

# MATERIALS

## SOFC Cathode Materials

### OVERVIEW

$\text{La}_{0.8}\text{Sr}_{0.2}\text{Ga}_{0.8}\text{Mg}_{0.115}\text{Co}_{0.085}\text{O}_{3-\delta}$  (LSGMC) has been reported as an optimized composition of LSGM-based electrolytes

- High conductivity at intermediate temperatures, i.e., 500-700°C.

The SOFC cathode, where molecular oxygen is adsorbed, converted to ions and introduced to the ion conductor, is critical to performance

The air cathode is typically bi-functional with both electronic and ionic conducting characteristics.

Several state-of-the-art materials are considered for our intermediate temperature IT-SOFCs:

- $\text{Sm}_{1-x}\text{Sr}_x\text{CoO}_{3-\delta}$  (SSC)
- $\text{Ba}_{1-x}\text{La}_x\text{CoO}_{3-\delta}$  (BLC)
- $\text{La}_{1-x}\text{Sr}_x\text{Co}_{1-y}\text{Fe}_y\text{O}_{3-\zeta}$  (LSCF)

### GOALS AND OBJECTIVES

By precisely controlling nitrate stoichiometry, synthesize perovskite-type oxides via glycine-nitrate combustion method

- favorable for the reduction of impurity phases
- good electrical properties were obtained from the samples.

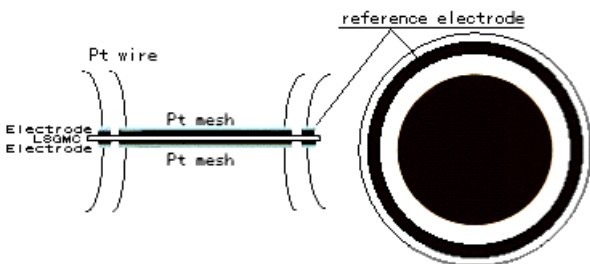
Use AC impedance spectrometry to show that LSGMC has lower impedance compared with conventional baseline electrolyte material 8-YSZ

- Optimization of composition and cell manufacturing processes can result in much higher ionic conductivity and SOFC power density

Show that composite cathodes perform better than the pure cathodes with significantly reduced polarization resistances

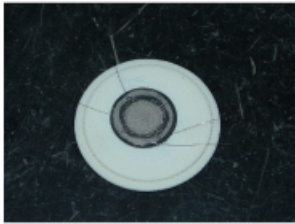
Perform additional electrochemical analyses, microstructural characterizations, and measurements of interfacial properties on cathodes/LSGMC systems to determine whether this materials set could be promising as an IT-SOFC

