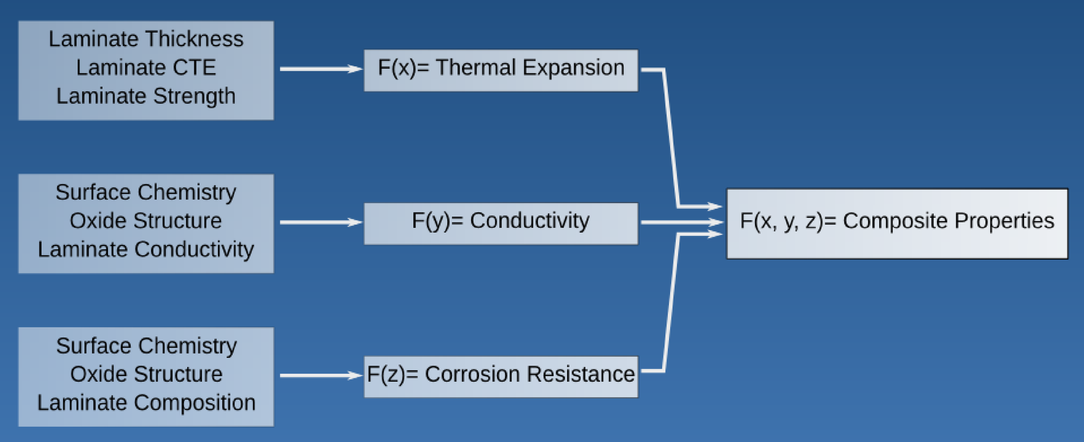
Hybrid Materials for SOFC Interconnect Applications

Micah Casteel

Rensselaer Polytechnic Institute

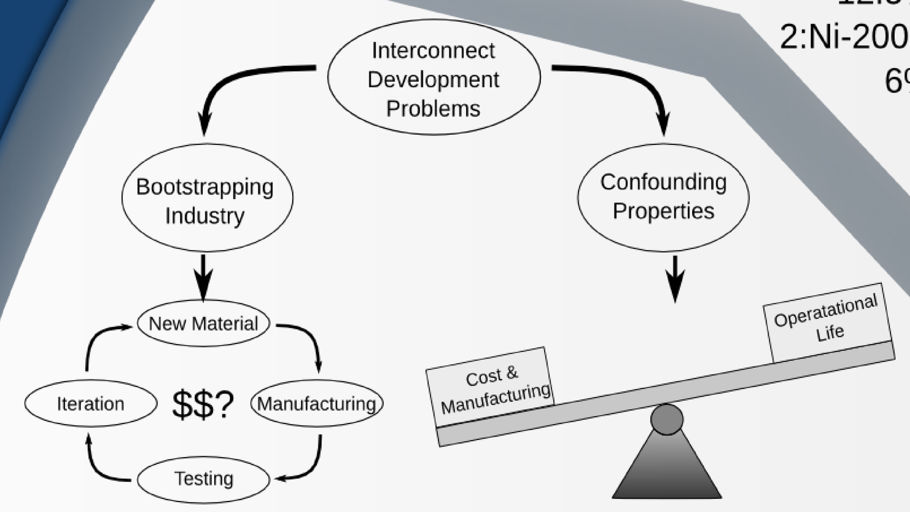
Hybrid Materials Design Approach

Due to the constraints imposed on this system, both technical and economic, the current materials in use are inadequate. However, designing a novel monolithic material would be economically unfeasible. Instead we chose to address this problems using a hybrid materials design approach.



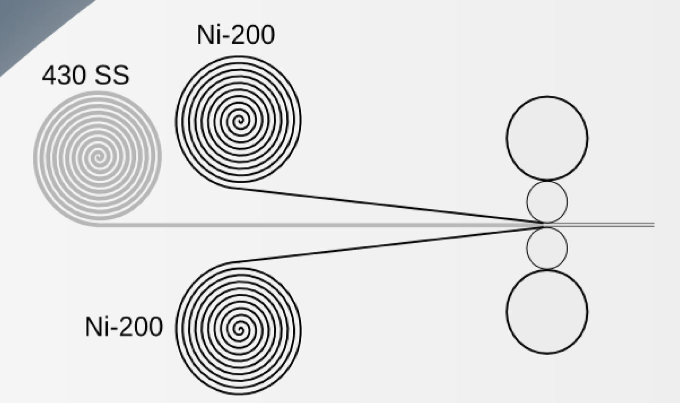
Abstract

Solid oxide fuel cells(SOFCs) allow for extremely high efficiencies of energy conversion and direct use of traditional fuels without upgrading our infrastructure. However, interconnect degradation (among other problems,) limits the adoption rate of SOFCS. This degradation is the result of inadequate materials, however no good alternatives exist. Our approach is to pursue novel materials combinations resulting in a new hybrid material that can be fabricated using common materials and materials processing techniques.

