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Rare earth doped SiO_2-containing ceria for solid oxid fuel cells applications

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Abstract – This work correlates the microstructure and the electrical conductivity of rare earth doped ceria and co-doped with Pr and La. It was seen that both codopants help to modify the microstructure but only La doping improves the grain boundary conductivity. By other side Pr presented a deleterious effect under the grain boundary electrical conductivity.

Rare earth doping is one way for enhancing the electrical conductivity of ceria. Due to its high conductivity, this material is eligible to replace yttria stabilized zirconia as electrolyte in solid oxide fuel cell, lowering the cell working temperature. The impure ceria produces secondary phases during sintering that is deleterious to the grain boundary conductivity because it blocks the charge carriers through the grain boundary. The co-doping is one way to modify the microstructure and to enhance the grain boundary and total conductivity [1, 2]. In this work, using CeO_2 containing SiO_2 and Al_2O_3 as main impurities, Pr and La co-doped CeO_2-12,5 mol% Gd_2O_3 were investigated. The powders were prepared by mechanical mixture of Cerium oxide, $Gd_2(NO_2)_3.6H_2O$, $Pr_{11}O_6$ and La_2O_3, all from Aldrich 99,9% purity. The successive calcination process was used to enhance the mixture homogeneity. Pellets were isostatically pressed at 200 MPa and sintered at 1450 ºC-20 h, 1500 ºC 2 and 8 h and 1600 ºC-2 h. The mainly characterization techniques were scanning electron microscopy (SEM) and impedance spectroscopy (performed from 200 to 600 ºC, 5 Hz-13 MHz in air). It was seen that both co-doping modifies the microstructure, concentrating the second phase on the grain boundaries triple points, as it can be seen in the figure 1A and 1B. Pr co-doping showed deleterious effects on the grain boundary electrical conductivity, figure 2A. On the other hand, La co-doping showed improvements on the microstructure and on the grain boundaries electrical conductivity (Figure 2B).

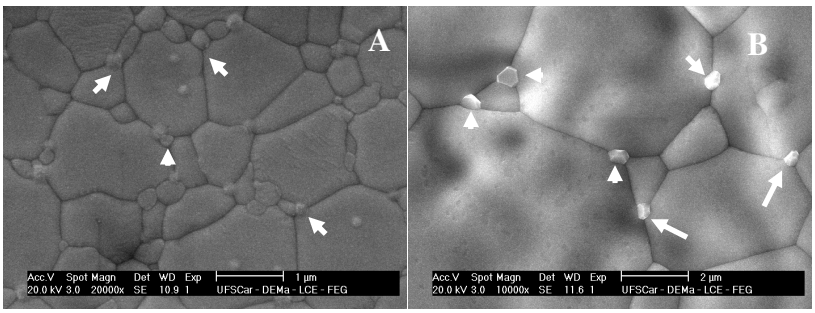

Figure 1: SEM micrographs of co-doped samples: (A) Pr and (B) La

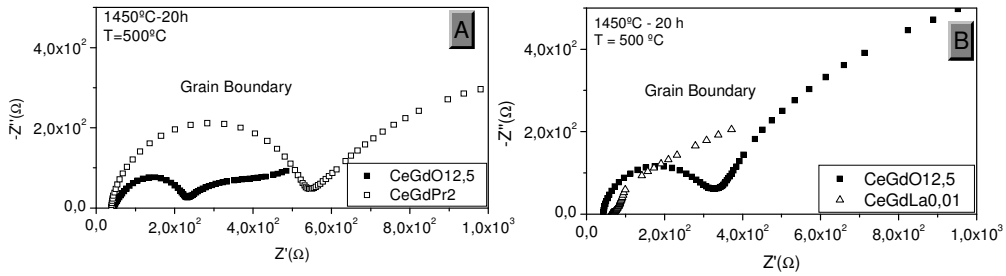

Figure 2: Impedance spectra co-doped samples: (A) Pr and (B) La

References

[1] G. B. Crochemore, D. P. F. de Souza; Revista Matéria; 13, p. 495 (2008).
[2] J. A. Lane, J. L. Neff, G. M. Christie, Solid State Ionics, 177, p. 1911 (2006).