The French Research network on Hydrogen energy

Synthesis, Structure and Stability of Proton Conductors $Ba(Zr_xCe_{0.8-x}Y_{0.1}Yb_{0.1})O_{2.90}$ with $0 \leq x \leq 0.8$

PROTEC Project

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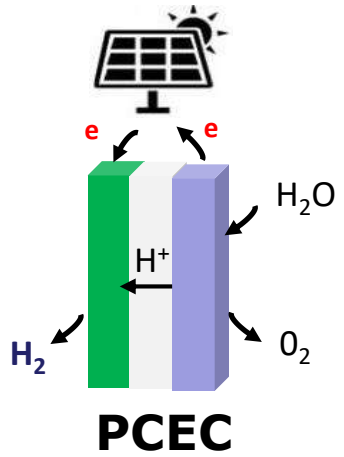

PCEC

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Objective

Study of proton conductors $Ba(Zr_xCe_{0.8-x}Y_{0.1}Yb_{0.1})O_{2.90}$

with $0 \leq x \leq 0.8$

5 studied compositions

- $x = 0$ $BaCe_{0.8}Y_{0.1}Yb_{0.1}O_{2.90}$
- $x = 0.1$ $BaZr_{0.1}Ce_{0.7}Y_{0.1}Yb_{0.1}O_{2.90}$
- $x = 0.4$ $BaZr_{0.4}Ce_{0.4}Y_{0.1}Yb_{0.1}O_{2.90}$
- $x = 0.7$ $BaZr_{0.7}Ce_{0.1}Y_{0.1}Yb_{0.1}O_{2.90}$
- $x = 0.8$ $BaZr_{0.8}Y_{0.1}Yb_{0.1}O_{2.90}$

Task 2.1 Development and optimization of materials and interfaces, Electrolyte.

Outline

- Bibliography
- Synthesis methods
- Heating treatments
- XRD Results
- Refinements
- Stability tests

Abstract

Synthesis, Structure and Stability of Proton Conductors $Ba(Zr_xCe_{0.8-x}Y_{0.1}Yb_{0.1})O_{2.90}$ with $0 \leq x \leq 0.8$

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This work is part of the PROTEC project of the PEPR H2 program, which aims to develop electrolysis cells based on proton conduction ceramics. Proton conduction electrolysis cells (PCEC) have attracted significant research interest due to their dry hydrogen production in contrast to their high-temperature analogues (SOEC) and their potential for reversibility and flexibility [1]. In particular, the development of proton-conducting ceramic electrolyte materials has been a focus of recent research efforts in this field.

In this study, we investigated the solid solution $Ba(Zr_xCe_{0.8-x}Y_{0.1}Yb_{0.1})O_{2.9}$, whose members are potential electrolyte materials for PCEC, focusing on two limiting compositions (x=0; BCYYb811, and x=0.8; BZYYb811) and three intermediate compositions (x=0.1; BZCYYb1711, x=0.4; BZCYYb4411, and x=0.7; BZCYYb7111). Among these compounds, BZCYYb1711 and BZCYYb4411 have already been integrated and tested in complete PCFC/PCEC cells and showed good performance [1-2]. In this work, a significant effort has been devoted to the synthesis of BZCYYb compounds in order to obtain pure and well-crystallized phases to unambiguously determine their structure. Figure 1 shows the linear evolution of the cell volume as a function of x in the $Ba(Zr_xCe_{0.8-x}Y_{0.1}Yb_{0.1})O_{2.9}$ compounds, which confirms their solid solution behavior. In addition, stability tests in H_2 or CO_2 hydrated atmospheres have been performed on the BZCYYb compounds and will be discussed.

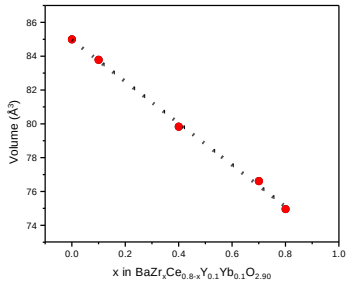

Figure 1: Cell volumes of investigated compositions

References:
1-Zhang, W., Liu, M., Gu, X., Shi, Y., Deng, Z., & Cai, N. (2023). Water Electrolysis toward Elevated Temperature: Advances, Challenges and Frontiers. *Chemical Reviews*.
2-Tian, H., Luo, Z., Song, Y., Zhou, Y., Gong, M., Li, W., ... & Liu, X. (2022). Protonic ceramic materials for clean and sustainable energy: advantages and challenges. *International Materials Reviews*, 1-29.

Thank you for your Attention