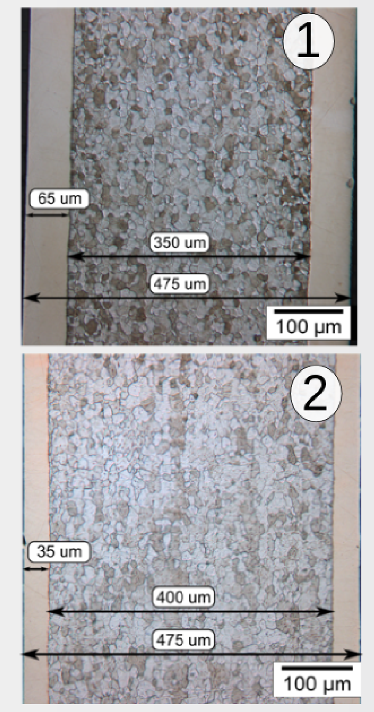


New materials require both industry development and balancing of individual properties

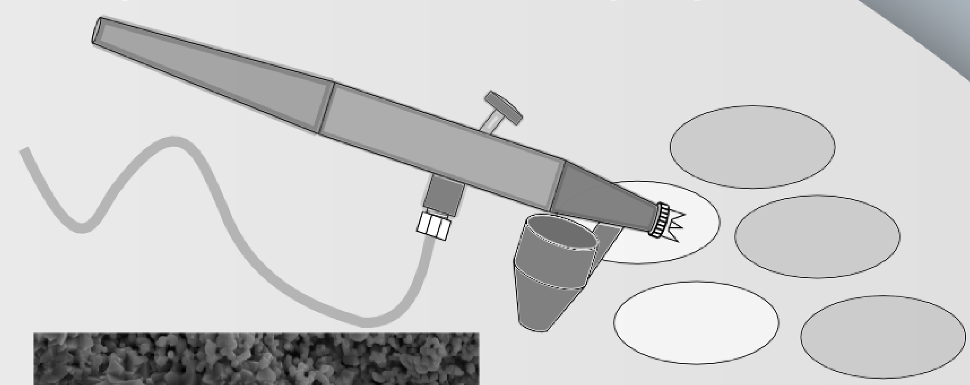
Step 1: Cold Roll Cladding

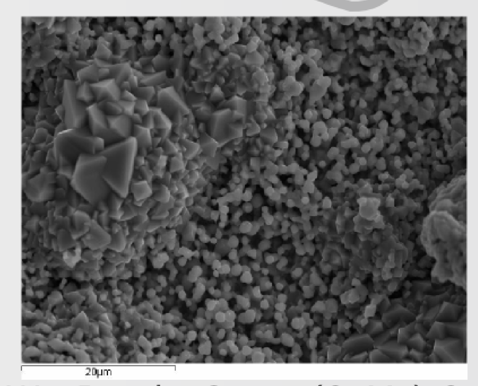


1: Ni-200 / 430 SS / Ni-200
12.5%-75%-12.5%
2:Ni-200 / 430 SS / Ni-200
6%-88%-6%

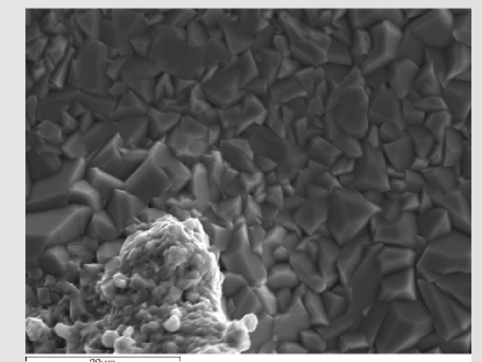


Step 2: Wet Powder Spray





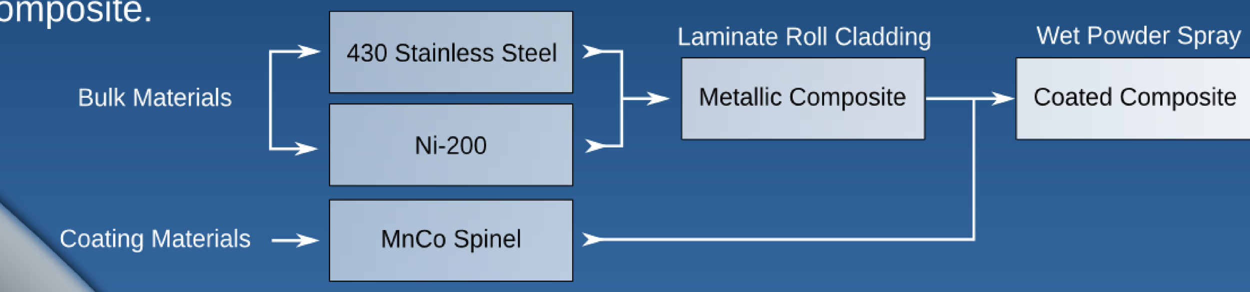
Wet Powder Spray: $(CoMn)_3O_4$
