Experimental datasets are analyzed in conjunction with empirical polarization analysis to extract essential information of the fuel cell, and finally refined by multi-physics numerical simulations.
- This procedure can also predict the SOFC performances for different utilization cases and working loads, as well as cell performance due to microstructural changes, such as infiltration and degradation.