Composite Cathode Infiltrated with Pyrochlore / Perovskite Materials

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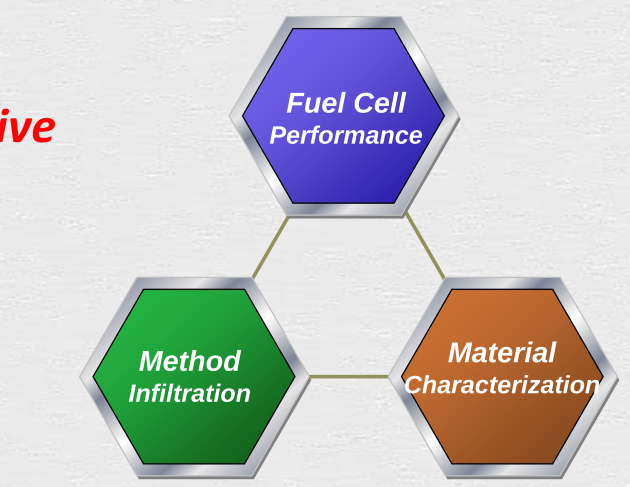
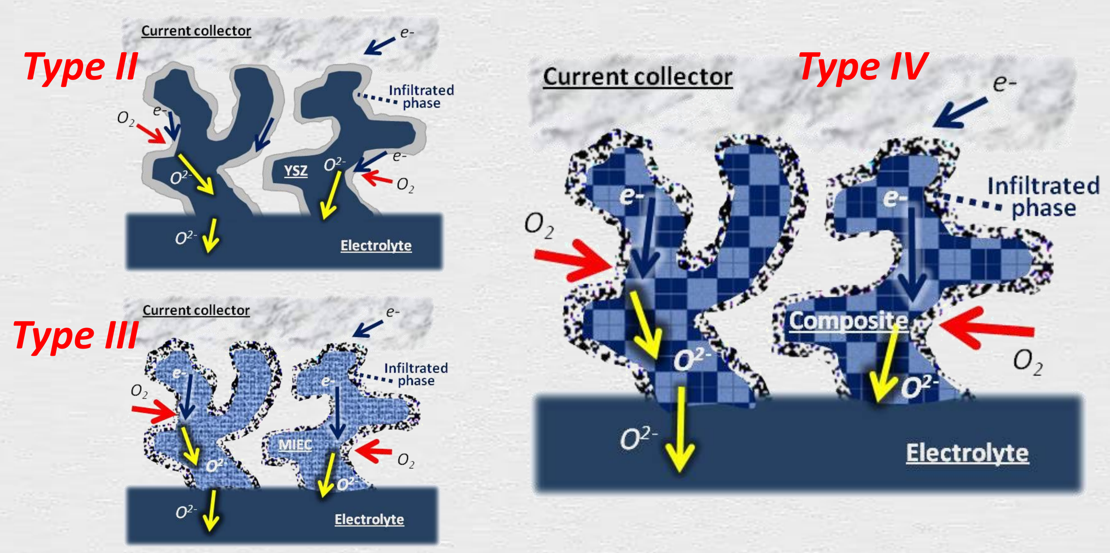
Introduction

Research Goal: Development of ***High Performance SOFC*** with ***highly active and stable cathode*** by application of controlled ***infiltration process***

1) Establish ***infiltration methodology*** by identification of process parameters.
2) Demonstrate ***high performance and stability of fuel cell*** prepared by infiltration.
3) Characterize ***electrochemical properties*** of MIEC cathode materials.



Strategy:



➢ Utilize ***a composite cathode,*** MIEC and ionic conductor, as a backbone (*Type IV*) *to optimize **activity and stability*** of cathode.

