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Non-stoichiometric oxides for energy storage and transformation: structure and dynamics for low temperature anisotropic oxygen ion diffusion

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Non-stoichiometric, oxygen-deficient perovskites have been proposed as a potential electrolyte in solid oxide fuel cells, since they can theoretically operate at a lower temperature than current materials. The main structure of interest is the brownmillerite structure ABO2.5, where A is typically calcium or strontium and B is iron or cobalt. This structure undergoes a reversible topotactic intercalation reaction to form the perovskite ABO3, which can be achieved using electrochemical oxidation or by "chimie douce"techniques.

SrCoO2.5 is able to intercalate oxygen at a particularly low temperature; however the reaction and the transport pathways for oxygen atoms are not well understood, as the diffusion is anisotropic and related to lattice dynamics, and is complicated further by the existence of two intermediate compounds between the brownmillerite and perovskite phases. In addition, the related compounds SrFeO2.5 and CaFeO2.5 do not always behave in the same manner.

The aim of this thesis is to grow thin films of SrCoO2.5 single crystals in a mirror furnace, in order to observe the anisotropy of the oxygen diffusion, increase the sample's reactivity, and to determine why the reaction is not the same when using the related compounds previously mentioned. This information will be valuable not only for SOFC development but also for an improved fundamental understanding of ionic diffusion mechanisms in ceramics.

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