Evaluation of amorphous fraction in quartz nanoparticles using the Rietveld method

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Quartz nanoscale crystals [1] were obtained by top-down route by a ball milling process [2]. Such material can be applied on several high technological applications, such as ceramic membranes for water treatment, admixture to increase mechanical proprieties in concrete, or silica glass fabrication. An interesting aspect of the processed material is that part of it undergoes an amorphization, most probably due to highly energetic compressive impact forces in the ball-mill machine. Theoretically, such impact forces may result in the formation of lamellar structures in the particle surface [3,4], causing partial or total amorphization of the nanoparticles. In this sense, the present work aims to better understand the amorphization of quartz nanoparticles by applying the Rietveld method [5]. Initially, natural quartz fragments were processed by ball milling and subjected to gravity separation for obtaining a very fine powder. Then, the obtained material was analysed by X-ray diffraction technique, and the diffractograms were processed by the Rietveld method in order to quantify the amorphous phase [6,7]. In addition, the nanoparticles morphology was also characterized by electron microscopy images. As a result, particles were obtained with an average size of ~100 nm, and according to the Rietveld method, the amorphous fraction is ~30% by weight. Completely amorphous particles were not found by electron microscopy, suggesting the formation of particles with crystalline core and amorphous surface.

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