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Short communication

Chemical and electrical properties of $BaPr_{0.7}Gd_{0.3}O_{3-\delta}$ ☆

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Abstract

Doped perovskites have a growing interest as electrolytes for IT-SOFCs. In the search for proton conducting electrolytes, Gd-doped $BaPrO_3$ was studied. The present work reports the chemical stability and electrical conductivity of $BaPr_{0.7}Gd_{0.3}O_{3-\delta}$ powders. This system is found to be highly reactive under water, CO_2 and hydrogen containing atmospheres. Comparison of the conduction behaviour measured at different atmospheres indicates that the system behaves as a p-type electronic conductor. The total conductivity is about 1×10^{-3} S cm^{-1} at 300 °C, in dry O_2. The resistance of the system seems to be dominated by the grain boundary contribution. However, structure investigation reveals there is a gadolinia segregation, which may act as a resistive barrier. The material is not suitable for SOFC applications due to its low stability.

Keywords: $BaPrO_3$; p-Type conductivity; Proton conductivity; Electrolyte; Electrode; Perovskite

1. Introduction

There is a growing interest on finding new materials susceptible to be used as electrolytes in IT-SOFC, which can reduce the operating temperature to the range under 600 °C. Therefore, energetic costs, chemical degradation and mechanical stress can be reduced.

In that direction, Fukui et al. [1] reported a new perovskite material supposed to be used as proton conducting electrolyte in high temperature proton conducting fuel cells. That material, $BaPr_{1-x}Gd_xO_{3-\delta}$, is very interesting because of its high conductivity (0.1 S cm^{-1} at 500 °C for $x = 0.3$). However, there are still some contradictory results about its nature of conduction. The same author pointed out that the dominant conduction species for the compound $x = 0.4$ used as electrolyte were mainly holes [2]. However, it was later said [3] that compound was not single phase for the mentioned composition and reported a conductivity of 5×10^{-3} S cm^{-1}, $t_{H+} = 0.85$ at 200 °C for $x = 0.3$.

In terms of chemical stability, $BaPrO_3$-based compounds seem to be chemically unstable under CO_2 [3] and under reducing conditions [4]. It has been recently pointed out that $BaPrO_3$ may be also partially reduced under humid conditions [5].

Due to the fact that there is few and contradictory bibliography about $BaPrO_3$ based compounds, in this paper we report a study on the chemical stability of the compound $BaPr_{0.7}Gd_{0.3}O_{3-\delta}$ and the AC impedance studies under various atmospheres.

2. Experimental work

2.1. Sintering studies and morphological characterization

The synthesis of $BaPr_{0.7}G_{0.3}O_{3-\delta}$ was done using the acrylamide combustion synthesis described elsewhere (Magrasó et al. [6]). The sintered bodies were obtained by uniaxial pressing at 3*t*, for 13 mm diameter discs.

A study of the sintering properties of this powder was carried out. The sintering temperature varies from 1250 to 1500 °C and time from 5 up to 30 h. Ramp rate was maintained constant at 3 °C min^{-1} from room temperature.

Because $BaPrO_3$ based compounds react with alumina at high temperatures [3] an old sintered pellet of the same composition was used between the alumina boat and the pellet in order to avoid undesired reactions and consequent stoichiometry losses.

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