SOFC development at CNH_2

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Introduction:

Solid oxide fuel cells (SOFC´s) are devices that convert chemical energy from reactants into heat and electricity with high efficiency. Usually, these systems operate at high temperatures (600-1000ºC) and are able to run with different fuels [1, 2]. Here we present the current activities that are being carried out at the Solid Oxide laboratory of the Hydrogen National Centre in Spain, which is focused on the development and electrochemical characterization of SOFC materials and devices.

Results and Discussion:

The fabrication methods for planar SOFCs have been found to be simple and inexpensive. In this work we describe the manufacture and characterization of both electrolyte and anode supported planar SOFCs for high temperature operation using either commercial or self-made materials.

On one hand, the electrolyte supported cells consist of $Gd_{0.2}Ce_{0.8}O_{1.9}$ (CGO) electrolyte of 200μm thickness and thin films (20-50μm thickness) of anode (Ni-CGO) and cathode $La_{0.6}Sr_{0.4}FeO_3$ (LSF). On the other hand, anode supported cells consist of a Ni–YSZ anode support of 800 μm thickness and 18 mm diameter, a 15–20 μm thickness YSZ electrolyte and a LSF cathode. $Sm_{0.2}Ce_{0.8}O_{1.9}$ (SDC) as barrier has been added between the electrolyte and the cathode.

In electrolyte supported cells, the electrolytes were prepared by tape casting and the deposition of thin layers of anodes and cathodes were made by manual spray coating. While in the case of anode supported cells, the anodes were made by uniaxial pressing and the deposition of thin layers of electrolyte, barrier, and cathode were made by manual spray coating.

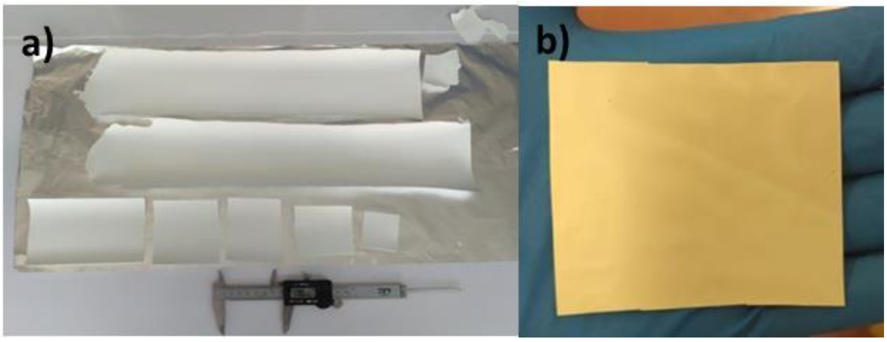

Figure 1. a) CGO tapes fabricated by tape casting. b) CGO tape sintered at 1400ºC.

Figure 1 shows CGO tapes fabricated by tape casting which are the electrolytes in electrolyte supported planar cells. Fig 1a) as prepared tapes. Fig 1b) tapes after the sinterization process. It is noteworthy that those tapes are flexible and easily processable using low-power laser techniques before the sinterization process. After that, the anode and the cathode layers were deposited in order to manufacture the cells.

Both types of cells were characterized by Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Spectroscopy (EDX). The cells were also electrochemically characterized in a button cell test rig (NorECs). The polarization curves and electrochemical impedance spectroscopy (EIS) measurements were performed by a multichannel Potentiostat/Galvanostat VMP3 (Biologic) using 100% of H_2 humidified at 3% as reactant gas in the anodic compartment and air in the cathodic one at temperatures between 750 and 900 °C.

Figure 2 shows the I-V and I-P curves obtained for the anode supported cells in the temperature range of 750-865ºC. As it can be seen, the open circuit voltages (OCV) are high enough to ensure an efficient sealing and to prove that the YSZ electrolyte layer was tight enough without gas cross over. The power density of the cell reaches values close to 200mW·cm^{-2} at 865ºC:

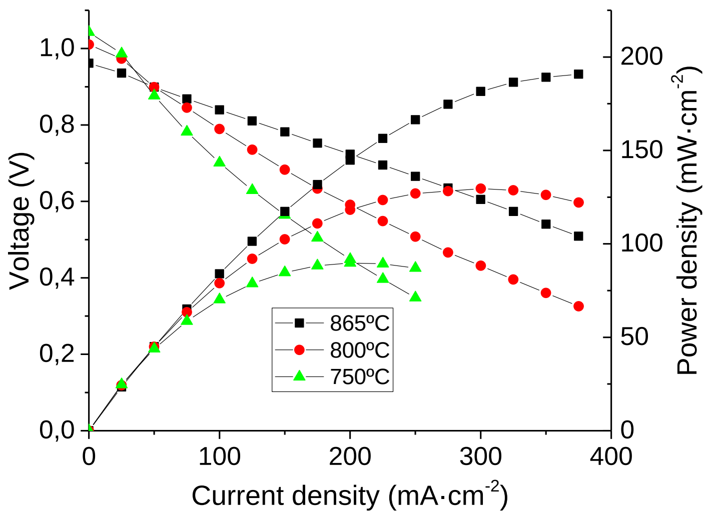

Figure 2. I-V and I-P curves for anode supported cells fabricated at CNH_2.

References:

[1] Singhal S. C, Kendall K.,"High Temperature Solid Oxide Fuel Cells: Fundamentals, Design and Applications". Oxford: Elsevier Advanced Technology, 2002.

[2] Larminie J., "Fuel Cell Systems Explained". 2nd edition, John Wiley & Sons, 2003.