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On the road to μ-*SOFC*s: high-pressure structural studies of doped ceria

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Doped ceria oxides form a family of widely studied compounds to be used as electrolytes in micro Solid Oxide Fuel Cells (μ-SOFCs) due to their high ionic conductivity in the intermediate temperature range. In fact, the insertion of a small amount of trivalent rare earth ions (RE^{3+}) into the fluorite-like (F) structure of pure ceria causes the occurrence of not associated oxygen vacancies that are free to move through the lattice, making the $Ce_{1-x}RE_xO_{2-x/2}$ systems good conductors of O^{2-} ions. The $Ce_{1-x}RE_xO_{2-x/2}$ solid solution is stable as long as the F lattice incorporates the doping ions, but when the RE^{3+} amount exceeds a certain value (x_{max}), different and complex scenarios may occur, mainly depending on the doping ion nature [1]. However, the highest values of ionic conductivity are always reached well below the x_{max} compositional limit. This is because the C phase nanoclusters (C being the typical RE_2O_3 structure for the smallest RE^{3+} ions) that trap oxygen vacancies are already growing within the F matrix with increasing x, thus affecting the ionic conductivity of the system [2]. Recently, our research group undertook a high-pressure structural investigation on several doped ceria systems (RE ≡ Lu, Sm, Nd/Tm) to evaluate the compressibility of the different mixed oxides. One of the main motivation behind such a study was to determine the most suitable electrolytes to be used in μ-SOFCs. In the present devices, the electrolyte is deposited as a thin film on a proper substrate, where it experiences a tensile strain due to the oxide-substrate lattice mismatch. A more compressible electrolyte should be able to better tolerate the aforementioned strain without creating dislocations, thus raising the overall performance of the μ-SOFCs devices. Moreover, starting from the present experiments, our group also developed a novel approach to evaluate the C defects content in doped ceria systems [3]. A full overview of the performed high pressure structural studies will be presented.

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