11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Influence of the powder synthesis route in the Microstructure and Electrical Conductivity of Yttria Doped Ceria

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Abstract –.The microstructure and electrical conductivity of yttria doped ceria were analyzed in samples prepared with powder synthesized through oxide mixture and amorphous citrate. The samples prepared with powder from amorphous showed exaggerated grain growth at both sintering temperatures compared to those obtained with powder from oxide mixture. The more conductive sample was the one prepared with oxide mixture and sintered at 1600 ºC.

The electrical conductivity of ceramics is strongly dependent on the purity of raw materials and the sintering conditions. Silica, a common impurity in raw materials, is usually the main limiting factor to obtain high conductivity. The microstructure and electrical conductivity of ceria based ceramics are very sensitive to the sintering temperature and the powder synthesis process. Other important factor is the appropriate choice of the dopant. Yttrium oxide has been widely used [1,2].

In this work yttria doped ceria powders were prepared by two processes: oxide mixture (PO) and amorphous citrate (PC) in order to correlate the powder characteristics with the microstructure and electrical conductivity. In the first case the mixture was prepared by vibratory mill with isopropyl alcohol for 6 hours. Subsequently the suspension was dried and the powder was deaglomerated in 80 mesh nylon sieve. The powder was calcined at 500 ºC for 1 hour. After calcination, the powder was mixed with PVB in isopropílic alcohol, dried and again deaglomerated in nylon sieve 80 mesh. In the second case cerium and yttrium nitrate, both 99% purity and supplied by Aldrich, were dissolved in distilled water with citric acid and hydroxyethyl cellulose (HEC) forming a gel. The gel was dried at 300 ºC generating the amorphous powder precursor that was calcined at 500 ºC in oxidizing atmosphere. Pellets of the powders prepared through different routes were isostatic pressed (200 MPa) and sintered at 1500 and 1600 ºC with 2 h dwell time. The sintered samples were characterized by X-ray Difractometry (Siemens D – 5000, Cu Kα 1,54Å), Scanning Electron Microscopy (SEM) (Philips XL30 TMP, Philips XL30 FEG) and Impedance Spectroscopy (IS) (HP 4192A).

The SEM analysis of samples sintered at 1500 ºC, Figure 1, showed that the grain growth of sample prepared by citrate process powder (PC) was bigger than oxide mixture powder (PO). The PC samples sintered at 1500 ºC showed total conductivity two times higher than the PO samples, however, become 4 times less conductive that PO sample when sintered 1600 ºC. The conductivity of the grain boundary was responsible for this sharp decrease (Figure 2A and 2B).

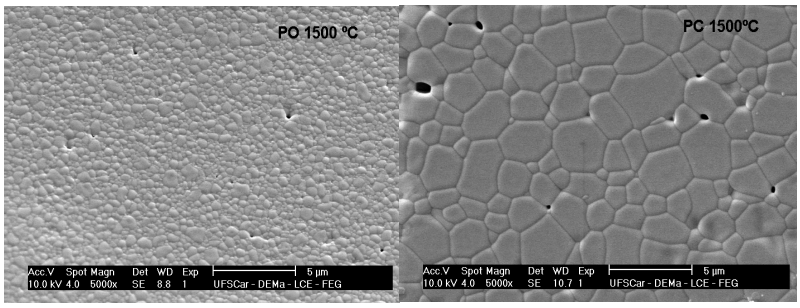

Figure 1: Microstructures of samples sintered at 1500 ºC prepared with oxide mixture powder (PO) and the amorphous citrate process powder (PC).

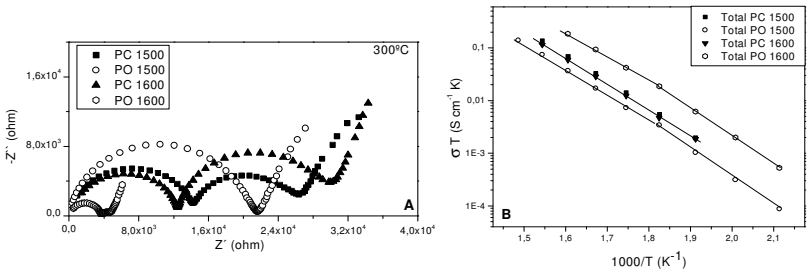

Figure 2: Samples prepared with powders from both rote and sintered at 1500 e 1600 ºC: A) Electrical Impedance spectra and B) Arrhenius plot for total conductivity.

References

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