Sintering behavior of anatase TiO_2 nanoceramic by Spark Plasma Sintering

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Nanocrystalline TiO_2 has been used in a wide range of applications, such as electro-electronic and sensing devices and photoelectric and photocatalytic processes. Moreover, much interest has been drawn toward to the sintering and full densification of nanoceramic TiO_2. However, preparing a fully-dense nanocrystalline TiO_2 can be difficult because the grains grow rapidly at the later sintering stages and due to that the phase transformation from anatase to rutile can contributes to the densification process. On the other hand, Spark Plasma Sintering (SPS), which has been used for the fabrication of a variety of materials, is highly appropriate for rapid densification of ceramic nanoparticles and the nanostructure preservation. In the present work, this technique has been used in order to obtain a fully-dense anatase TiO_2 nanoceramic. The microstructure of the samples sintered by SPS was investigated using scanning electron microscopy (SEM) while densities were determined by the Archimedes' method. A monophasic anatase ceramic, confirmed by R-X, was achieved at 900 °C for 10 min under a pressure of 75 MPa. The final relative density and grain size were 95% and ~60 nm, respectively. The shrinkage under heating was continuously monitored and used to check the mechanisms involved in the green compact densification. We assumed that the first and intermediate sintering stages occurs by GB sliding and particle rotation mechanism probably controlled by the interface diffusional processes. Additionally, the electric conductivity was investigated as a function of temperature. The results of densification, microstructure and conductivity were compared with the results found in the literature and discussed.