### Sample Cell Experiment: Cathode/LSGMC Polarization Study

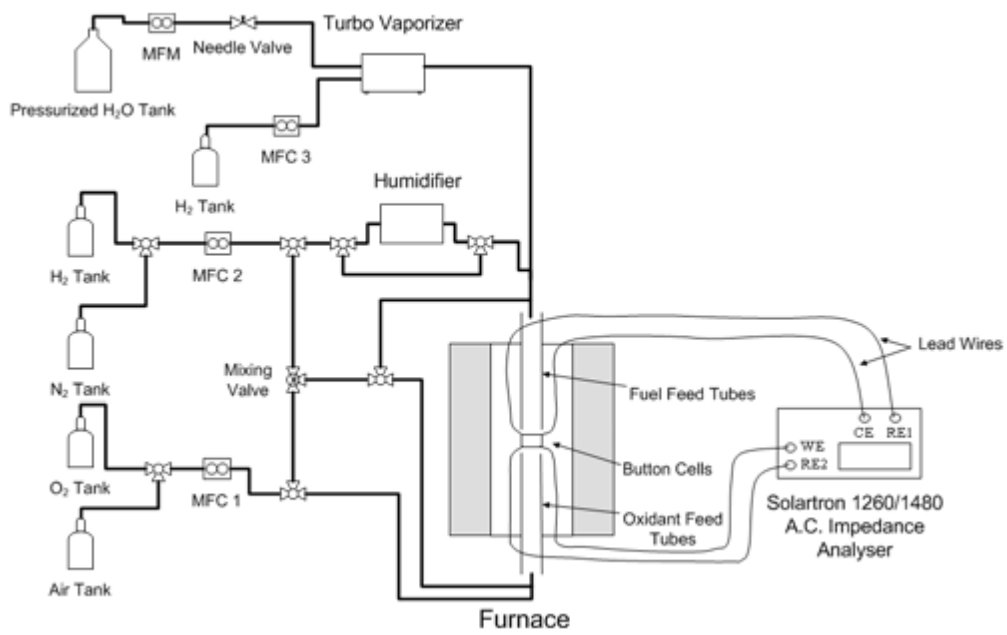


**Schematic diagram of cathode/electrolyte interfacial characterization sample**

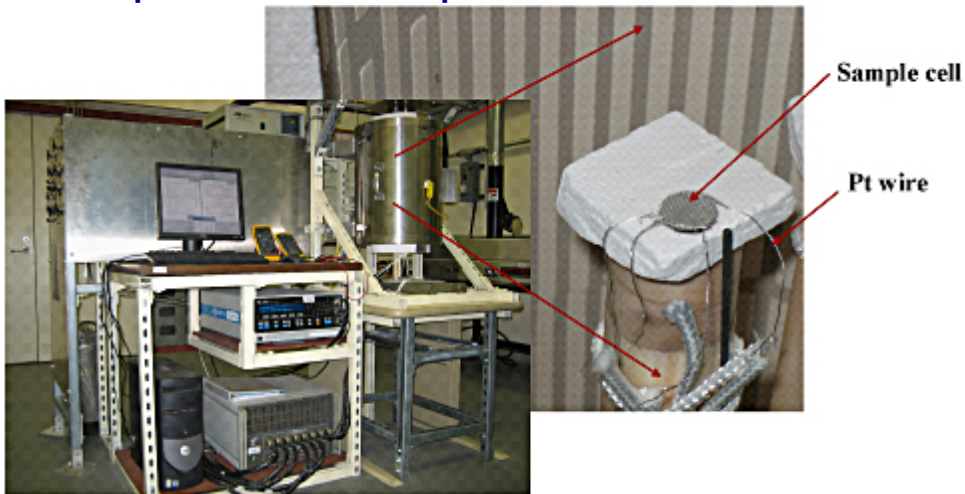
Overpotential vs. Current density curves can be obtained to indicate the cathodic kinetics of investigated cathode materials base on Butler-Volmer equation:

$$i = i_0 \left[ \exp\left(\frac{\alpha_a F \eta}{RT}\right) - \exp\left(-\frac{\alpha_c F \eta}{RT}\right) \right]$$


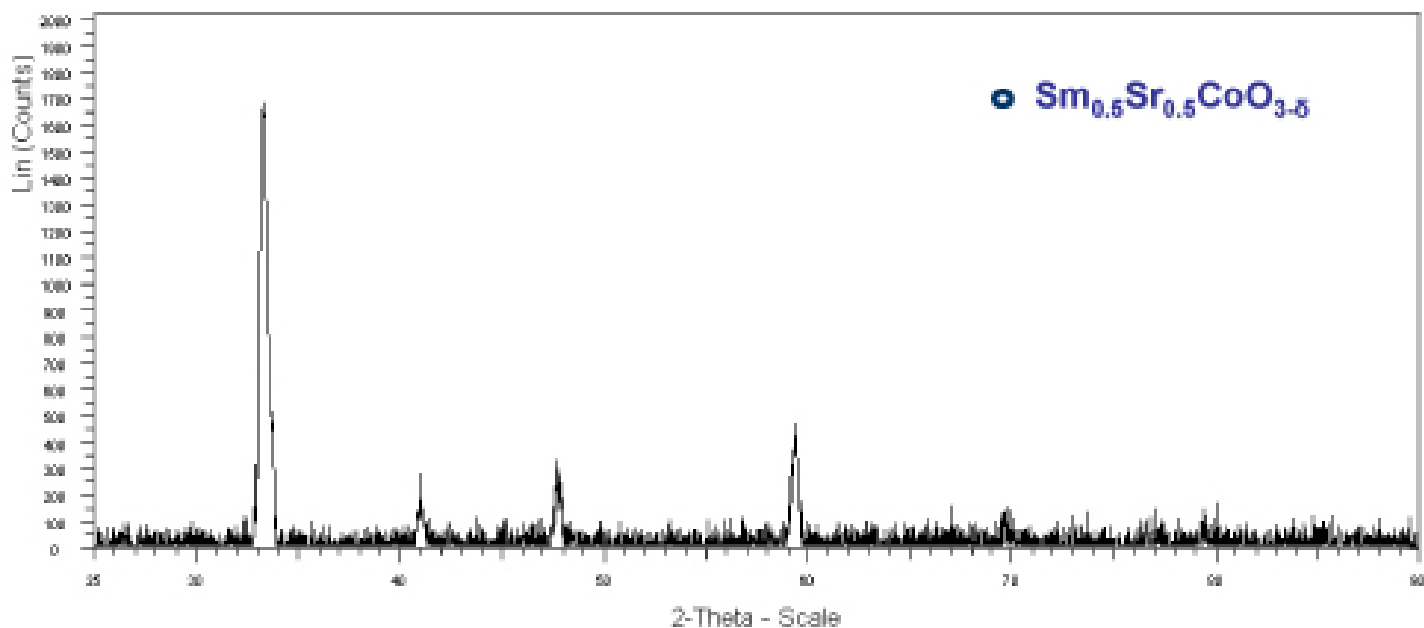
## Experimental Apparatus for DC Polarization Test