Substrate 430 SS

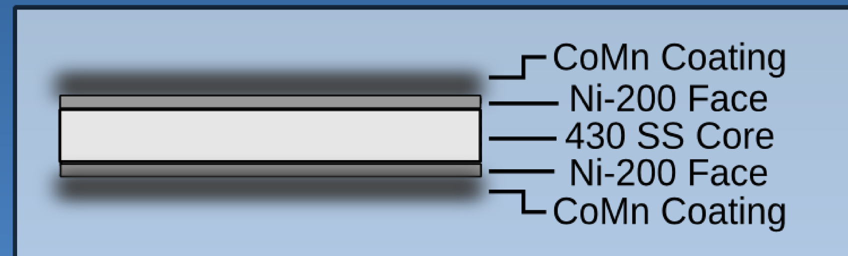


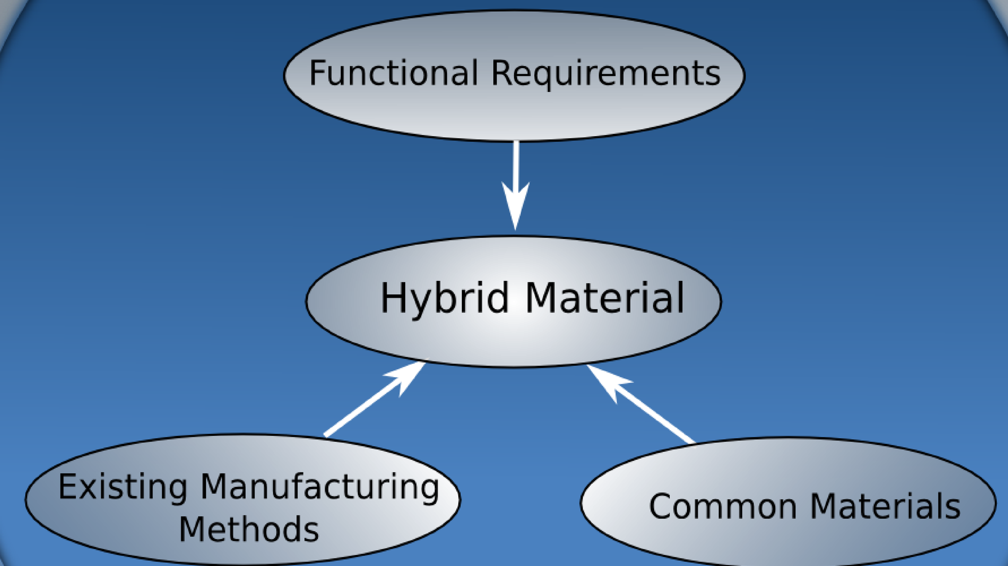
Wet Powder Spray: $(CoMn)_3O_4$
Substrate Ni-200

Manufacturing the Hybrid Material

Our model hybrid material is manufactured using commercially available precursors and existing fabrication processes. We chose to use bulk materials with simple compositions that adequately exhibited ther properties of interest. They were assembled in a functional laminate composite.

