Vertically Aligned Nanostructures for SOFC applications

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INTRODUCTION

One of the most recent strategies to enhance the electrode performance is preparing composite materials leading to an increase of the triple-phase-boundary (TPB) length. On this way, heteroepitaxial nanocomposite films such as vertically aligned nanostructures (VANs) deposited by Pulsed Laser Deposition (PLD) are one of the most promising and recent approaches to obtain nanocomposite active layers for energy applications[1]. In this work, thin films VANs based on $(La_{0.8}Sr_{0.2})_{0.98}Fe_{0.8}Ti_{0.2}O_{3-\delta}$-$Ce_{0.9}Gd_{0.1}O_{1.95}$ (LSFT-GDC) electrodes were obtained for their use as functional layers in Solid Oxide Fuel Cells (SOFCs).

EXPERIMENTAL/THEORETICAL STUDY

LSFT-GDC and LSFT films were deposited onto STO, YSZ and LSAT (001) single cristals at 650 ºC in a surface PLD. The crystal structure and microstructure of the active layer were characterized by XRD, AFM and electron microscopy techniques. In-plane conductivity of the samples was studied by four-probe Van der Pauw method to obtain the total conductivity of the samples. The electrochemical characterization of the films deposited on YSZ (001) was carried out in symmetrical configuration by impedance spectroscopy under different atmospheres.

RESULTS AND DISCUSSION

XRD patterns revealed that two different crystalline phases are clearly discernible. In addition, the cell parameters of the LSFT and CGO phases are similar to those reported for thein the literature. It has to be noted that an epitaxial growth on the (001) direction for both phases was observed for the samples deposited on STO and LSAT. In the case of the samples deposited on YSZ, (110) orientation was observed for LSFT, similar to that reported for a LSM-SDC VAN[2]. Additional phases are not observed despite the co-sintering of LSFT and GDC. The thickness of the VAN functional layer is about 100 nm and exhibits high density without the presence of porous areas. STEM image and EDS elemental mapping showed alternant nanocolumns of 5 nm of each phase and HR-TEM images confirmed that the columns are well defined and showed high crystallinity (Fig. 1).

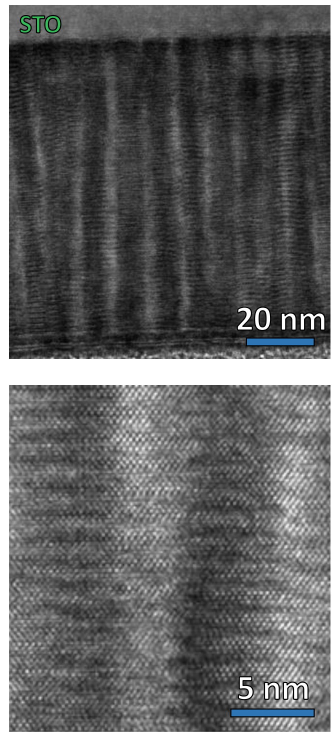

Fig. 1 HR-TEM images of the LSFT-GDC vertically aligned nanocomposite electrodes.

The area specific resistance (ASR) of the electrodes in symmetrical cells was determined by impedance spectroscopy in air, diluted and pure hydrogen obtaining ASR values as low as 1 $\Omega \cdot cm^2$ at 650 ºC in air, being these values one of the lowest reported for thin films for SOFC applications.

CONCLUSION

Redox stable vertical aligned nanostructures (VANs) based on $(La_{0.8}Sr_{0.2})_{0.98}Fe_{0.8}Ti_{0.2}O_{3-\delta}$-$Ce_{0.9}Gd_{0.1}O_{1.95}$ electrodes are obtained by PLD. The extension of the TPB leads to obtain very high electrochemical activity for SOFC applications.

REFERENCES

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