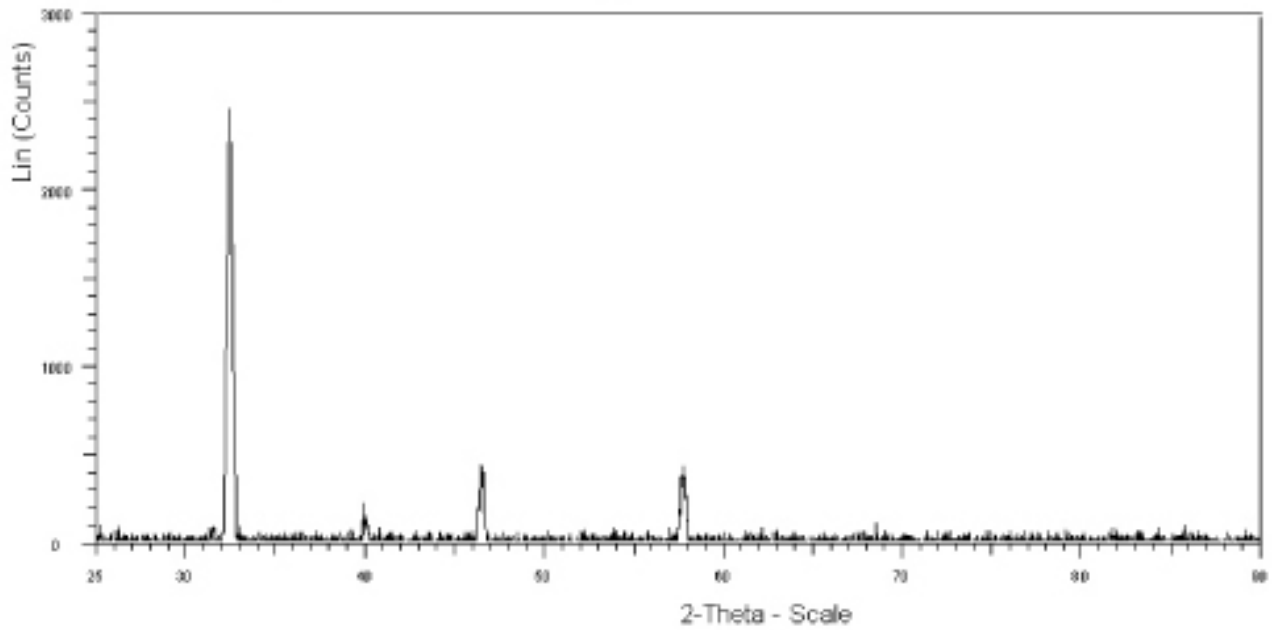
## Experiment: A.C. Impedance Tests for LSGMC



