11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

An experimental setup to synthesize ceramic nanoparticles by the spray pyrolysis technique for electrolytes in solid oxide fuel cells

R. A. Rocha[(1)*], E. N. S. Muccillo[(1)], E. Djurado[(2)], R. Muccillo[(1)]

(1) IPEN - CCTM / CMDMC, Travessa R 400, Cidade Universitária, S. Paulo - SP, Brazil, 05508-900.
email: rarocha@ipen.br
(2) LEPMI, Groupe Grenoble INP - PHELMA - UJF - CNRS (UMR 5631), 1130 rue de la Piscine B.P. 75, 38402 St. Martin d'Hères Cedex, France
*Corresponding author.

Abstract – An experimental setup was assembled to produce nanosize powders with optimized characteristics by the spray pyrolysis technique, an alternative route to obtain particles after atomization of an aqueous solution assisted by ultrasound, followed by thermal treatment at relatively low temperatures. This technique provides crystalline spherical nanoparticles, which will be used to produce low temperature sinterable dense ceramics for electrolytes in solid oxide fuel cells.

Chemical synthesis of ceramic materials and control of process parameters should lead to dense ceramics with nanometric grains. These ceramics can be obtained from powders constituted by nanometric particles with reduced average crystallite size and high specific surface area. Many synthesis techniques have been proposed to produce powders with optimized properties. Nanometric powders may allow reduced sintering and crystallization temperatures, yielding homogeneous and dense microstructures [1].

The spray pyrolysis technique is an alternative to obtain complex oxides at relatively low temperatures. These oxides consist of nanometric spherical particles with chemical homogeneity without amorphous phases. The technique is based on the controlled formation of an aerosol followed by thermal treatment and powder collection. Precipitation, decomposition and calcination occur in a continuous process [1,2], as shown in Fig. 1 [1]. The droplets are caused by the atomization of the solution and all of them are submitted to the same conditions during the thermal treatment [3].

An experimental setup was prepared at our laboratory to produce nanometric spherical particles for precursors to dense solid electrolytes for testing unitary solid oxide fuel cells (SOFC). The main components of the setup are the ultrasonic atomizer, the constant level flask to promote a continuous solution feed for atomization, a tubular furnace with a quartz tube, that acts as a reactor, and an electrostatic collector for the ceramic particles at the end of the process. The droplets are carried through the reactor by an inert gas.

Depending on the synthesis conditions, different particles morphology can be obtained [1,4,5]. To use as a precursor for electrolytes in SOFCs, dense particles are more interesting and then, synthesis conditions should lead to a volume precipitation, as show in figure 2 [5]. Not only the morphology can be changed through the process, but also the particle size distribution, the homogeneity and the phase composition [2,3]. Reported results have shown that the characteristics of zirconia-based ceramics are not dependent on the composition or the concentration of additives, but are dependent on the experimental parameters [2].

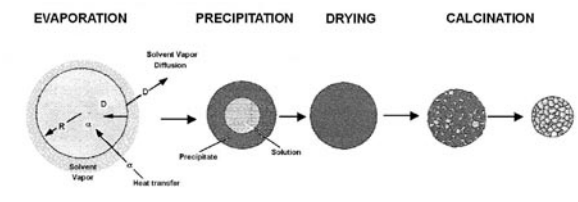

Figure 1: Particle formation during thermal treatment in the spray pyrolysis technique [1].

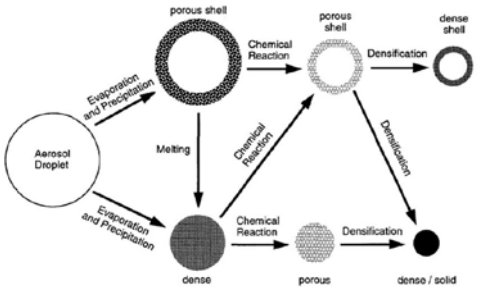

Figure 2: Morphologies obtained by spray pyrolysis [5].

References

[1] G. L. Messing, S. C. Zhang, G. P. Jayanthi, *Journal of the American Ceramic Society* **76** [11] (1993) 2707-2726.
[2] E. Djurado, E. Meunier, *Journal of Solid State Chemistry* **141** (1998) 191-198.
[3] D.J. Janackovic, V. Jokanovic, L. J. Kostic-Gvozdenovic, S. Zec, *Journal of Materials Science* **32** (1997) 163-168.
[4] K. Okuyama,I. W. Lenggoro, *Chemical Engineering Science* **58** (2003) 537-547.
[5] S. Jain, D. J. Skamser, T. T. Kodas, *Aerosol Science and Technology* **27** (1997) 575-590.