

Ultrasound effect in nanoquartz pressing behavior

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Abstract

Nanoquartz is defined as quartz in nanometric scale, and usually presents crystalline structure similar to the α -quartz. In this work, nanoquartz obtained by milling of natural quartz in ball mill was submitted to different treatment times in ultrasound batch, and then pressed and sintered. The pressing analysis by the Janssen-Walker model revealed great variation of pressing behavior as a function of time of ultrasound treatment: one has an empirical parameter BC positive (0,0012) whereas the other has a negative one (-0,0298).

Key words: Nanoquartz, ultrasound, pressing.

Introduction

Nanoquartz is defined as quartz in nanometric scale, and usually presents crystalline structure similar to the α -quartz^[3]. Nanoquartz obtained by milling of natural quartz in ball mill was submitted to different treatment times in ultrasound batch, and then pressed and sintered.

Previous works show that the ultrasound treatment increases the concentration of silanol groups ($\equiv\text{Si-OH}$) on silica surface^[2]. It is also known that the pressing and compaction processes involve the distribution of stresses throughout the powder, by sliding, rotation, particle deformation, and rupture^[1]. The objective of this work was to investigate the influence of such groups in the pressing behavior, using the Janssen-Walker (J-W) model^[1] for the compaction of powder constrained by a cylindrical geometry.

Results and Discussion

Four samples of nanoquartz powder were treated in ultrasound batch for 2 hours, and 4 samples were treated in the same batch for 4 hours. All specimens were pressed under 30 MPa and sintered in an electric furnace at 700 °C for 90 minutes. The samples were weighed and their diameters and thickness were measured. They were then analyzed by the J-W model, which correlates the average density with the aspect ratio of the sample, h/D , where h is the thickness and D the diameter of the sample, by the equation:

$$\rho = A + B \ln(\sigma) - BC(h/D) \quad (1)$$

where ρ is the average density, σ is the applied pressure and A , B and C are empirical constants. The linear regression resulted in two different equations for the material treated for 2 hours (equation 2) and for the material treated for 4 hours (equation 3), with ρ expressed in $\text{g}\cdot\text{mm}^{-3}$.

$$\rho = -0,0014 + 0,0298(h/D) \quad (2)$$

$$\rho = 0,0012 - 0,0012(h/D) \quad (3)$$

Image 1 shows the image of the samples and Image 2 shows the comparison of equations

2 and 3, and the experimental data obtained, showing the great difference in pressing behavior.

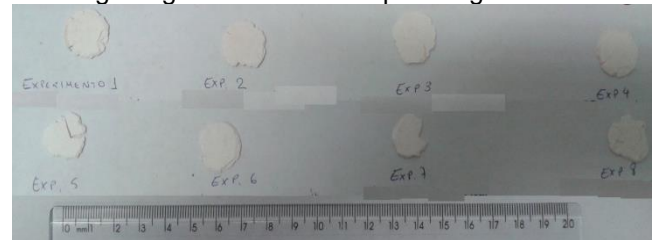


Image 1. Samples prepared for the experiment

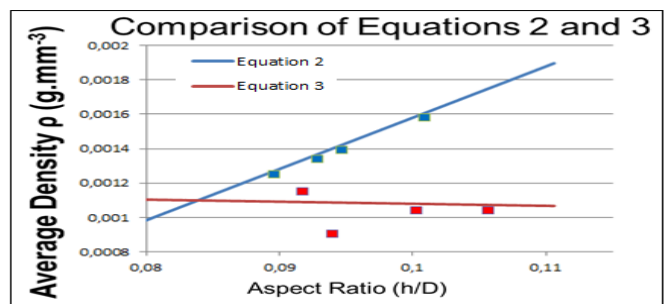


Image 2. Comparison of Equations (2) and (3).

Conclusions

The ultrasound treatment affects in a significant way the pressing behavior. The J-W model predicts that the average density is almost constant with the variation of aspect ratio for a sample treated for 4 h, but is a strong function of this ratio for the ones treated for 2 h.

Acknowledgement

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