Tuning the electrochemical properties of an oxygen electrode versus a nanostructure control for Solid Oxide Fuel Cell.

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Introduction

Since the operation of solid oxide fuel cells at intermediate temperature (IT-SOFCs) causes an increase of the interfacial polarization losses as well as ohmic losses in the electrolyte, the cell performances have to be improved. To compensate for the efficiency reduction, alternative cathode materials have being evaluated**.** To our advantage, thin film mixed ionic and electronic (MIEC) conductors offer the benefit of extending the gas/electrode/electrolyte triple phase boundary, where the oxygen reduction reaction occurs, to the entire plane of the cathode-electrolyte interface, leading to enhanced performance. MIEC conductors such as $La_{1-x}Sr_xCo_{1-y}Fe_yO_{3-\delta}$ have permitting the oxygen reduction reaction to occur in a larger volume fraction of the cathode with comparison to pure electronic conductors. Much can also be done in terms of microstructural design[1].

The present work reports a systematic study correlating the microstructural aspects of the nanostructured $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$ (LSCF6428) cathode film prepared by electrostatic spray deposition and respective electrochemical performances.

Results and Discussion

This work describes a wide variety of original microstructures of LSCF6428 films prepared by electrostatic spray deposition (ESD) on dense $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ substrate. The ESD process, unique in France, operates at relative low temperature while allowing excellent degree of control over the stoichiometry and microstructure of the films, which makes it most adequate in this study. Dense, columnar and coral single phased LSCF6428 films have been systematically mapped[2] by SEM (Figure 1) and XRD observations varying ESD parameters such as nozzle-to-substrate distance, solution flow rate and substrate temperature for a given solution of precursors with thicknesses ranging from 3 to 25 μm. A detailed microstructural characterization was obtained using FIB tomography.

The influence of the LSCF6428 microstructure has been investigated on the electrochemical performance of LSCF cathodes using AC impedance spectroscopy at OCP using a Solartron (SI 1280B) potentiostat/galvanostat frequency response analyzer with frequencies between 0.01 Hz and 20 kHz. The best electrical data of nanostructured LSCF6428 films, 3 μm thick, were obtained for columnar films on CGO leading to area specific resistance (ASR) values as low as 0.13 $\Omega.cm^2$ at 600 ^oC[4].

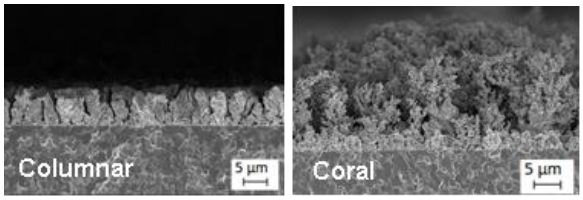

Figure 1. LSCF6428 films fabricated by ESD with innovative microstructures.

Conclusions

This work describes a wide variety of original microstructures of LSCF6428 ceramics prepared by electrostatic spray deposition (ESD) on dense $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ substrate. The dependence of electrochemical performances on innovative LSCF6428 cathode microstructure has been clearly highlighted. The lowest ASR value of 0.13 $\Omega.cm^2$ for a LSCF film, 3 μm thick containing only 20 mol.% Co and characterized by 30 nm grain size with a unique columnar microstructure is measured to date at 600°C[2-4]. To conclude, these encouraging results indicate that further improvement may be achieved by optimizing the microstructure of the assembly.

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