Infiltrated Phase	Electrocatalytic Materials (*pyrochlore* or *perovskite*)	
Scaffold	Composite (MIEC + Ionic)	LSCF[1)] + SDC[2)]

1) $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ 2) Sm_2O_3-doped CeO_2

Infiltration Methodology

1. Component of Infiltration Solution

Nitrate mixture containing *citric acid* in aqueous solvent

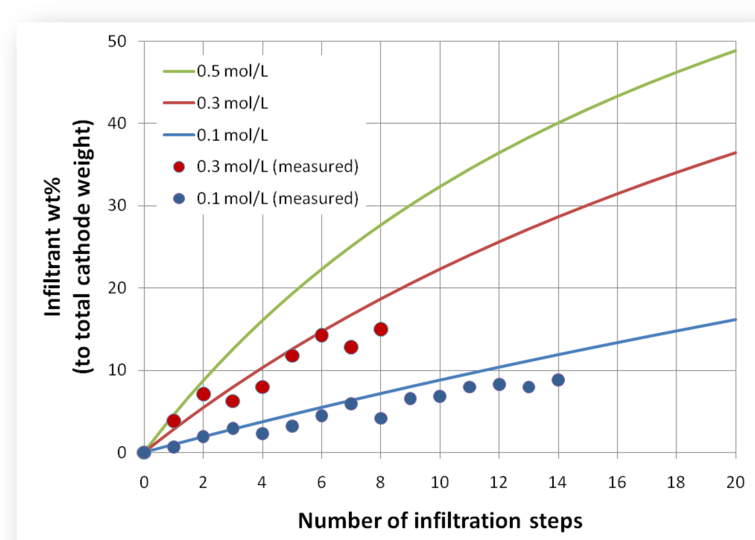
2. Calcination Temperature: ***2-step Calcinations***

- 450°C for decomposition of solvent and organic component
- 850°C (LSCo) or 950°C (LSZ) for phase formation

3. Dosage, Concentration, and Number of Infiltration Steps

Controlling Parameters		Dependant Parameters
Pore Volume of Cathode	→	*Dose*
Concentration of Solution	→	*Residual Solid Amount*
Number of Infiltration Steps	→	*Coverage (Loading Amount)*

➢ Relationship between loading amount and number of infiltration steps for various solution concentration.

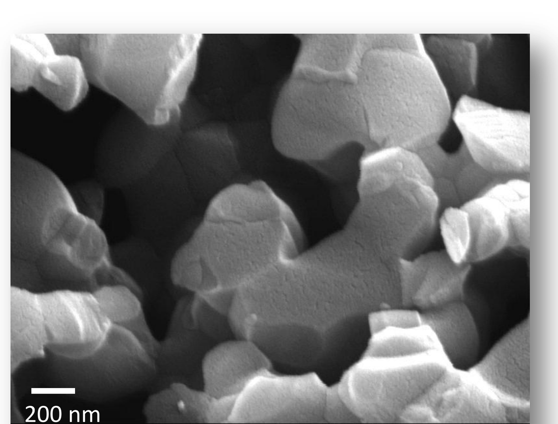


4. Backbone Structure

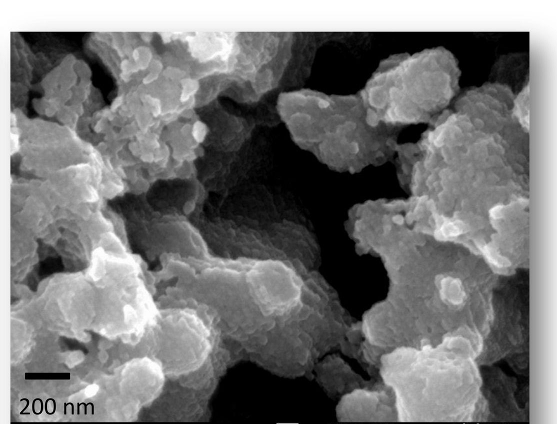
Consideration of porosity, surface area and surface chemistry of material (wettability)

