$LaCr_{0.75}Mn_{0.25}O_{3+\delta}$ –CGO nanocomposite electrodes for highly efficient Solid Oxide Fuel Cells

Javier Zamudio-García[1*], Jose Manuel Porras-Vázquez[1], Enrique R. Losilla[1], David Marrero-López[2]

[1]Department Inorganic Chemistry, Crystallography and Mineralogy, University of Málaga, Spain
[2]Department Applied Physics I, University of Málaga, Spain
zamudio@uma.es

INTRODUCTION

One of the most recent strategies to enhance the electrode performance is the preparation of nanocomposite materials, leading to an increase of the triple-phase-boundary (TPB) length. In this way, spray-pyrolysis deposition has been proposed due to the fact that it is an easy method that has been applied previously to prepare nanocrystalline electrodes, with a significant improvement in comparation with traditional electrodes.[1] In this work, a new nanocomposite based on manganese-doped lanthanum chromite (LCM) and gadolinium doped ceria (CGO) has been proposed for highly efficient and stable electrodes for Solid Oxide Fuel Cells.

EXPERIMENTAL/THEORETICAL STUDY

YSZ electrolyte pellets were obtained from commercial powders (Tosoh) pressed into disks and sintered at 1400 ºC for 4h. Afterwards, the electrode was sprayed with a solution containing the corresponding nitrates in distilled water with a concentration of 0.025 M. The optimum temperature deposition, time and flow rate was 300 ºC, 1h and 20 mL/min, respectively. After the deposition, the samples were heated at 800 ºC for 1h to achieve crystallization. Simultaneously, the materials were synthesized by the freeze-drying precursor method for comparison purposes.

RESULTS AND DISCUSSION

XRD patterns show that two different crystalline phases are clearly identified. In addition, the position of the peaks matches well, independently of the LCM/CGO ratio. Additional phases are not observed despite the co-sintering of LCM and CGO. Similar XRD patterns are obtained for the samples deposited on YSZ pellets.

The thickness of the electrode is about 5 µm and exhibits a large porous area. STEM images and EDS elemental mapping of the nanocomposite calcined at 1000 ºC reveal that CGO and LCM particles are well distinguished and homogenously distributed, ensuring percolation of both phases and therefore increased TPB sites (Fig. 1).

The overall electrode polarization resistance of the electrodes in symmetrical cells was determined by impedance spectroscopy in air and diluted and pure hydrogen obtaining ASR values as low as 0.1 $\Omega\cdot cm^2$ at 800 ºC in air and 0.26 $\Omega\cdot cm^2$ at 650 ºC in pure H_2, being these values almost one order of magnitude better in comparison with the same materials prepared by traditional methods.

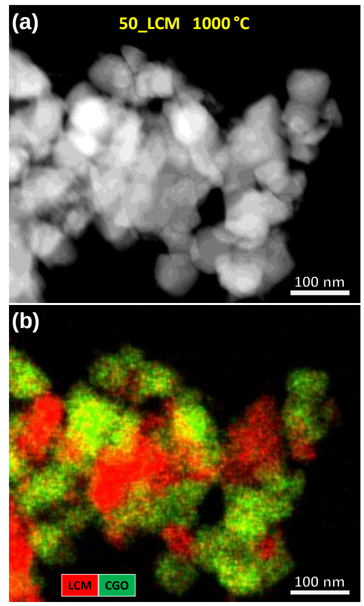

Fig. 1 STEM image and EDS analysis of LCM-CGO nanocomposite electrodes.

LSGM supported cells (300 µm) using LSCF as cathode and LCM/CGO nanocomposite as anode generates a maximum power density of 580 $mW\cdot cm^2$ at 800 ºC, a high improvement respect to the same materials supported onto electrolyte cell.

CONCLUSION

Nanocomposite electrodes based on lanthanum chromites with ceria has been prepared using the spray-pyrolysis precursor method achieving better electrochemical properties than traditional electrodes for SOFC.

REFERENCES

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