**Electrochemical characterization of pyrochlore materials for potential application in low-temperature devices**

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Crystalline solid ion conductors are of huge importance to contemporary energy and sensor technologies. With the continuous progression of materials science, these materials play an increasingly prominent role in the development of next-generation devices for sustainable energy storage and generation. Oxide ceramics like yttria-stabilized zirconia (YSZ) can offer high ionic conductivity at elevated temperatures in combination with high (electro)chemical stability, making them pivotal to various electrochemical devices [1].

Electro-chemo-X (EC-X) devices or on-chip batteries and micro fuel cells, however, are expected to operate in a much lower temperature range between 200 °C and room temperature and require chemical stability against Si and easy thin film preparation, e.g. by sputtering. Promising fast proton conductors for these applications are highly doped ceria and zirconia, but there are few reliable studies on the ionic and electronic conductivity of relevant materials [2].

In recent years, significant attention has been directed towards materials with the general formula , which exhibit remarkable high-temperature proton conductivity coupled with oxygen ion conductivity. However, the precise structure of these materials is often challenging to predict and can vary from a fluorite-type to a pyrochlore or even a monoclinic structure, or a mixture of these structures [3].

For this work, materials with the composition (with A e.g. La, Y, Sm, Pr and B e.g. Ce, Zr) were prepared *via* the Pechini method. Using XRD, SEM and Raman spectroscopy, the pellets were characterized for purity and structural information. In order to gain a comprehensive understanding of the transport properties of the samples, the ionic and electronic partial conductivities at high temperatures characterized by impedance spectroscopy and Hebb-Wagner measurements. Given the low ionic conductivity at room temperature, atomic force microscopy (AFM)-based measurement techniques were additionally employed to obtain information regarding near-surface transport processes in this temperature regime [4]: Kelvin Probe Force Microscopy (KPFM) was used to analyze the surface potential, which is a sensitive indicator of changes in local defect concentrations and offers information about the bulk and grain boundary potential differences, thus providing insights into differences in transport characteristics [5]. The electrochemical results are discussed in line with the precise structure and in the context of a defect model.

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**Literature:**

[1]D.A. Agarkov, M.A. Borik, G.M. Korableva, *et al.*, *J Solid State Electrochem* **28**, (2024) 1901–1908.

[2] K. Neuhaus, H. D. Wiemhöfer, *Solid State Ionics*. **371** (2021) 115771.

[3] M.A. Subramanian, G. Aravamudan, G.V.s. Rao, *Prog. Solid State Chem*. **15** (1983) (2) 55-143.

[4] K. Neuhaus, C. Schmidt, L. Fischer, W. A. Meulenberg, K. Ran, J. Mayer, S. Baumann, *Beilstein J. Nanotechnology*. (2021) (12) 1380-1391.

[5] S. Sadewasser, G. T. *Kelvin Probe Force Microscopy*; 2012.