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STRUCTURAL ANALYSES OF SINTERED MT AND BZT CERAMICS

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1. INTRODUCTION

Development of dielectric materials is increasing with a rapid progress in mobile and satellite communications systems, where magnesium titanates find their place owing to good dielectric properties. Recently it has been established that, these materials, which are based on binary magnesium titanates ($MgTiO_3$ and Mg_2TiO_4) can be applied in MW engineering. These materials differ extremely low dielectric loss in the microwave range and high dielectric constant [1-3].

On the other hand, barium-titanate compounds have attracted great attention for their specific microwave properties, as well. They were commonly used as parts of resonators, filters and multilayer ceramic capacitors, in the microwave region [4]. The crystal phase with the structure $BaZn_2Ti_4O_{11}$ is present in various commercial microwave dielectric materials based on barium-titanate compounds [5].

Taking all this into account, in this article, the influence of mechanical activation of the MgO-TiO_2 and $BaCO_3$-ZnO-TiO_2 systems on phase composition, crystal structure and microstructure before and after sintering process, has been reported.

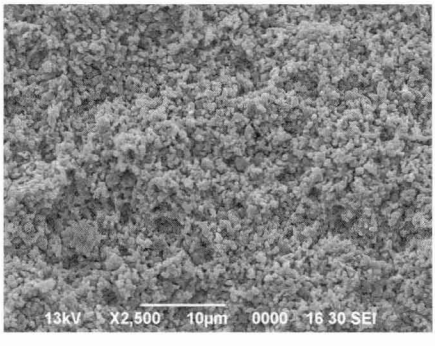
2. EXPERIMENT

Mixtures of MgO and TiO_2 powders at a molar ratio $MgO:TiO_2$ = 2:1 were mechanically activated in a high energy planetary ball mill (Retsch type PH 100). Mixtures of $BaCO_3$, ZnO and TiO_2 powders at a molar ratio $BaCO_3$:ZnO:TiO_2 = 1:2:4 were mechanically activated, also. The milling process of MT system was performed in air for 5 to 120 minutes and for BZT system for 20 to 80 minutes. Ball to powder mixture mass ratio was 20:1. Samples were denoted as MT-0 to MT-120 and BZT-0 to BZT-80, according to the milling time.

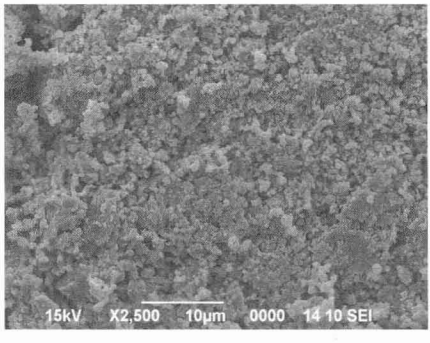
The binder-free powders were compacted in an 8 mm diameter tool. Compacts were placed in an alumna boat and heated in a tube furnace (Lenton Thermal Design Typ 1600). MT compacts were sintered isothermally at 1100 to 1400°C and BZT compacts were sintered isothermally at 1100 to 1300°C for 2h. The heating rate was 10°C/min. The morphology of obtained powders before and after heating was characterized by scanning electron microscopy (JEOL JSM-6390 LV). The pallets were cracked and covered with gold in order to perform these measurements. X-ray powder diffraction patterns after milling and thermal treatment were obtained using a Philips PW-1050 diffractometer with λCu-K_α radiation and a step/time scan mode of 0.05°/1s.

3. RESULTS AND DISCUSSION

High-energy ball milling as method to synthesize nano size materials has many advantages, such as simplicity, relatively inexpensive to produce, applicable to any class of materials, etc [6]. It has been established that sintering temperature is lowered down owing to magnesium-titanate and barium-zinc-titanate preparation in nanocrystalline form.



a)



b)

Fig. 1. *SEM micrographs of (a) MT-0 and (b) BZT-0 sintered at 1100°C for 2h.*

Formation of contact necks at the beginning stadium of sintering process is clearly visible at Fig. 1. (a). Grains still own their starting shape, no relevant mass transport has been observed. Insufficiently sintered sample with in places formation of contact necks are the main characteristics for BZT-0 sintered sample, along with small particles of various compounds within the starting sintering phase.

4. CONCLUSION

Formation of various magnesium-titanate phases and pure barium-zinc-titanate phase along with densification process is observed during micrographs analysis. One can notice that MT samples activated 120 minutes and BZT samples activated 80 minutes and sintered have advantageous microstructures, with the appropriate pores/materials ratio.

5. REFERENCES

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