

Cathode Catalytic Activity of Lanthanum Strontium Aluminum Ferrite for Solid Oxide Fuel Cells

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Lanthanum Strontium Ferrite (LSF) has high electrical conductivity and performs well as an solid oxide fuel cell (SOFC) cathode material. Recently thermodynamic and electrical conductivity data have been published which suggest that aluminum doped LSF may have superior cathode activity than the undoped material.

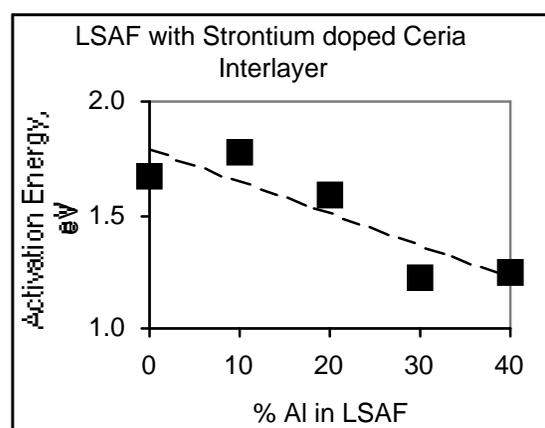
A series of Lanthanum Strontium Aluminum Ferrites (LSAF) of composition $\text{La}_{0.8}\text{Sr}_{0.2}\text{Al}_x\text{Fe}_{1-x}\text{O}_3$ were prepared with "x" ranging from zero to 0.4 fraction. The materials were prepared by glycine nitrate combustion, calcined at 1200 °C, attrition milled, and sieved to 625 mesh. A ink comprising 50 wt % oxide powder, and 50% screen print binder (Ferro), was mixed in a 3 roll mill until uniform. The ink was screened onto yttria stabilized zirconia and sintered at 1250 °C for 2 hrs. The resulting electrodes were 25 microns thick with 50% porosity. Electrodes were prepared with and without an intervening strontium (20%) doped ceria (SDC) interlayer. Electron microscopy revealed a consistent microstructure across the series of compositions.

The electrodes were characterized using current interrupt cyclic voltametry (CI-CV) and AC impedance. A lugin probe Pt/Ag/AgO reference wire was placed within 1.8 mm of the working electrode surface with a platinum paint counter electrode. The CI-CV data provide direct information on the single electrode faradaic resistance of the material without the complications arising from two electrode measures. The cathodic measurements were taken over a temperature range of 650°C to 850°C and analyzed as conventional Tafel plots to obtain the number of electrons involved in the rate limiting electrochemical step and the zero overvoltage exchange current density, I_0 . The I_0 values were analyzed by Arrhenius reaction kinetics to obtain the activation energy for the rate limiting step. This approach has the distinct advantage of providing a measure of catalytic activity towards oxygen reduction that removes

much of the dependence on electrode microstructure. By this means, quantitative measures of activity for different materials could be compared.

The activation energies depended upon the presence or absence of a SDC interlayer. The E_a values without the ceria interlayer were higher by about 0.5 eV and were more irreproducible from sample to sample as compared to samples with the SDC interlayer. In the presence of the SDC, the electrochemistry was well behaved and reproducible. The E_a values decreased from 1.7 eV to 1.4 eV with the increase in Al content from 0 to 40 %. These results are shown in the figure. These activation energies are consistent with other reported literature values. These results suggest that the ceria interlayer does more than just prevent formation of a resistive zirconate interlayer and actually contributes to enhanced catalytic activity.

A significant decrease in E_a is seen with increasing Al content suggesting that higher aluminum contents would promote catalytic reduction of oxygen. However Kuscer et al. report electrical conductivities that decrease with increasing Al content from .34 S/cm for 0% Al to .063 S/cm for 40% Al. These results suggest that actual performance of the electrodes may not follow our reported catalytic activity. We observed the 0% Al material to be



a slightly better cathode at all temperatures than the 40% Al material. However for composite electrodes where electrical conductivity is not as important the higher aluminum contents may be beneficial.

D. Kuscer, M Hrovat, J Holc, Bernik, D Kolar, J. Power Sources, 61, (1996) 161.