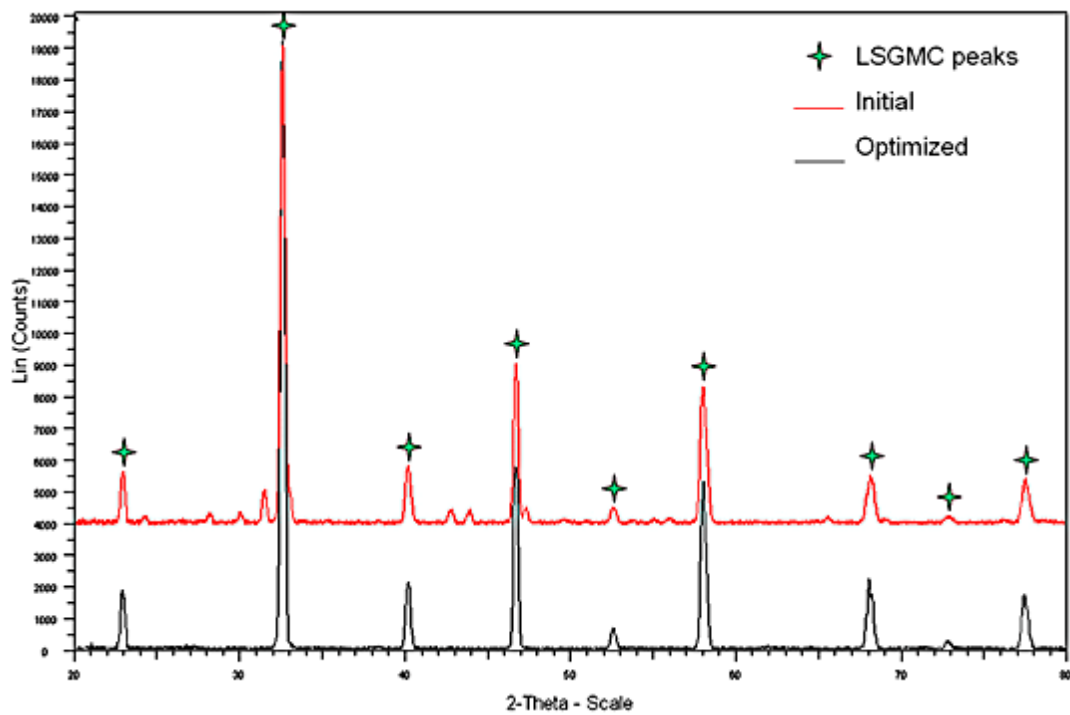
## XRD pattern of SSC powder calcined at 900°C



