11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Nanostructured Cobaltite Cathodes for Intermediate Temperature Solid Oxide Fuel Cells

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Abstract – We present a study of the microstructure and electrode resistance of nanostructured and porous LSCFO ($La_{0.4}Sr_{0.6}Co_{0.8}Fe_{0.2}O_{3-\delta}$) cathode films deposited by a variety of methods. The aim of the work is to identify the sintering conditions to obtain low cathode overpotential values.

$La_{1-x}Sr_xCo_{1-y}Fe_yO_{3-\delta}$ (cobaltite) is a good candidate for solid oxide fuel cell (SOFC) cathode because this material presents high ionic and electronic conductivity, and compatibility with Cerium Gadolinium Oxide (CGO) electrolytes allowing a lower temperature of operation [1,2]. Most of reported cobaltite films have been deposited by slurry deposition techniques such as spraying [3], painting [4], or spin coating [5]. Many researchers have been searching new cathode materials but in order to further increase SOFC performance, it is possible to modify the microstructure of the electrodes that also affects the performance of the system .

In this work, powders and films with the same composition, i.e. $La_{0.4}Sr_{0.6}Co_{0.8}Fe_{0.2}O_{3-\delta}$ (LSCFO), were prepared and deposited by different methods:

- Acetic acid-based gel and a hexamethylenetetramine (HTMA) routes to obtain powders with grain sizes ranging from 10 to 250 nm depending on sintering conditions. Cathodes films from powders were deposited onto CGO ceramic substrates (pressed $Ce_{0.9}Gd_{0.1}O_{1.95}$ disks) by serigraphy, spin coating and dip-coating [6].
- Synthesis of nanostructured tubes prepared by a porous polycarbonate membrane approach with tube diameters ranging from 100 to 500 nm and ~20nm crystallite size.
- Nanostructured cathode thin films with vertically-aligned nanopores (VANP) processed using a pulsed laser deposition technique (PLD) deposited on various substrates (YSZ, Si and CGO) [7].

The structure, morphology and composition of the powders and films were characterized by X-ray diffraction, transmission and scanning electron microscopy, and energy dispersive spectroscopy, respectively. The grain size and strain of initial powders and films prepared through different routes was analyzed by Rietveld analysis. The influence of the microstructure on the transport properties (ionic and electronic conductivity) was evaluated by means of impedance spectroscopy.

We found that the electrochemical properties of LSFC cathodes films strongly depend on the microstructure that is mainly determined by synthesis parameters and technique used for the film deposition.

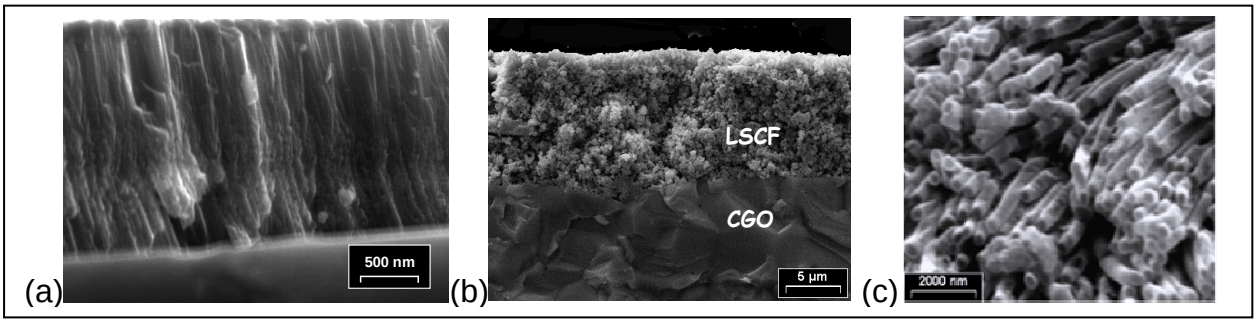

Figure 1: SEM images of LSCF films prepareded by (a) PLD, (b) HMTA deposited by Spin coating, and (c) nanostructured tubes.

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