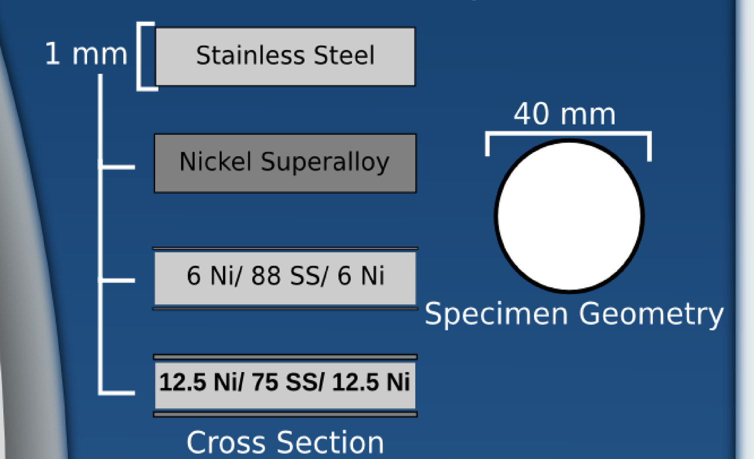






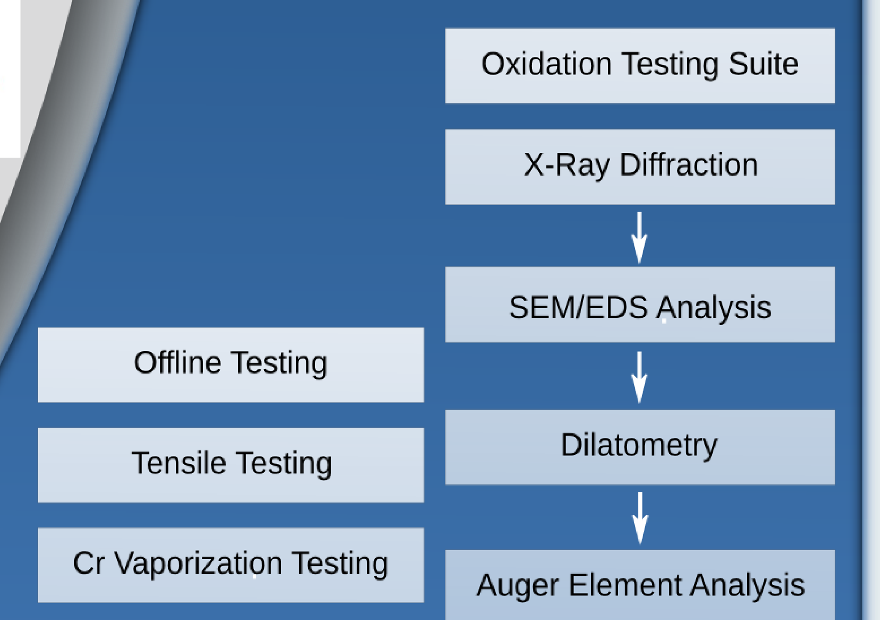
Screening Hybrid Materials

Due to the wide variety of important materials properties a comprehensive screening method was created to facilitate gathering the most information from the least number of specimens.

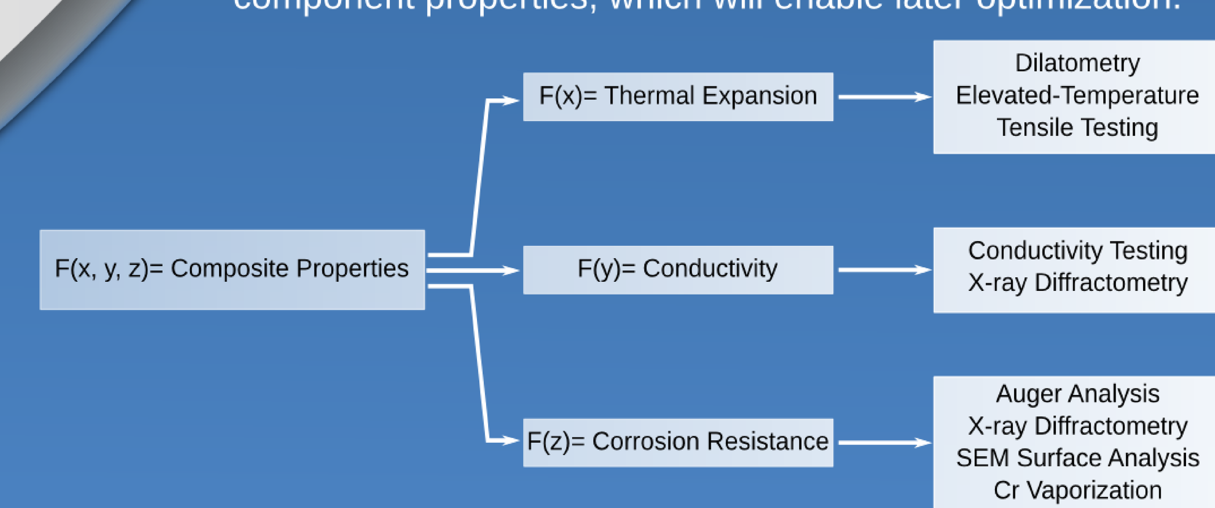


Incoming materials were cut into disc specimens and sorted into groups for oxidation testing. Samples were pulled at intervals of 250 Hours for analysis

Following oxidation, specimens underwent the series of tests shown below with alternative specimens undergoing the "offline" test procedures.