## XRD pattern of LSCF powder calcined at 900°C



## XRD pattern comparison of LSGMC

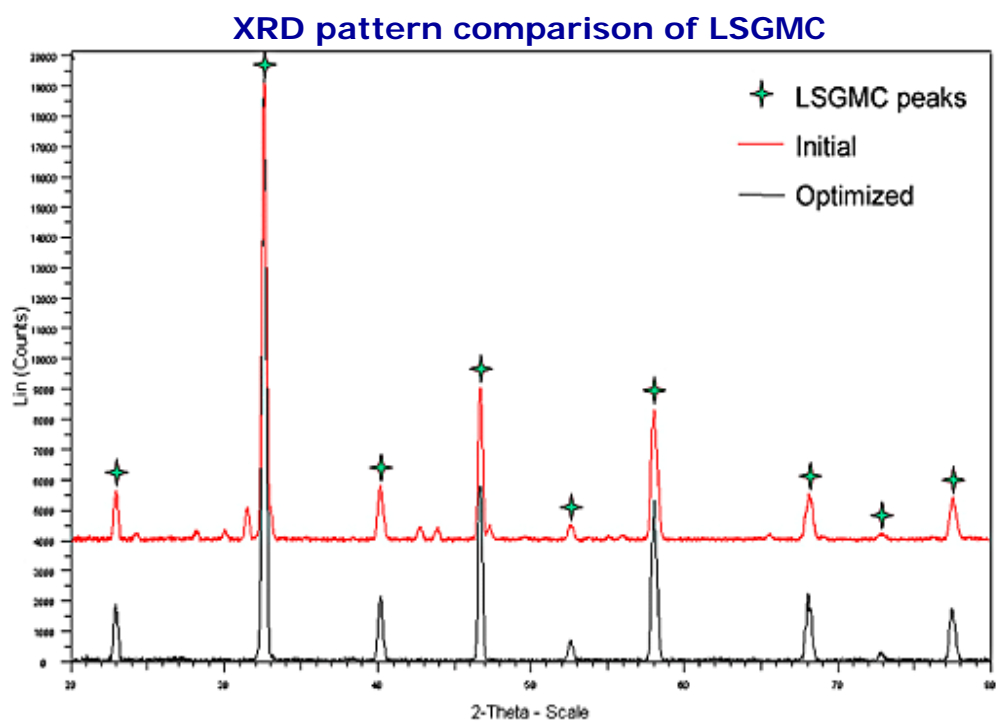
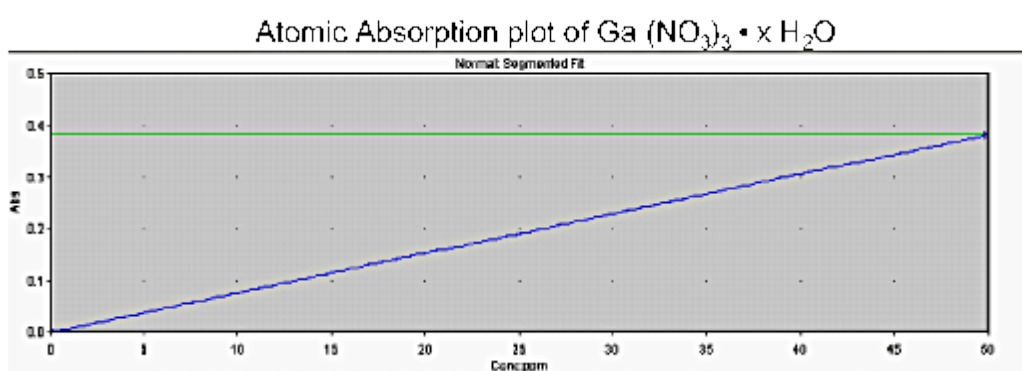
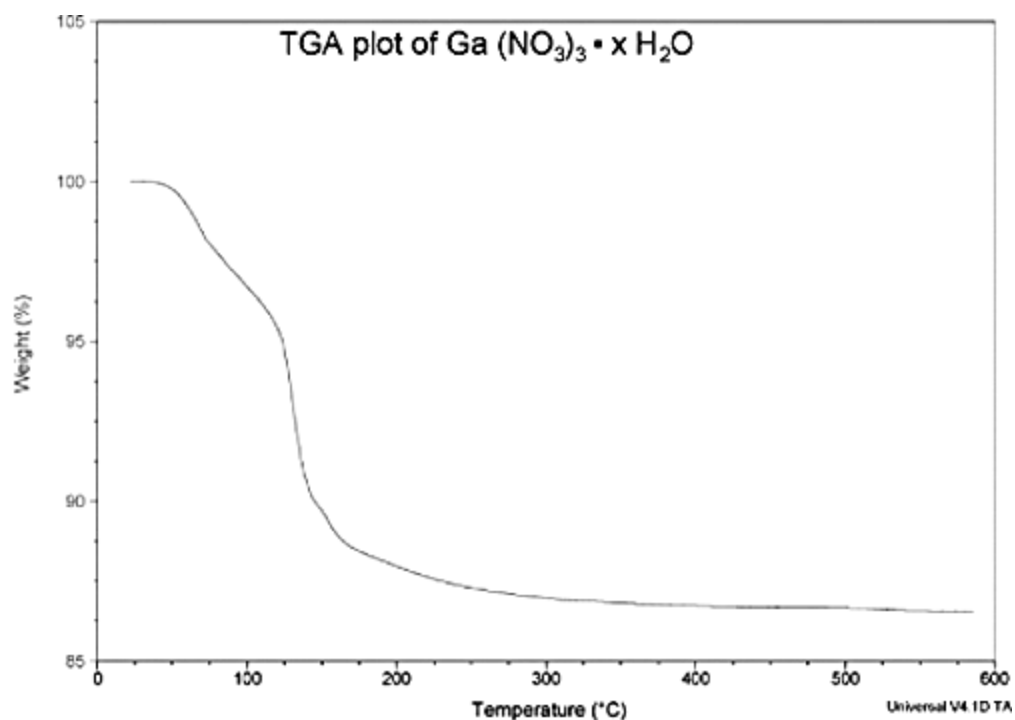


