MICROSTRUCTURAL CHARACTERIZATION OF ZIRCONIA-CERIA CERAMICS

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Over the last years, ceria-doped zirconia ceramics have attracted much attention due to its mechanical properties (mechanical strength of 7-10 GPa and fracture toughness of 6-30 $MPa.m^{1/2}$) as well as improved performance in wet environments, compared with yttria-doped zirconia. The main disadvantages of this system are the difficulty for densification and the relative coarse average grain size of the sintered ceramic [1]. Several processing techniques have been used to synthesize powders in the nanometer range. Moreover, some special steps during processing, like milling or crystallization, are necessary to obtain high density after sintering [2-4]. The aim of this work was to synthesize a reactive zirconia-ceria powder with suitable microstructural characteristics to attain high density after sintering.

Zirconia-11 mol% ceria ceramics have been synthesized by the coprecipitation technique. Some variables of this processing technique have been studied and optimized in order to obtain pellets with high densities ($\geq$ 98% of the theoretical value), and low average grain sizes ($\leq$ 1 μm). Zirconyl chloride (BDH and IPEN) and cerium nitrate (IPEN) have been used as precursors. Calcined powders with 11 nm average particle size were uniaxially and isostatically pressed into pellets. Sintering has been carried out at 1500 °C/ 2 h in air. X-ray diffraction and scanning electron microscopy techniques have been used to characterize powders and sintered pellets.

Apparent densities of $\geq$ 98% of the theoretical value have been attained using both precursors, showing that densification does not depend on the starting chemicals. X-ray results showed total stabilization of the tetragonal phase with lattice parameters compatible with those expected for this composition. The main microstructural results are summarized in Fig. 1. For the precursor from BDH (fig. 1a) the polished and thermally etched surface reveals small grains and low porosity content. An average grain size of 500 nm has been calculated from the grain size distribution (fig. 1b). For the other precursor, the grains are comparatively coarser (fig. 1c) and the corresponding distribution (fig. 1d) does not show any maximum. These results show that the average grain size of the sintered ceramic depends on the precursor material.

References

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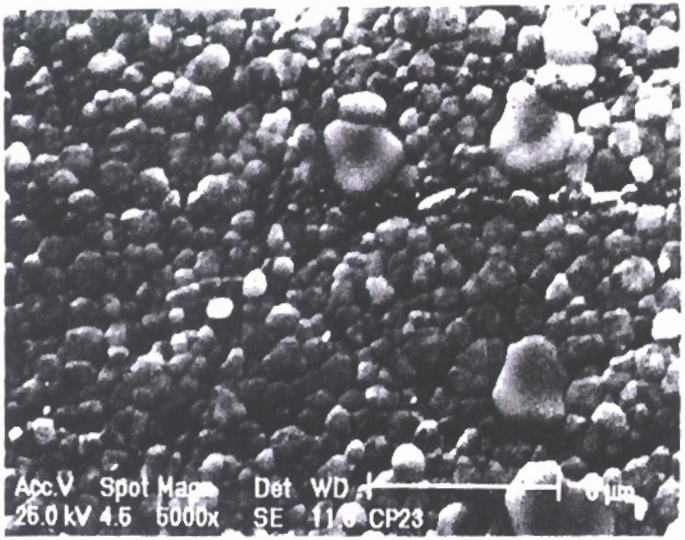
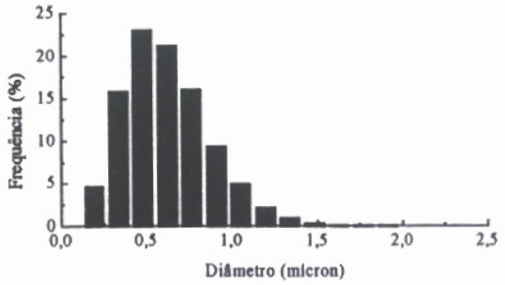
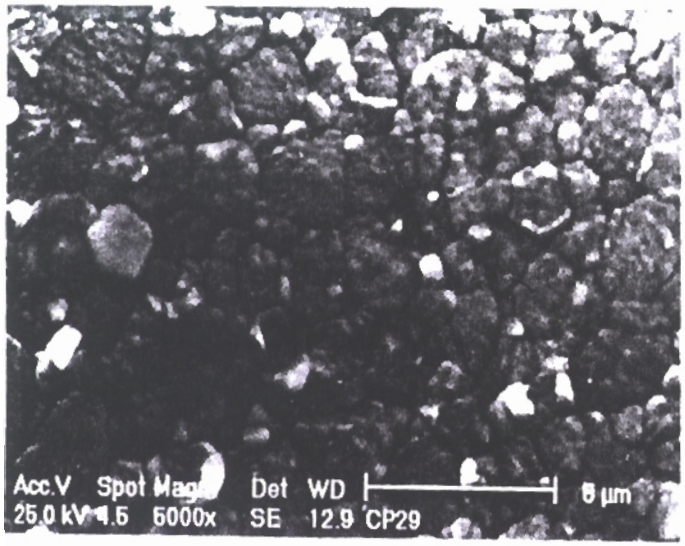
(a)

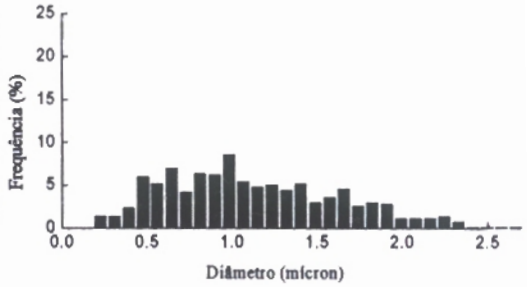


(b)





(c)



(d)

FIG 1 Scanning electron micrographs (a, c) and grain size distributions (b, d) of ZrO_2: CeO_2 prepared from BDH and IPEN precursors, respectively.