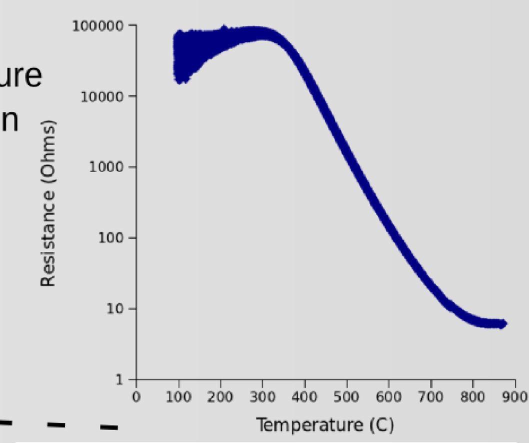


Ideally, the data collected from all of these tests will allow the composite material properties to be parsed into individual component properties, which will enable later optimization.

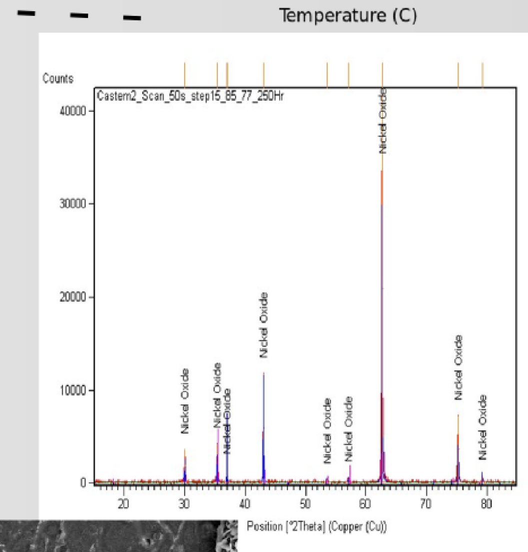


Test Sequence

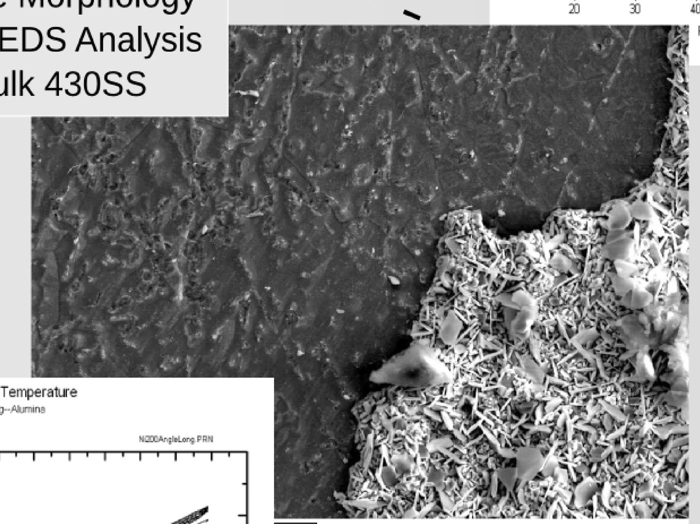
Conductivity Vs. Temperature
Bulk Ni-200, 250 oxidation



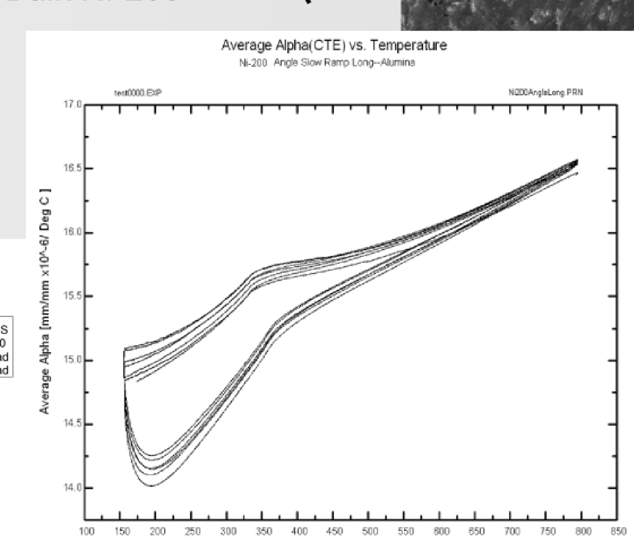
Oxide Structure
X-Ray Diffraction
Clad specimen with WPS Coating



