Tailoring of $BaCe_{0.9}Y_{0.1}O_{3-\delta}$ electrolyte properties by co-doping

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Abstract:

$BaCe_{0.9}Y_{0.1}O_{3-\delta}$ has been known as one of the best proton conducting electrolyte, which enables its application in intermediate-temperature solid oxide fuel cells (IT-SOFC) operating between 500 °C and 700 °C. The main disadvantage of this material is its instability in a CO_2-rich atmosphere that limits its application with respect to fuel selection. Therefore, many attempts has been made to improve its stability by replacing yttrium with other dopants, or by co-doping.

In this study, we compared $BaCe_{0.9}Y_{0.1}O_{3-\delta}$ and $BaCe_{0.85}Y_{0.1}M_{0.05}O_{3-\delta}$ (M = {In, Zr, Nb}) electrolytes by taking into consideration the dopant properties (primarily the valence, electronegativity and ionic radius) and how they influenced the microstructure, conductivity and chemical stability of doped $BaCeO_3$. The samples were synthesized by the citric-nitric autocombustion method. $BaCe_{0.85}Y_{0.1}In_{0.05}O_{3-\delta}$ was sintered at 1400 °C for 5 h in air, while the temperature of 1550 °C was required for the other materials to complete the sintering. This makes the doping with In a preferable method since sintering temperatures above 1500 °C can lead to a certain materials degradation resulting in BaO loss. The total conductivities (σ) measured at 700 °C in wet hydrogen decreased in the following order: $BaCe_{0.9}Y_{0.1}O_{3-\delta} > BaCe_{0.85}Y_{0.1}Zr_{0.05}O_{3-\delta} > BaCe_{0.85}Y_{0.1}Nb_{0.05}O_{3-\delta} > BaCe_{0.85}Y_{0.1}In_{0.05}O_{3-\delta}$. By comparing the stability of the ceramics exposed to a 100% CO_2 atmosphere at 700 °C for 5 h and examined by X-ray analysis, it was observed that only $BaCe_{0.85}Y_{0.1}In_{0.05}O_{3-\delta}$ could sustain the aggressive environment. The exposed sample contained only traces of secondary phases, while the other compositions were partially or significantly decomposed. By taking into account the values of the Goldschmidt tolerance factor (t) and dopant electronegativity (χ), it was found that the dopant electronegativity had a decisive role in inhibiting the carbonation of the ceramics.

Biography of presenting author

Dr. Aleksandar Radojković is a senior research fellow at the Institute for Multidisciplinary Research, University of Belgrade. In 2014 he acquired PhD degree in Materials science at the Faculty of Technology and Metallurgy, University of Belgrade, after having defended dissertation thesis entitled: “Properties of yttria doped barium cerium oxide ceramics as an electrolyte for solid oxide fuel cells”. His research interests include proton conductivity and elctrical properties of $BaCeO_3$-based materials and their application in solid oxide fuel cells, and synthesis and characterization of multiferroic $BiFeO_3$. he has published more than 20 research articles in SCI(E) journals.

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