## Stoichiometry Control for LSGMC

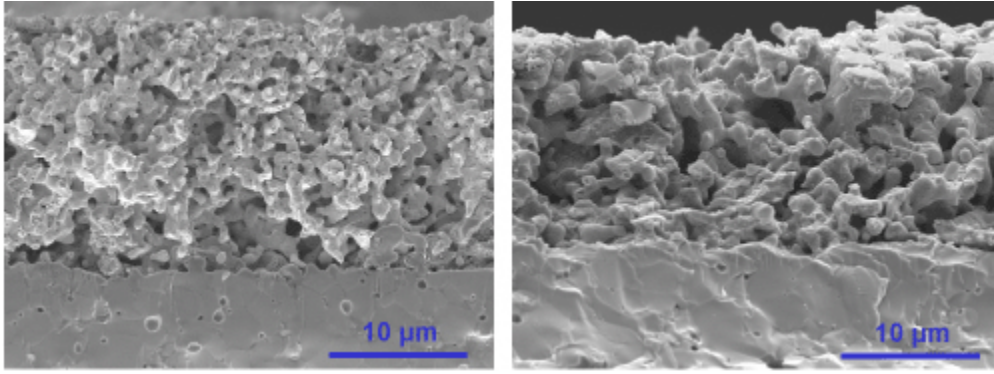
Gallium precursor contents play a key role in desired LSGMC stoichiometry

Lattice water value  $x$  in  $\text{Ga}(\text{NO}_3)_3 \cdot x \text{H}_2\text{O}$  determined:

- CIS result from manufacturer: 8.88
- TGA measurement: 4.58
- AA test: 8.90



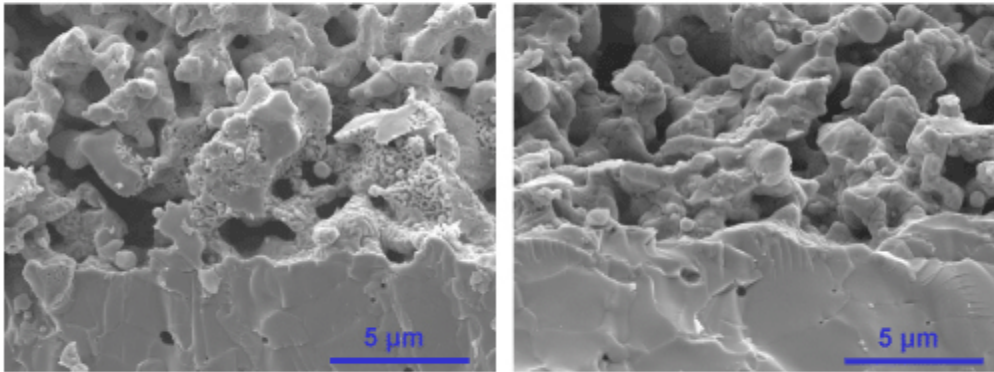
### SEM of Cathode/LSGMC Interface



(a)

(b)

Cross-sectional views of (a) Composite SSC0.7LSGMC0.3 (b) SSC on LSGMC



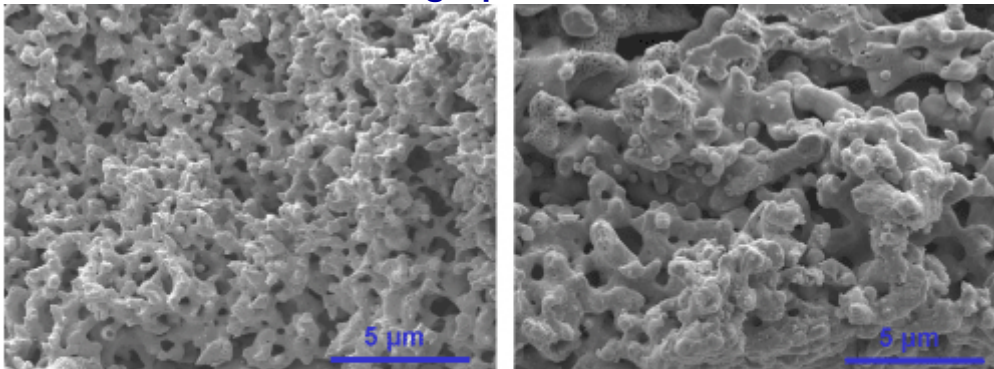
(c)