✓ Cathode microstructures of a baseline cell and the infiltrated cells

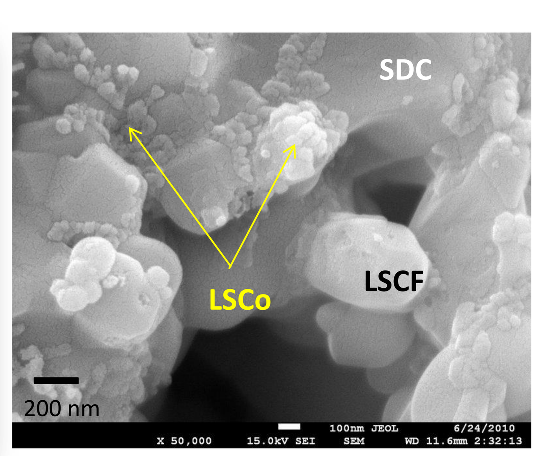
LSZ: $La_{1.97}Sr_{0.03}Zr_2O_7$
LSCo: $La_{0.6}Sr_{0.4}CoO_3$



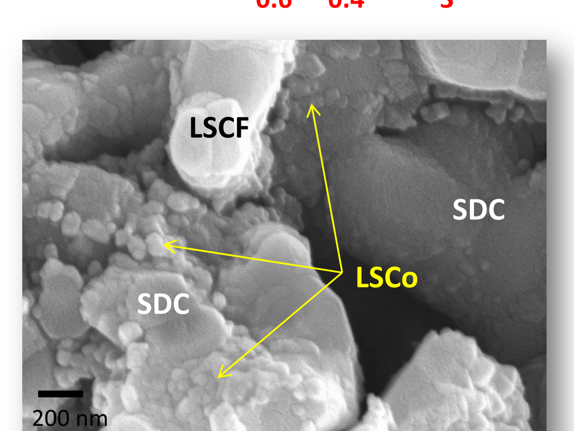
✓Cathode of a Baseline Cell



✓31 wt% LSZ Infiltrated Cathode



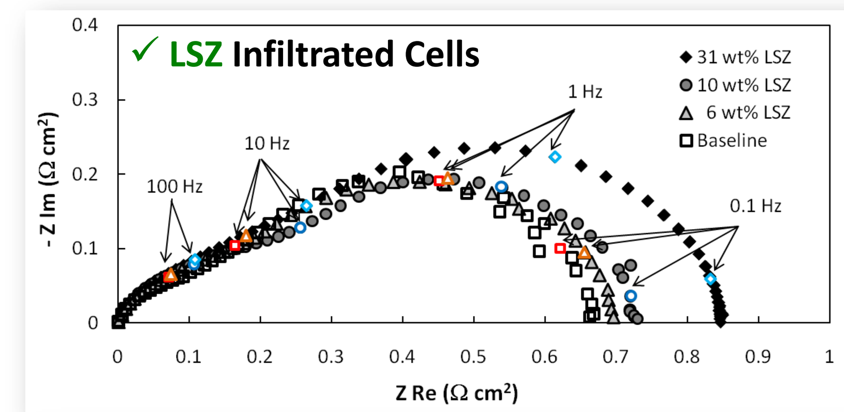
✓11 wt% LSCo Infiltrated Cathode



✓31 wt% LSCo Infiltrated Cathode

Infiltration Performance: Fuel Cell Testing

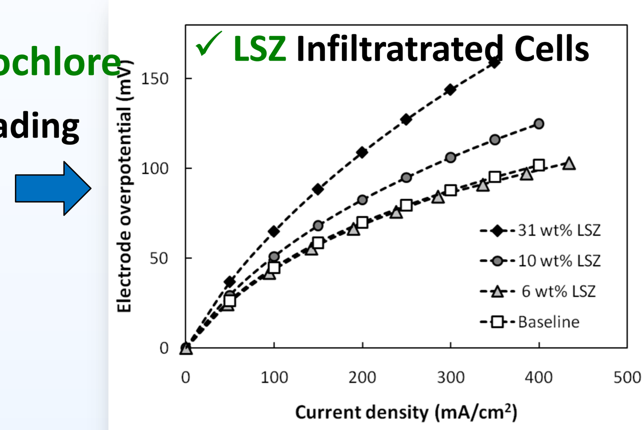
1. Polarization resistances (R_p) at OCV and electrode overpotential of the infiltrated cell at 750°C

