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Sintering Process and Characterization by Atomic Force Microscopy of Ferroelectric Ceramics: Nanophase $KSr_2Nb_5O_{15}$ – CuO

D. C.Vieira[(1)*], J. S. Marcuzzo[(2)] and A. C. C. Migliano[(1)]

(1) Instituto de Estudos Avançados (IEAv), Departamento de Física Aplicada, São José dos Campos, Brasil, e-mail: [vieiradc,migliano]@ieav.cta.br.
(2) Instituto Tecnológico de Aeronáutica, Departamento de Engenharia Mecânica, São José dos Campos, Brasil – e-mail: jossano@gmail.com.
*Corresponding author.

Abstract – $KSr_2Nb_5O_{15}$ ceramic doped with 1 wt % CuO were manufactured by pressureless sintering at 1100 and 1200 °C and the surface topographies of these ceramics were investigated by atomic force microscopy (AFM). CuO – KSN ceramic systems presented higher density than KSN ceramic without doping. AFM images of the doped materials revealed grains with distinct morphologies as a function of the sintering temperatures and nanophases are nucleated fundamentally at the grain boundaries. These nanophases are heterogeneous (chemical compositions and morphologies) which can be attributed with the oxidation – reduction process of CuO leading to the typical defects formation in the microstructures.

Ceramic materials and crystals that exhibit ferroelectric behavior are used in several technological applications such as system for microelectronics (MEMS), ultrasound images, sensors of infrared, pressure sensors and another applications. Strontium and potassium niobate ($KSr_2Nb_5O_{15}$ – KSN) is a ferroelectric oxide with tetragonal tungsten bronze structure (TTB). KSN is a lead free material, having classical ferroelectric or relaxor behavior due that several ions can be inserted in the crystalline lattice [1]. The objective in the present work was to investigate the surface morphology of the KSN – CuO ceramic by AFM. The powder precursor of KSN was synthesized by oxide mixture in a high-energy ball mill and the fabricated process of the ceramic systems is the same as described elsewhere [2]. CuO was used as promoters of sintering process of the KSN ceramic. The topographical analyses of the surfaces were acquired in an atomic force microscope (Shimatzu SPM 9500) in intermittent mode and constant force. The density of the KSN ceramic is lower than the KSN - CuO ceramic. SEM images of the KSN ceramic showed that the resultant microstructure consists of region with higher density and regions with porous structures. The CuO - KSN ceramic system presented higher density in comparison with the ceramic without doping. AFM image of the KSN doped with 1 wt% CuO sinterized at 1100 °C (Figure 1) showed that bigger and smaller grains have distinct morphologies; the smaller grains seem to have a regular structure as self-assembly layers. AFM image of the KSN ceramic doped with 1 wt% CuO sinterized at 1200 °C (Figure 2) shows differences in the morphology between both investigated systems. Nucleation of nanophases at the grain boundaries was observed in these ceramic systems. The oxidation – reduction process of CuO (Cu^{II} – Cu^{I}) influences in the defects formation, which is related with the sintering temperature [3]. Scanning electron microscopy with EDX and X – rays diffraction results also will be presented.

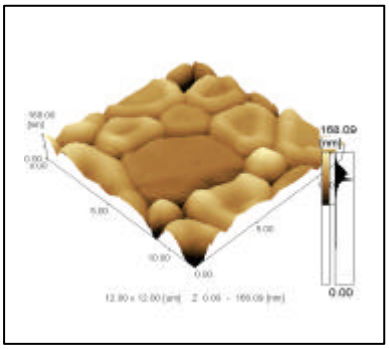

Figure 1: AFM image of KSN – CuO ceramic system sinterized at 1100 °C (1 wt % CuO).

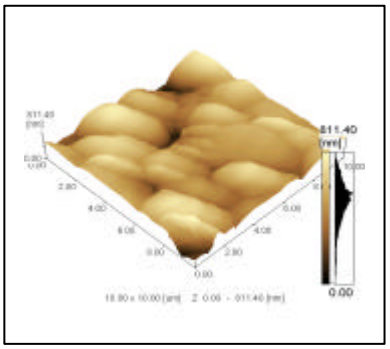

Figure 2: AFM image of KSN – CuO ceramic system sinterized at 1200 °C (1 wt % CuO).

References

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