

Influence of synthetic method on the properties of $\text{La}_{0.5}\text{Ba}_{0.5}\text{FeO}_3$ SOFC cathode

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Perovskite type (ABO_3) oxides have been widely studied as SOFC cathode materials at high temperatures. Given that several of the challenges hindering SOFC technology are consequence of the high operation temperature (about 1000°C) [1,2], an important goal is to reduce it to 600-800°C. To minimize this effect new perovskite-type mixed ionic-electronic conducting oxides have been widely studied as promising IT-SOFC cathodes. Among them, iron perovskites (LSF) seem to be good candidates mainly for their appropriate thermal expansion match with YSZ electrolytes and their good catalytic activity for the oxygen reduction [3,4]. The properties of these compounds and thus their cell performance depends on several factors: the right choice of A and B elements, the amount of doping cations (A_{1-x}A_x) and some structural parameters such as the tolerance factor [5], the average size of the A-site cations ($\langle r_A \rangle$) and the A cation size disorder ($\sigma^2(r_A)$). Studies on the influence of the hole-doping (x) in the A-site of LSF perovskites have shown good cathode performances in compounds with intermediate doping levels [6]. The change of $\langle r_A \rangle$ and $\sigma^2(r_A)$ indicate that better performances are observed for highest $\langle r_A \rangle$ and lowest $\sigma^2(r_A)$ [7]. External parameters, such as the synthetic method, are also important factors that influence the final properties [8]. In this sense it has been observed that porosity, grain size and morphology of the compounds strongly depend on the sample preparation techniques.

In this research, a $\text{La}_{0.5}\text{Ba}_{0.5}\text{FeO}_3$ perovskite has been synthesized by two different methods (ceramic and glycine-nitrate routes) in order to study the synthetic method influence on the properties of this compound as IT-SOFC cathode material. This composition has been chosen due to its intermediate hole doping level (0.5) and high average size of the A-site cations ($\langle r_A \rangle = 1.48 \text{ \AA}$, when r_A are standard 12-coordinate ionic radii), these parameters, according with previous studies should show interesting properties for its use as SOFC cathode.

It has been observed that the two $\text{La}_{0.5}\text{Ba}_{0.5}\text{FeO}_3$ compounds show different room temperature crystal structure depending on the synthesis route. The sample obtained by the ceramic method has higher oxygen vacancy content, but in the other hand the SEM micrographs show that glycine-nitrate process leads to a compound with porous structure and particles with nanometric grain sizes. At 700 or 800°C the electrical conductivity of both samples is similar but the sample obtained by glycine-nitrate route shows better electrochemical performance. The ceramic sample has lower adherence than the glycine counterpart and this derives in higher values of polarization resistance. It is believed that this is a consequence of the heterogenous morphology of this sample. Therefore, it seems that the glycine-nitrate synthetic method is a more appropriate technique for preparing perovskite cathodes.

Keywords: Chemical synthesis; Electrical conductivity; Neutron powder diffraction; Perovskite phases

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References

- [1] A. Orera, P.R. Slater, *Chem. Mater.* 22 (2010) 675-690.
- [2] A. Moran-Ruiz, K. Vidal, A. Larrañaga a, M.A. Laguna-Bercero, J.M. Porras-Vazquez, P.R. Slater, M.I. Arriortua, *J. Power Sources* 269 (2014) 509-519.
- [3] K. Lu, F. Shen, *Int. J. Hydrogen Energ.* 39 (2014) 7963-7971.
- [4] T. Yu, X. Mao, G. Ma, *Ceram. Int.* 40 (2014) 13747-13751.
- [5] V.M. Goldschmidt, T. Barth, G. Lunde, W. Zachariassen: Skriffter Norse Videnskaps-Akad. Oslo, 1, *Mat. Naturv. Klass.*, n° 2 y 7, 1926.
- [6] K. Vidal, L.M. Rodríguez-Martínez, L. Ortega-San-Martín, A. Martínez-Amesti, M.L. Nó, T. Rojo, A. Laresgoiti, M.I. Arriortua, *J. Power Sources* 192 (2009) 175-179.
- [7] A. Ecija, K. Vidal, A. Larrañaga, A. Martínez-Amesti, L. Ortega-San-Martín, M.I. Arriortua, *Solid State Ionics* 235 (2013) 14-21.
- [8] Z. Shao, W. Zhou, Z. Zhu, *Progr. Mater. Sci.* 57 (2012) 804-874.