(d)

The interface of (c) Composite SSC0.7LSGMC0.3 (d) SSC on LSGMC

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### SEM Micrographs of Cathodes



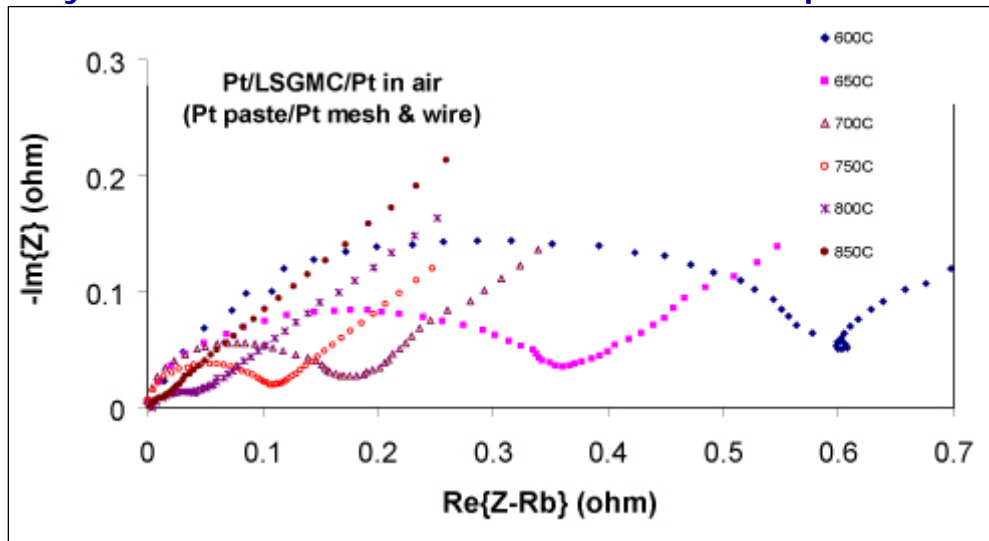
(e)

(f)

