Matrix Study of Aged SOFCs: Performance and Materials Degradation

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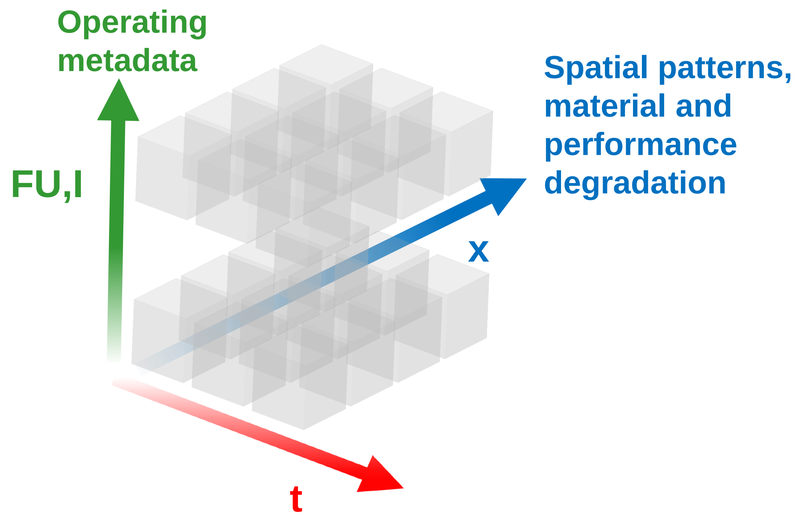
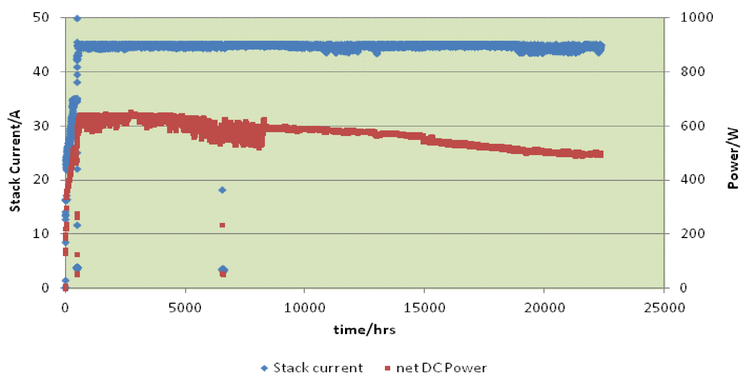
LSCF, doped ceria barriers, YSZ electrolyte and Ni/YSZ cermet comprise a commonplace SOFC material set to which many companies have gravitated. Acumentrics SOFC, Inc has successfully commercialized fuel cells using these materials with the help of both DOE and DOD funding, and in this project will partner with Professor Gopalan's group at Boston University to investigate the their degradation in stacks deployed in commercial applications. An understanding of degradation mechanisms will be developed from both electrochemical and material characterization of aged cells that have been extracted from stacks that have been run from 1000 to 28,000+ hours. By sampling and characterizing cells from failed, or aged stacks, it should be possible to derive a picture of electrical performance and material condition as a function of operating time and cell spatial position. The SOFC stacks are run under varying conditions based on the customers load, and thus associated with each stack would also be metadata such as fuel utilization and operating current. While the data sets will be obtained for tubular cells, the electro-ceramic materials are common to a majority of industrial cell designs and thus the material degradation results should have widespread relevance.

Remote LPG and NG Applications

Acumentrics' RP500 series generator and user-replaceable cell stack, the most popular generator and bundle, with more than 200 in the field. Generally Acumentrics' stacks will perform past their warranty period (1 yr), but whether a stack fails prematurely or surpasses its design life (2 yrs), the SOFC system can be shut down and the SOFC stack and quickly replaced in the field, and started up in ~ 30 minutes. Stacks from the RP500 and RP1500 will be used for the analyses in this study.



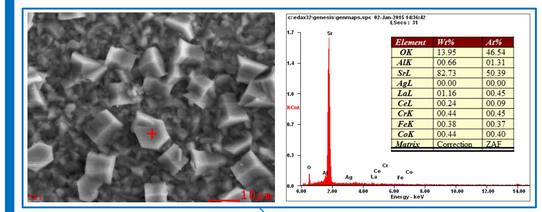
Temporal behavior
Aged stacks 1000-28,000hrs

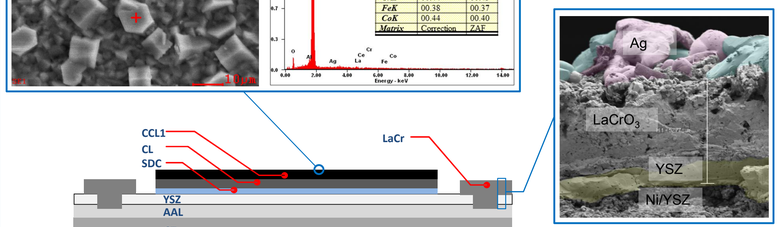


RP500 stack operating for >20000 hrs deployed in East Texas. This unit is using unprocessed well head gas and is being run at constant current The degradation rate in this example is ~0.9%/khr. The longest running stacks have now surpassed 3 years of continuous operation.

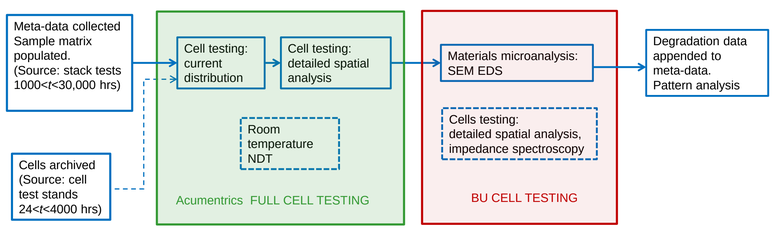
Materials and Performance Degradation

(Blue insets) SEM and EDS used to identify compounds on the surface of the dense $LaCrO_3$ over sprayed on to the electrolyte. A chromate based phase appears to have evolved on the air side. Point EDS spectrum taken from the cathode top surface of a cell from a stack operated for 6000+ hours, showing evidence of strontium segregation





One of 4 cells to explore spatial dependency of degradation



Spatial analyses of cell performance and degradation will be performed at both Acumentrics and Boston University. Materials characterization will be carried out using Boston University's state of the art facilities.