Acta Microscopica, Vol.6, Supl.A, September 1997.
Proc. XVI Meeting of the Brazilian Society for Electron Microscopy.

MICROSTRUCTURAL ANALYSIS OF THORIA-YTTRIA CERAMIC POWDERS AND SINTERED PELLETS*

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ThO_2: 9 mol% Y_2O_3 reactive ceramic powders have been prepared by a chemical route[1] to obtain dense ceramic pieces to be used as electrochemical transducers in gas sensing devices. Nb_2O_5 addition has been tried to enhance densification of sintered pellets through the liquid phase sintering mechanism. The ceramic powders have been analyzed by X-ray diffraction for phase content and lattice parameters determination. Only the cubic fluorite phase has been detected. TEM analysis has been performed to study powder morphology and determine average particle size. The result is shown in Fig. 1 (top): the powders are agglomerated and have approximately 30 nm average particle size. ThO_2: 9 mol% Y_2O_3 pellets have been prepared by pressing at 147 MPa and sintering at 1550 °C during 2 h. Some specimens have also been prepared by adding 0.25 mol% Nb_2O_5 to the thoria-yttria powder prior to sintering. Apparent densities have been determined by the water immersion method. X-ray diffraction analysis has been done to ascertain solid solution formation. SEM analysis has been carried out in samples polished down to 1 μm and thermally (1500 °C) and chemically etched. Lattice parameters have been determined and correlated to Vegard's law, an evidence of solid solution formation through Y^{3+} substitution for Th^{4+}. The micrographs in Figs. 1 (middle) and 1 (bottom) show surfaces of ThO_2: 9 mol% Y_2O_3 ceramic pellets with and without Nb_2O_5 addition, respectively. Their microstructure is found to be composed of circular-shaped cross sections of grains with 0.2 μm average grain size. Moreover, Nb_2O_5 addition prior to sintering leads to an increase in the porosity. TEM and SEM analysis have then been used as suitable tools to study ceramic powder and pellet morphologies to further understanding of the impedance spectroscopy electrical behavior of ThO_2:9 mol% Y_2O_3 solid electrolytes [2,3].

Acknowledgements: To Dr. A. H. A. Bressiani, Dr. E. N. S. Muccillo, Nildemar A. Ferreira and Celso V. de Morais; To CNEN and FAPESP for financial support and to CNPq for the schollarship to one of the authors (I. C. C.)

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* CNEN, FAPESP, CNPq

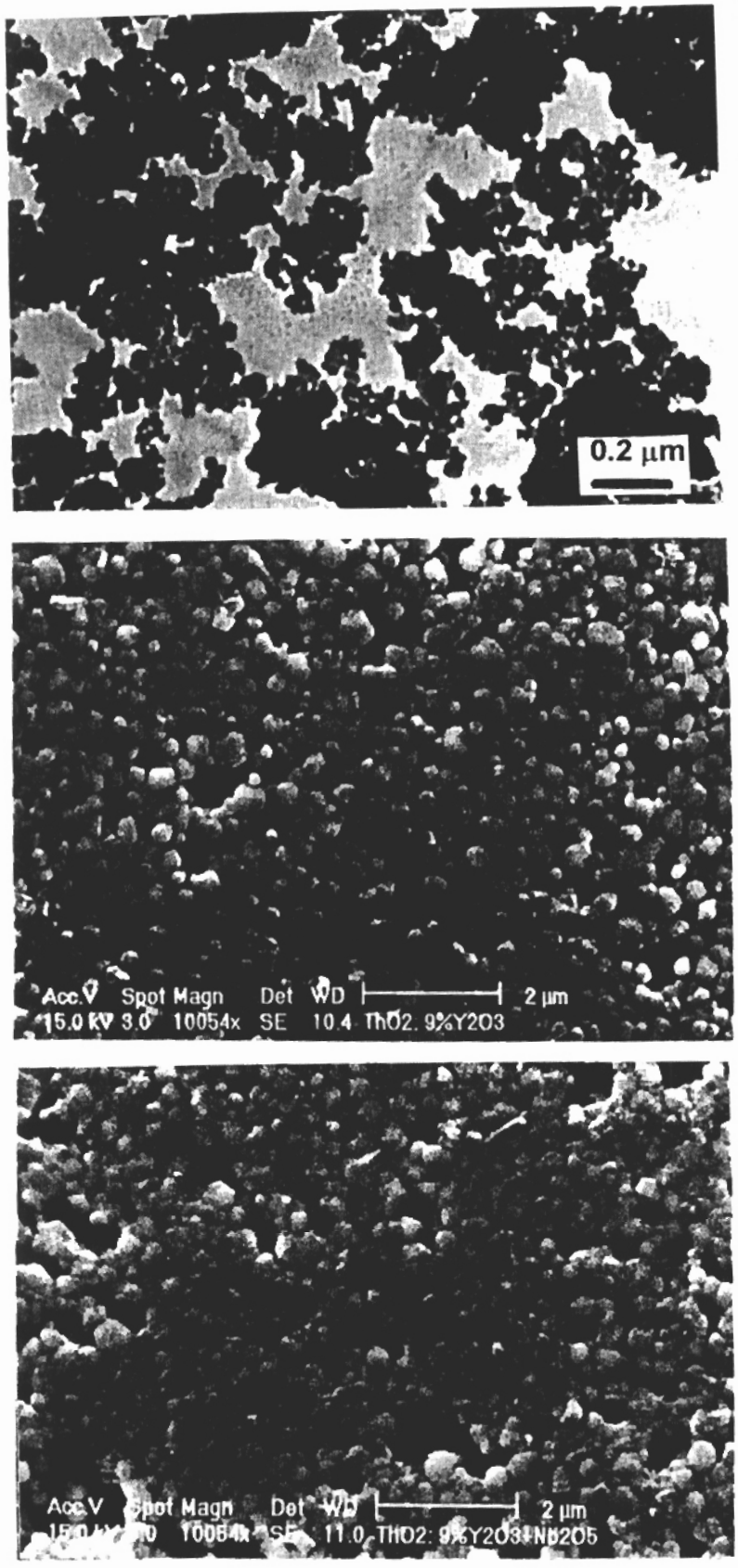

Fig. 1: TEM micrograph of ThO_2: 9 mol%Y_2O_3 ceramic powder obtained by the citrate technique (top); SEM micrographs of polished and etched surfaces of sintered ThO_2:9 mol% Y_2O_3 (middle) and ThO_2:9 mol% Y_2O_3+ 0.25 mol% Nb_2O_5 (bottom) pellets.