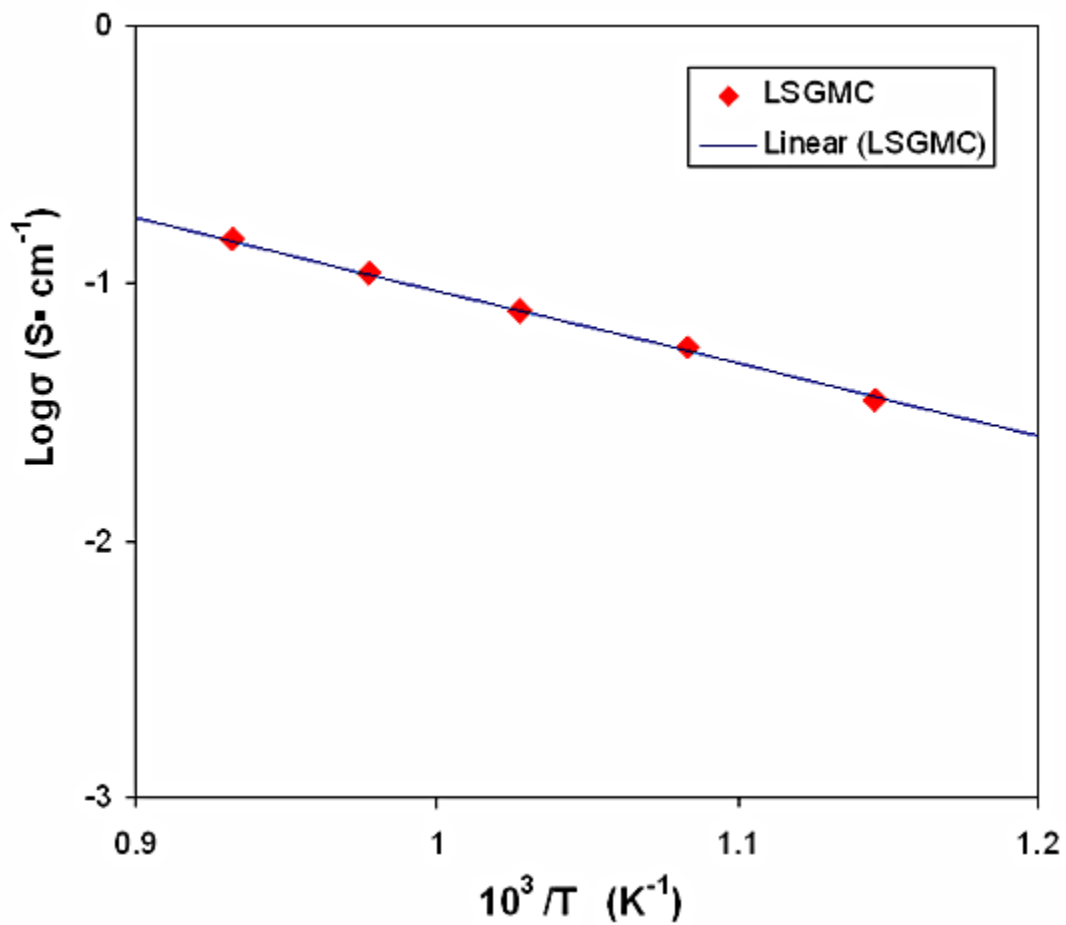
Cross-sectional views of (e) Composite SSC0.7LSGMC0.3 (f) SSC cathode

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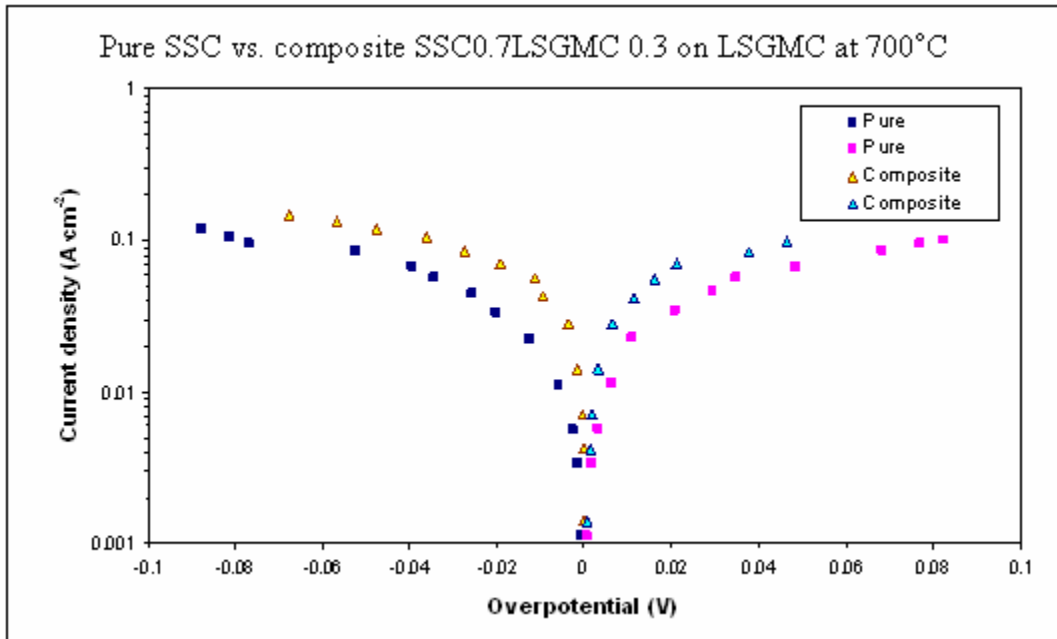
## Conductivity Measurement for LSGMDC Polarization: pure SSC on LSGMC



## Conductivity of LSGMC



## DC polarization performance comparison



## PERSONNEL

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## SPONSORS

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