High efficiency cathodes for SOFCs prepared by spray-pyrolysis

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1 Abstract

In recent years, lowering the operating temperature of the Solid Oxide Fuel Cells (SOFCs) to the intermediate temperature range (500-700 ºC) has become the main challenge for this technology. The electrolyte resistance might be substantially reduced by using thin film electrolytes. However, the cathode polarization resitance is responsible for much of the loss in performance at low temperatures. Thus, the development of cathode materials with high electro-catalytic activity for the oxygen reduction reaction (ORR) is essential for this technology.

Lanthanum strontium manganite $La_{1-x}Sr_xMnO_{3-\delta}$ (LSM) is the cathode material most widely used in SOFCs. However, LSM exhibits high activation energy for oxygen reduction reaction (ORR) and poor ionic conductivity, limiting its application at high temperatures. Alternative mixed ionic-electronic conductors, such as $La_{1-x}Sr_xCo_{1-y}Fe_yO_{3-\delta}$ (LSCF) and $GdBaCo_2O_{5+x}$ (GBC) has been investigated, exhibiting better performances in the intermediate temperature range [1]. The performance of these electrodes might be improved at reduced temperature by extending the triple phase boundary length at which gas, electrode and electrolyte phases are simultaneously in contact, serving as the predominant site for the electrochemical reactions.

To date, the preparation of electrodes via wet infiltration of a cation solution into a porous electrolyte backbone is one of the most effective methods to increase the TPB area and to improve the efficiency of the cathodes, despite the limitations of this process for large-scale manufacturing of SOFCs.

In this contribution an alternative preparation method based on spray-pyrolisis deposition into an electrolyte backbone is proposed, which posses a series of advantages with respect to the classical wet infiltration process, including easy industrial implementation, preparation in one single deposition/thermal step as well as low cost [2]. The most widely used cathodes in SOFCs technology were prepared by this alternative method process: $La_{1-x}Sr_xMnO_{3-\delta}$ and $La_{0.6}Sr_{0.4}Co_{1-y}Fe_yO_{3-\delta}$ (y = 0-2) series. The electrodes were deposited on porous $Ce_{0.8}Gd_{0.1}O_{1.95}$ (CGO) backbones at 250 ºC by conventional spray pyrolysis from an aqueous precursor solution of metal nitrates. The structure, microstructure and electrochemical properties of these materials have been investigated by X-ray diffraction, field-emission SEM (**Fig. 1.a**) and impedance spectroscopy in symmetrical cells. The values of polarization resistance (**Fig. 1.b**) are extremely low, ranging from 0.40 Ωcm^2 for LSM to 0.07 Ωcm^2 for $LSCF_{0.2}$ at 600 ºC in air, compared to those previously reported in the literature for commercial electrolytes deposited at high temperature, e.g. 25 Ωcm^2 for LSM.

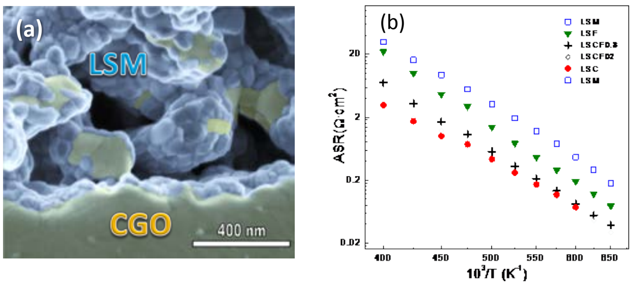

Fig. 1. (a) SEM of LSM cathode deposited by spray-pyrolysis on a porous CGO backbone and **(b)** area specific polarization resistance (ASR) values for different cathodes.

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3 References

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