

## Interactions and Compatibilities of LSGM Electrolyte and LSCM Anode

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## Interactions and Compatibilities of LSGM Electrolyte and LSCM Anode

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The strontium- and magnesium-doped lanthanum gallate (LSGM) is one of the few available electrolyte materials that have drawn much attention in the efforts to reduce solid oxide fuel cell (SOFC) operating temperatures. This is due to its high ionic conductivity (0.12-0.17 S/cm at 800°C) over a wide range of oxygen partial pressures ( $1\text{-}10^{-20}$  atm), and the conductivity is higher by a factor of over two compared to the existing yttria doped zirconia (YSZ) (0.052 S/cm) [1-3]. The LSGM materials, however require very high temperatures, 1450-1550°C for example, to be fully densified [4]. Three issues associated with these high firing temperatures are: (1) the LSGM electrolyte reacting with the currently used nickel-based anode during sintering, forming low conductive compounds, for example  $\text{LaNiO}_3$  [5-8]; (2) Ga depletion; and (3) decreasing anode porosity [9]. Because of these reasons, LSGM based SOFCs are limited, at this time, to the LSGM electrolyte supported configuration, which is usually prepared by densifying the LSGM electrolyte first and then applying the anode and cathode layers afterwards.

One possible approach to use electrode supported LSGM thin electrolyte configuration is to employ new electrode materials that are compatible to the LSGM, especially during high temperature firing, and to fabricate the thin LSGM electrolyte cells using conventional processes.  $\text{La}_{0.75}\text{Sr}_{0.25}\text{Cr}_{0.5}\text{Mn}_{0.5}\text{O}_3$  (LSCM) was reported showing a significant reduction of the polarization resistance (from 10 to  $<1\ \Omega\text{cm}^2$ ) and increase in electrical conductivity (to 1.5 S/cm in 5%  $\text{H}_2$  at 900°C) [10, 11]. Interfacial studies have primarily focused in the cell operating temperature range, and very little information is available in relation to the compatibilities within the cell fabrication (LSGM sintering) temperature range.

In this paper, we report our work on the interactions between  $\text{La}_{0.8}\text{Sr}_{0.2}\text{Mg}_{0.2}\text{O}_{2.8}$  (LSGM) electrolyte and  $\text{La}_{0.75}\text{Sr}_{0.25}\text{Cr}_{0.5}\text{Mn}_{0.5}\text{O}_3$  (LSCM) anode in the cell fabricating temperature range (1100-1500°C). Power mixtures and bi-layer samples were fired for 2-72 h at 1400-1500°C and characterized using XRD, SEM and EDS techniques. Although there were 15-20% differences in firing shrinkage during fabrication, the thermal expansion coefficients of the LSCM anode closely matched (less than  $1\times 10^{-6}/^\circ\text{C}$ ) with the LSGM electrolyte in the fuel cell operating temperature range. There were no interactions detected from XRD data during fabrication under 1500°C and dwell for 2 h. However, severe reactions were found in samples with dwell time 6 h and over at 1500°C to form low conductive phases (Fig. 1). Energy-dispersive spectrometry (EDS) analysis (Fig. 2) indicated that the reaction/diffusion zones were between 50-150  $\mu\text{m}$ . The overall results suggested that LSCM is a thermomechanically and chemically compatible anode material with LSGM electrolyte at the fuel cell operating temperatures and fuel cell fabrication conditions (under 1500°C and dwell for 2 h and shorter).

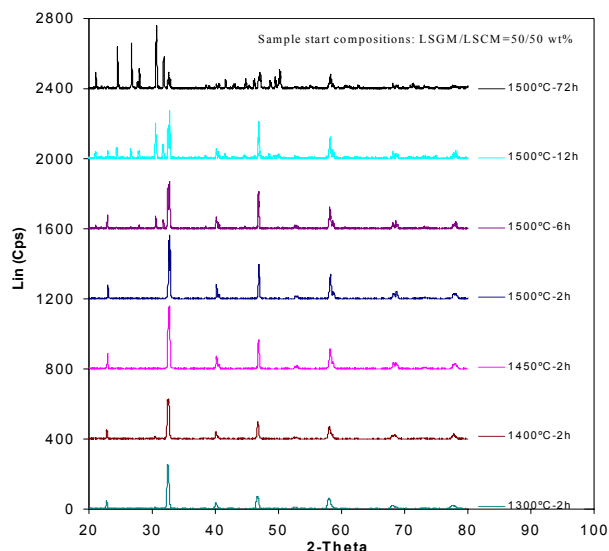


Figure 1. XRD Patterns of LSCM and LSGM Mixture (50:50 wt%) Fired at Various Firing Temperatures and Dwell Times. Interaction Phases Appeared in the Samples Fired at 1500°C for 6 h and above.

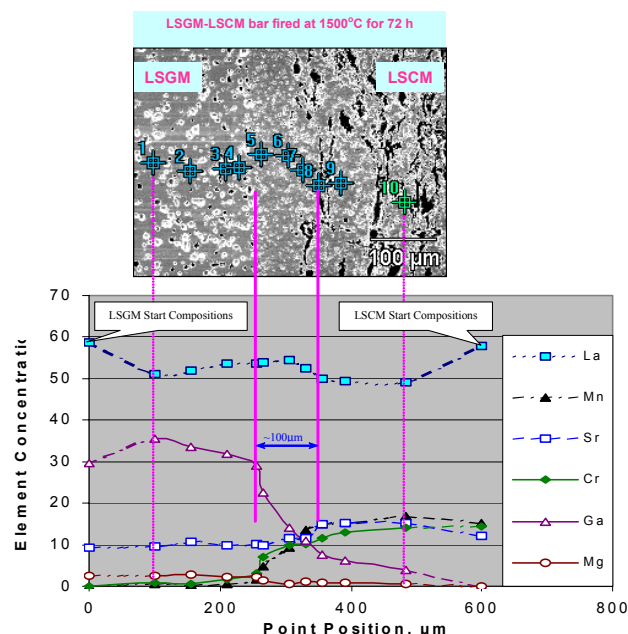


Figure 2. EDS Multipoint Scan Results of the LSCM-LSGM Bi-layer Sample Fired at 1500°C for 72 h. The Group Points on the far Left-Hand Side Were the LSGM Powder Start Compositions While the Group Points on the far Right-Hand Side Were the LSCM Compositions.

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