# Phase amorphization during high-energy milling of mixtures of zirconia with yttria or ceria powders

R. Muccillo, L. Franchi, J. T. Santos, I. C. Cosentino, E. N. S. Muccillo

Centro Multidisciplinar para o Desenvolvimento de Materiais Cerâmicos
CCTM – Instituto de Pesquisas Energéticas e Nucleares
Av. Prof. Lineu Prestes, 2242, cidade Universitária, S. Paulo, 05508-000, SP, Brazil

**Keywords**: high-energy milling, amorphization, zirconia ceramics.

**Abstract.** Phase amorphization studies were carried out on mixtures of commercial zirconia and yttria or ceria powders prepared by to high-energy milling. The structural characterization of powders was performed by X-ray diffraction. The specific surface area was determined by nitrogen adsorption, and morphology of powder particles was observed by scanning electron microscopy. For the mixture of zirconia and yttria, the amorphization of yttria is clearly observed for short times of milling, whereas the structure of zirconia remains almost unchanged. The mixture of zirconia and ceria reveals a different degree of amorphization, which occurs simultaneous and gradually with large milling times.

## Introduction

Zirconia-based ceramics are important materials for high-technology applications not only as a structural ceramic but also as a functional material [1]. Interest in nanocrystalline zirconia ceramics has increased in the last decade as their properties are often considerably improved compared with conventional zirconia ceramics.

Over the last few years, a great deal of work has been made on the production of ultrafine ceramic powders. Both technological and scientific interests in ultrafine-grained powders for processing of ceramic components are motivated by the promise of improved sinterability, reduction in flaw sizes and low-temperature superplastic deformation. Other improvements in materials properties are related to enhanced homogeneity, transparence in opaque ceramics, and giant magnetoresistance [2].

Nanocrystalline materials have been synthesized by a number of techniques comprising all three phases, namely, the solid phase, the solution phase, as well as the vapor phase [3].

High-energy milling is a solid phase technique more recently proposed for the preparation of ultrafine ceramic powders, because the brittle components get fragmented during milling and their particle size gets reduced continuously [4]. Besides the reduction of the average particle size, in the case of zirconia-based ceramics, other phenomena have been observed during high-energy milling, such as solid solution formation [5], structural phase transition [6], and amorphization [7]. The mechanism of amorphization by high-energy milling is not clearly understood. However, the amorphous phase formation is known to be critically