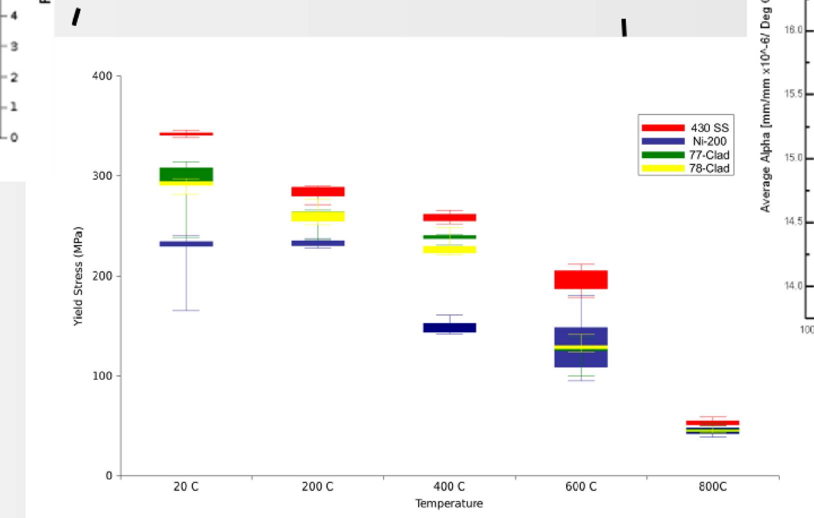
Oxide Morphology
SEM/EDS Analysis
Bulk 430SS



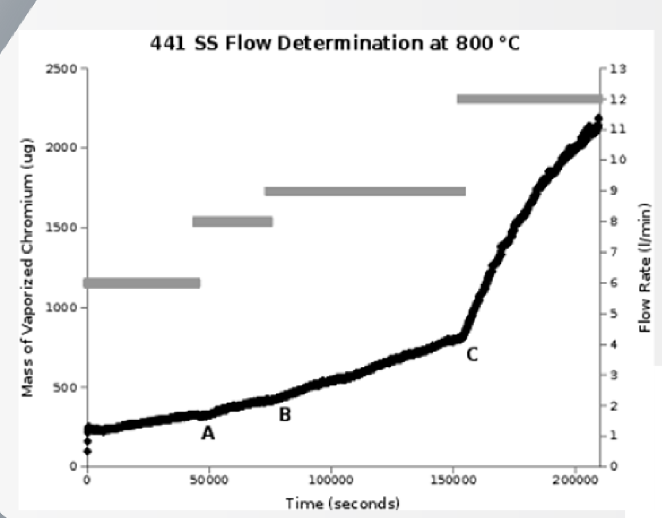
Thermal Expansion
Dilatometry
Bulk Ni-200



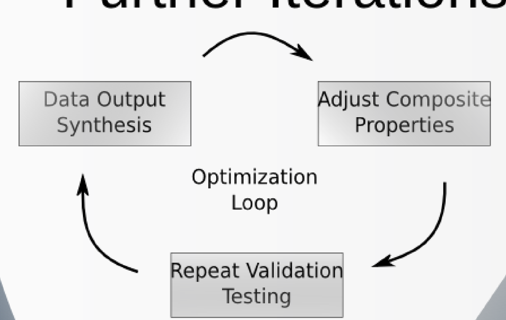
High Temperature Strength
Elevated Temperature
Tensile Tests
All Materials



Vaporization Rate
Flow Determination
Bulk 441SS (previous work)



Further Iterations



Acknowledgements

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Conclusions & Future Work

Current results indicate that the hybrid materials design method may produce good quality SOFC interconnect materials. It has been shown that it is possible to create new composite materials using commercially available materials and existing manufacturing techniques and there is a great deal of potential for futher optimization.

Data collection is approximately 75% complete with oxidation processing complete and analysis ongoing on all specimens. Tensile testing and initial dilatometry has been completed. All data collection is scheduled to be completed by May 10th and final analysis by May 30th.

Further work will be completed to optimize the properties of these novel hybrid materals utilizing the experience gained.