# Ag-Perovskite Composite as SOFC Cathode-Interconnect Contact

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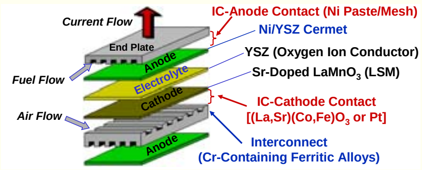
## Introduction

- Electrical contact layers are used to reduce the electrode/interconnect interfacial resistance
- While Ni-paste/mesh is widely used to establish electrical contact on the anode side, finding a suitable material for electrical contact between the cathode and interconnect is challenging




## Issues and Research Focus

The major issues for current contact materials:

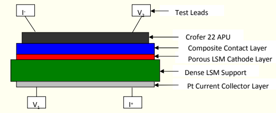
- Noble metals
  - Pt and Au are too expensive
  - Ag has the volatility problem
- Perovskites
  - $(La_{0.6}Sr_{0.4})(Co_{0.8}Fe_{0.2})O_3$ (LSCF) has higher coefficient of thermal expansion (CTE)
  - $(La_{0.8},Sr_{0.2})MnO_3$ (LSM) possesses poor sinterability

*The primary focus of this research is the development and evaluation of Ag+perovskite composite contact materials for use at the cathode-interconnect interface:*

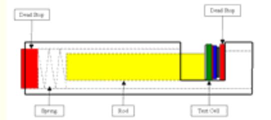
- *Ability to block Cr migration to the cathode*
- *Tolerance to thermal cycle-induced damage*

## Area-Specific Resistance (ASR) Measurement

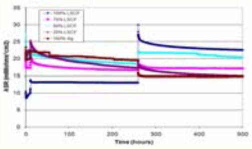
- Test cells were fabricated using LSM support, LSM cathode, and Crofer 22 APU interconnect

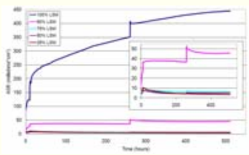



- ASR was measured with a constant current density of 250mA/cm$^2$ under a compressive stress of 0.15 kg/cm$^2$



## ASR Change during Isothermal Exposure

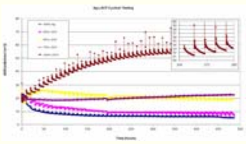


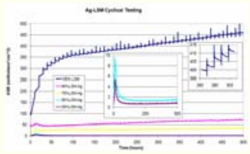


- A single thermal cycle was shown to have a significant effect on the ASR, especially for the cells with low Ag.
- The 100% LSCF contact showed self-healing behavior after thermal cycle, while the 100% LSM contact did not.
- The addition of 10%A g led to an order-of-magnitude reduction in ASR for the LSM contact.

## ASR Change during Cyclic Exposure

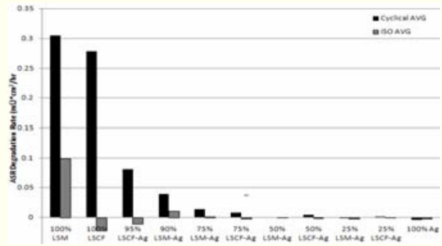
- Thermal cycling substantially increased the ASR degradation rates of the cells, particularly the cells with low Ag-content.





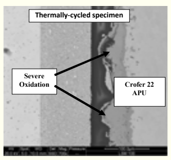
- Both the LSM and LSCF cells exhibited a step increase in ASR after each cycle, followed by gradual ASR improvement during each 10-hr holding period.

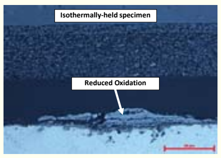
## Comparison of ASR Degradation Rate for Different Contact Materials




- Thermal cycling caused much higher ASR degradation rates than isothermal holding.
- The addition of as little as 5-10% Ag into the composite reduced the ASR degradation rate drastically

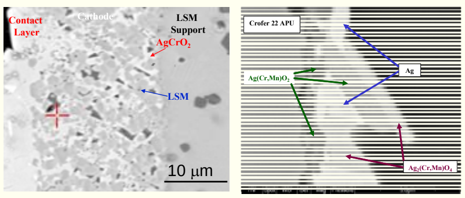
## Abnormal scale growth was observed on the Crofer 22 APU after cyclic oxidation




- It happened only at the contact/interconnect interface for the cycled cell; it was not observed at such interface for the isothermally-exposed cell.
- Thermal stresses developed during cycling caused repeated cracking of the $Cr_2O_3$ scale, leading the formation of extensive oxidation products

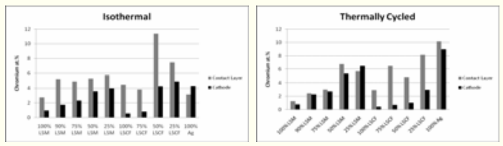
## Significant Cr migration was observed in the cathode layer with Ag-containing contact




100% Ag Contact Material after Cyclic Exposure at 800°C for 500h

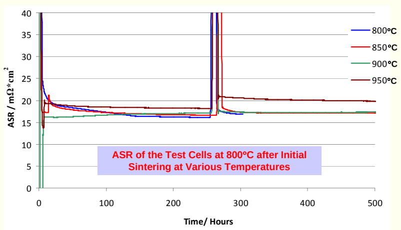
- The majority of the Ag-containing phase was $AgCrO_2$ in the cathode.
- Both $AgCrO_2$ and $Ag_2CrO_4$ were observed in the contact layer.

## Quantification of Cr migration to the Cathode after Isothermal and Cyclic Tests




- The LSCF-containing contacts absorbed most of the Cr within the contact layer, inhibiting it from migrating to the cathode.
- The LSM-containing contacts were much less effective at preventing Cr-migration.

## A new ceramic contact material system has been identified that is highly sinterable




- An sintering temperature of only 800-900°C is sufficient
- Comparable ASR with Ag-based contact materials
- Highly effective in blocking Cr migration to the cathode

## Summary

- The Ag-LSM contact materials exhibited higher overall ASRs than Ag-LSCF. The addition of as little as 10 vol.% Ag into perovskite contact materials resulted in an order of magnitude reduction in ASR degradation rates.
- Isothermally-tested cells exhibited much more stable ASR's than thermally cycled cells.
- LSCF was a more effective "Cr-getter" than LSM due to its ability to absorb Cr in the contact layer.
- Composite contact materials with high amounts of LSM caused severe oxidation of Crofer 22 APU after cyclic test, resulting in rapid ASR degradation.
- A new contact material system has been identified that is highly sinterable, effective in blocking Cr migration, and possesses low ASR.

## Acknowledgments

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