Synthesis and Characterization of $BaZr_xCe_{0.8-x}Y_{0.1}Yb_{0.1}O_{3-\delta}$

R.I.V. da Silva[1], W.K. Yoshito[2], D.I. dos Santos[3], S.M.A. Jorge[1], J.P.S. Valente[1], M.A. Centeno[4], J.A.G. Odriozola[4], M.J. Saeki[1]
[1] Chemistry and Biochemistry Department, Unesp, Botucatu-SP, Brazil.
[2] National Commission Nuclear Energy, IPEN, São Paulo-SP, Brazil.
[3] Physics Department, Unesp, Bauru-SP, Brazil.
[4] Material Science Institute, CSIC, Seville University, Seville, Spain.
rivs83@ibb.unesp.br

Keywords: IT-SOFC, Doped zirconate-cerate, chemical stability.

Introduction

Proton Conductive Ceramics has became known for allowing the reduction of operating temperature of Intermediate Temperature Solid Oxide Fuel Cell, known as IT-SOFC [1]. The most studied materials are the perovskite type oxides as $BaCeM^{III}O_{3-\delta}$ (BCM^{III}) (M^{III} = metals with valence 3+), that exhibit good proton conductivity. However, it has low chemical stability in the presence of acidic gases such as CO_2 and SO_2 [1]. Compounds with adequate chemical stability under CO_2 atmospheres can be provided by doping the cerates with zirconium. In particular, $BaZr_{0.1}Ce_{0.7}Y_{0.1}Yb_{0.1}O_{3-\delta}$ showed an outstanding mixed ion conduction (by proton and oxide ion), in IT-SOFC operating conditions [1,2]. Thus, the aim of this study was to obtain the $BaZr_{0.1}Ce_{0.7}Y_{0.1}Yb_{0.1}O_{3-\delta}$ (BZCYYb) and $BaCe_{0.8}Y_{0.1}Yb_{0.1}O_{3-\delta}$ (BCYYb) and evaluate the effect of zirconium on chemical stability under CO_2 containing atmospheres of this oxide system.

Experiments

The compounds were synthesized by EDTA-Citrate gel Method [1,2]. After gelling, it was dried at 150ºC/2h and 250ºC/2h and pyrolysed at 400ºC/4h, in air. Finally, it was heat treated at 1100ºC/10h, also in air. These compounds were characterized by X-Ray Diffraction (XRD). The compounds were submitted to a–5mol% CO_2 (N_2 balance) atmosphere at different temperatures: 400°C, 500ºC, 600ºC and 700ºC, for 4 hours, and they were also characterized by X-Ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR).

Results and Discussion

The XRD patterns (Fig. 1) showed that EDTA-Citrate gel Method can provide materials under perovskite crystal structure, for both samples, however, the inclusion of Zr leads to a more symmetrical crystalline structure.

In the Fig. 2, it can be seen that there is no formation of $BaCO_3$ when the samples are submitted to an heat treatment at 400°C and 500°C in CO_2 atmosphere. At 600°C, the BZCYYb sample was relatively stable with small formation of $BaCO_3$, while BCYYb sample revealed to be quite unstable at 600°C, demonstrating the key role of zirconium for chemical stability. At 700°C, both samples proved unstable. The chemical stability results were confirmed by FTIR.

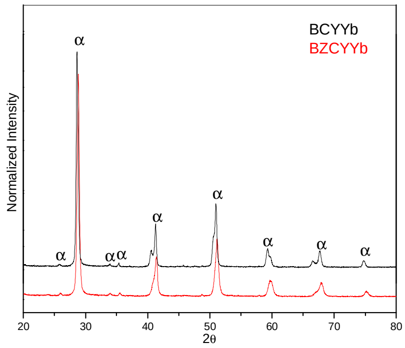

Fig. 1. XRD patterns of BZCYYb and BCYYb after heat treated at 1100ºC/10h in air. α - perovskite.

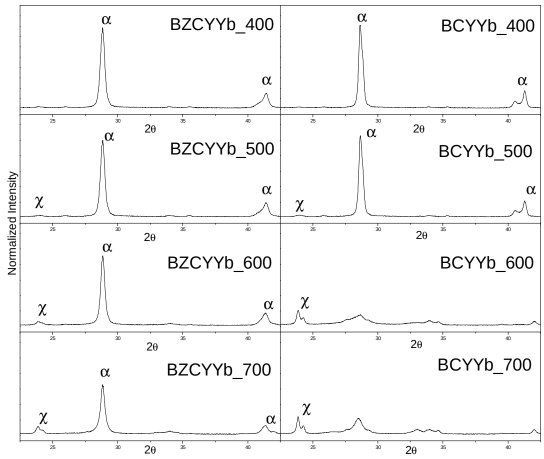

Fig. 2. XRD patterns of BZCYYb and BCYYb after submitted to heat treatment in 5mol% CO_2. α – BZCYYb perovskite and χ - barium carbonate.

Conclusions

The BZCYYb compoud presented perovskite crystalline structure with higher symmetry. The BZCYYb and BCYYb compounds were stable under CO_2 atmosphere at 400°C and 500°C, whereas just BZCYYb was stable at 600°C.

Acknowledgements

CAPES, “Multiusuários” Lab (FC-UNESP) and IPEN.

References

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