

Electrical Properties of $\text{Gd}_2\text{Hf}_{2-x}\text{Zr}_x\text{O}_7$ Solid Electrolytes Synthesized by Mechanical Milling

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ABSTRACT

Gadolinium hafnates $\text{Gd}_2\text{Hf}_2\text{O}_7$ belong to a family of complex oxides with general formula $\text{A}_2\text{B}_2\text{O}_7$ which can show two different structural arrays, pyrochlore and non stoichiometric fluorite. These materials are known by their interesting electrical and thermal properties; thus, some of them are good oxygen ion conductors at high temperatures and can be used as solid electrolytes in SOFC's (Solid oxide Fuel Cells). Some others show low thermal conductivity and high thermal stability which make them attractive materials for TBCs (Thermal Barrier Coatings) to protect metal components of gas turbines and diesel engines.

The properties of these materials are significantly affected by the presence of defects such as vacancies and structural disorder. Therefore, their electrical and thermal properties can be modified by single or multiple chemical substitutions or by processing.

The ceramic method to obtain lanthanides hafnates usually involves thermal treatments at temperatures higher than 1500°C by long periods of time. This work deals with the mechanochemical synthesis and characterization of advanced ceramics of general formulae $\text{Gd}_2\text{Hf}_{2-x}\text{Zr}_x\text{O}_7$ ($x = 0, 0.4, 0.8, 1.2, 1.6$ and 2). This powder processing method allows obtaining metastable phases at room temperature that include a large number of structural defects, which will have an interesting effect on their electrical properties for their use as solid electrolytes. We also analyze the effect of substitution of Hf by Zr on the crystal structure and electrical properties of the gadolinium hafnate.

Results show that solid solutions $\text{Gd}_2\text{Hf}_{2-x}\text{Zr}_x\text{O}_7$ can be obtained by mechanical milling, by using a planetary mill and Ytria Stabilized Zirconia vials and balls. Their electrical properties, analyzed by impedance spectroscopy, reveal that these oxides are potential candidates to be used as solid electrolytes in SOFC's.

Keywords: SOFC's, pyrochlores, hafnates