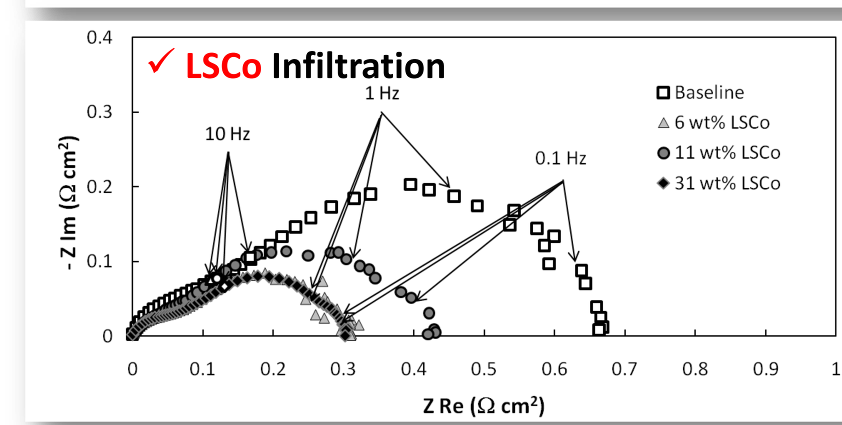


LSZ ($La_{1.97}Sr_{0.03}Zr_2O_7$): Electrically insulating pyrochlore

⬅ Rp increased with increasing amount of LSZ loading

Increased overpotential of LSZ-infiltrated cells is proportional to the amount infiltrated ➡

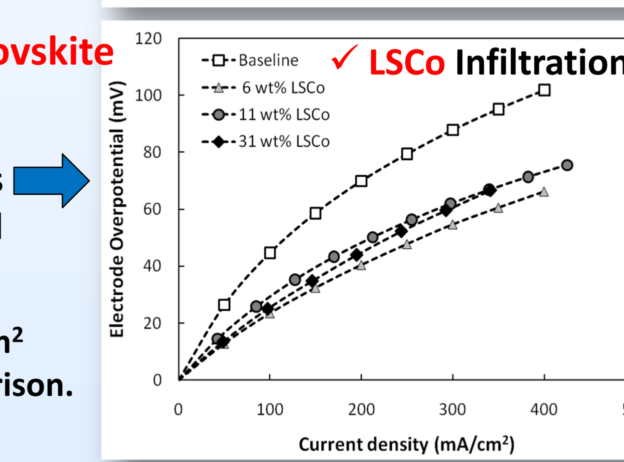




LSCo ($La_{0.6}Sr_{0.4}CoO_3$): Electrocatalytic active perovskite

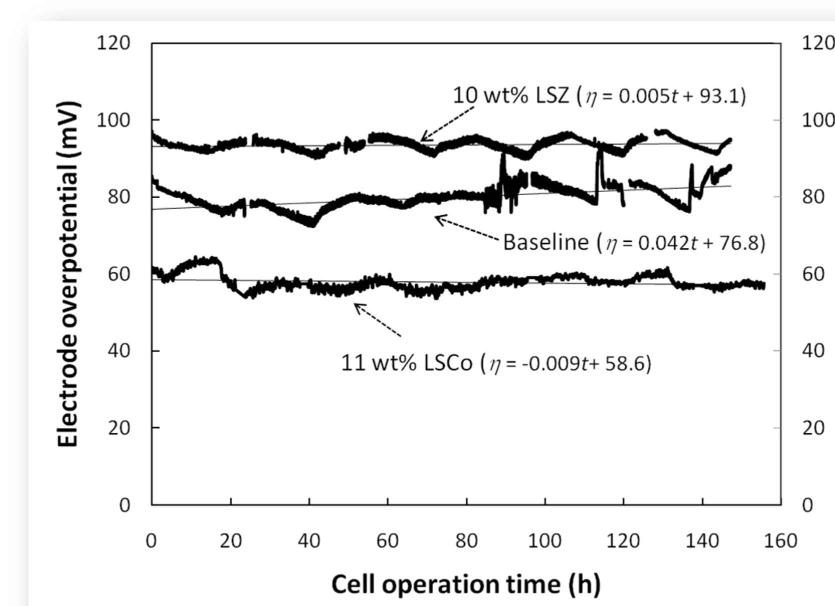
⬅ Rp decreased significantly by LSCo infiltration

Decreased overpotential of LSCo-infiltrated cells seems to be independent on the amount infiltrated ➡



* Rp was measured after 24 hrs operation under 0.25 A/cm²
* Ohmic resistance is subtracted from raw data for comparison.

2. Electrode overpotential variation for 200 hrs operation (750°C)

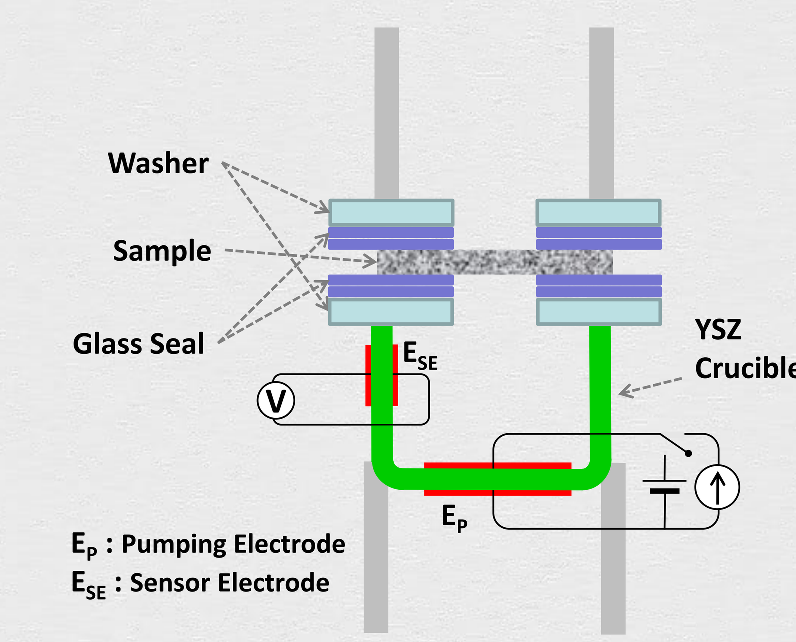


No significant degradation in cell performance for 200 hrs operation was shown for all the cells tested, including **LSCo**-infiltrated one.

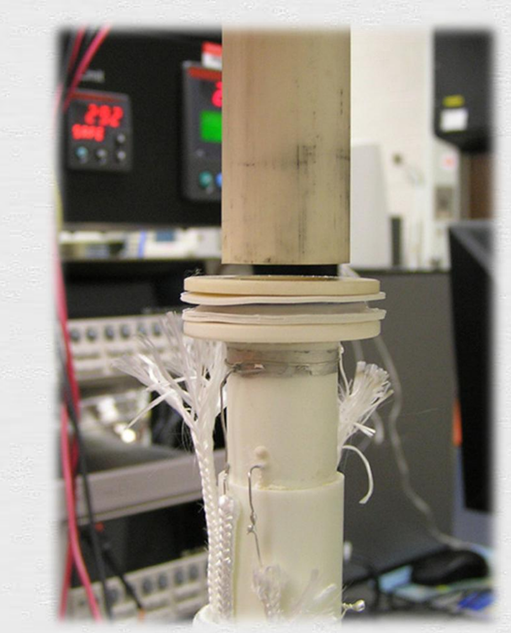
*Electrode overpotential was calculated from the cell voltage under 0.25 A/cm² by subtracting ohmic contribution.

Cathode Material Characterization

Ionic Conductivity Measurement Utilizing Faradaic Method



<Schematic diagram>



<Measuring system setup>

Summary

✓*A composite cathode of a commercial cell was successfully modified with LSZ or LSCo infiltration.*
✓*Infiltration methodology correlating dosage to structure was developed.*
✓*Effects of electrocatalytic activity of infiltrated materials on cathode performance were demonstrated.*
✓*Faradaic method system for ionic conductivity measurement was developed.*

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