Experimental study of the morphological properties of the compound $NaNbO_3$

Estudio experimental de las propiedades morfológicas del compuesto $NaNbO_3$

V. Isaza[1]*, J.L. Izquierdo[1]

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Abstract

Polycrystalline $NaNbO_3$ samples were obtained by standard solid state reaction and their morphological properties carefully studied. The EDS spectrum of a $NaNbO_3$ polycrystalline sample. The analysis of the chemical composition of the $NaNbO_3$ samples showed that their cationic contents were very close to the nominal ones. The obtained single crystals were orthorhombic prisms of sizes up to 3µm.

Keywords: *Sodium niobate, polycrystalline, SEM, EDS*

Resumen

Muestras policristalinas de $NaNbO_3$ fueron obtenidas por el método estándar de reacción en estado sólido y sus propiedades morfológicas fueron cuidadosamente estudiadas. La composición química del compuesto fue obtenida usando espectroscopía de dispersión de rayos X. Los resultados indican que las muestras tienen una composición química cercana a la molar. A su vez, el análisis morfológico por medio de microscopia electrónica de barrido (SEM) indica que las muestras son policristalinas con tamaños de grano de 3 µm.

Palabras clave: *SEM, Niobato de sodio , EDS*

1 Institución Universitaria Pascal Bravo, Facultad de Ingeniería, Laboratorio de Materialografía, Grupo GIIEN, Medellín, Colombia

* Corresponding author: v.isaza@pascualbravo.edu.co

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1. Introduction

In recent decades, the study of new ferroelectric materials has increased because of how damaging lead (Pb) is to people´s health and the environment. In 2003, the European Union included the PZT (Pb (Ti, Zr) O_3) as a dangerous substance and should therefore be gradually withdrawn. Due to the large range of applications of PZT, its replacement has led to the development of new piezoelectric materials lead among these materials the compound $NaNbO_3$ (niobate Sodium) is where the correlation between structural and electrical properties have interesting properties (required ferroelectricity, antiferroelectricity, piezoelectricity) and the origin of the understanding of these properties has become a challenge for condensed matter physics. This material has attracted particular interest not only for being an array of piezoelectric materials, but also for their applications transducers, actuators, capacitors, and memory storage. Varying the Curie temperature of $NaNbO_3$ based solid solutions is caused by different concentrations of $LiNbO_3$, here we would be interested in knowing what the electrical properties would be at room temperature: antiferroelectricity and ferroelectricity, and ferroelectricity induced field and in which piezoelectric applications, pyroelectric, electro-optical and / or ferroelastic can wait and apply [1].

2. Experimental

Polycrystalline samples $NaNbO_3$ were prepared by the method of solid-state reaction from a mixture of precursors (Na_2CO_3 and Nb_2O_5) high purity powder through an agate mortar. A series of heat treatments to the stoichiometric mixture NaNbO3 in a NABERTHERM RHTC 80-230 / 15 in a programmable tube furnace available in the laboratory of materialography at Pascual Bravo university Institution performed at air atmosphere, a first heat treatment undoped compound with the following conditions being maintained 930 ° C 6 h with a heating rate of 3 ° C / min was performed. When doping is done with Li and the resulting powder is subject again to heat treatment in order to make inclusion of these ions in the crystal structure, this treatment is carried out at the following conditions, 1050 ° C for 2

h. Once the procedure is completed sintering furnace was allowed to cool to room temperature, a cooling ramp was performed in order to know the behavior of the oven. Samples completed a test is performed using the technique of X-ray diffraction.

3. Morphological properties of $NaNbO_3$

The study of the morphological properties of materials with ferroelectric perovskite type structures has attracted in recent years the effort to design new materials free of lead compound. Thus, the ABO_3 perovskite $NaNbO_3$ derived from a prototype material chosen for this purpose.

The analysis was performed on a mixture of unreacted starting reagents in stoichiometric amounts to resemble synthesis conditions. The total reaction is:

$$Na_2CO_3 + Nb_2O_5 \rightarrow 2NaNbO_3 + CO_2$$

The ferro-paraelectric transitions at relatively high temperature, interesting piezoelectric properties and the discovery of ferroelectric - relaxor behavior in solid solutions derived from $NaNbO_3$, has given a strong impetus to the study of new compositions based on sodium niobate. This compound has great interest in showing a variety of structural phase transitions associated with a change from a non-polar antiferroelectric phase to another and finally to a ferroelectric. Although $NaNbO_3$ is antiferroelectric at room temperature (Tc = 366 K) [2-4], it is transformable in stable ferroelectric polarization hot and by forming solid solutions. Including the $NaNbO_3$-ABO_3 induce type ferroelectric phase stabilization interesting for the development of high temperature piezoelectric devices activity.

The EDS spectrum of a sample $NaNbO_3$ Polycrystalline after reacting sintered powder at 1050 ° C for 2 h in the oven, then slow cooling to room temperature occurs is showed in Figure 1. The analysis if the chemical composition of NaLi showed that its cationic composition was very close to the nominal.

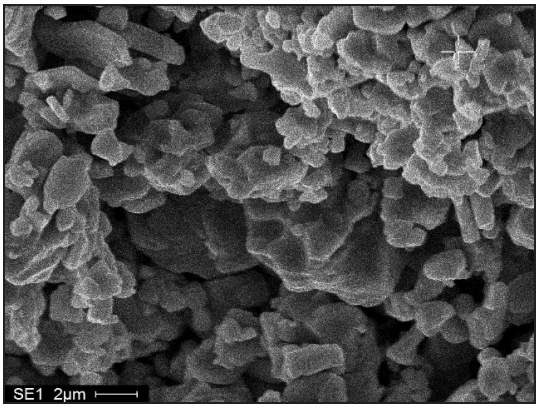

FIGURE 1. AVERAGE GRAIN SIZE OF THE COMPOUND $NaNbO_3$.

The measurement is carried out in a scanning electron microscope (SEM), the grain size of this compound is 3µm, found in this study, both the grain size and chemical composition to verify incomes of reagents used and the formation of the desired compound. In Figure 2 the chemical composition of this compound is shown:

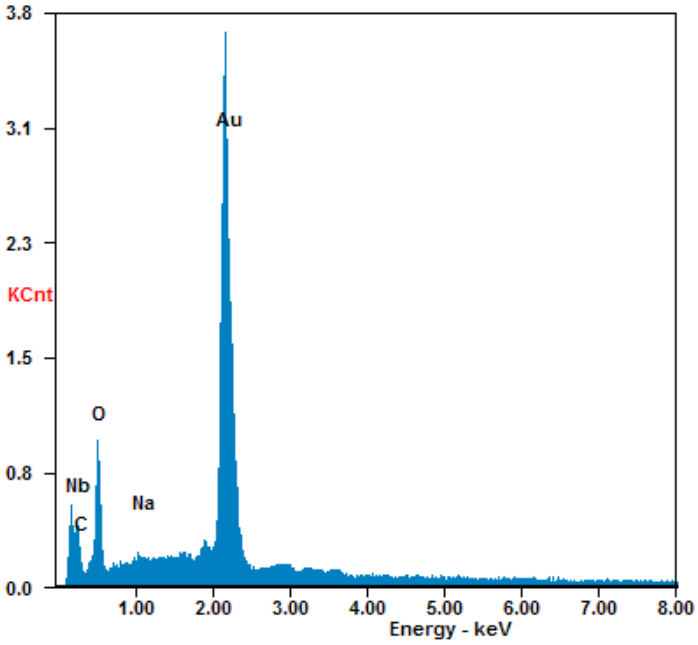

FIGURE 2. SPECTRUM SHOWING THE CHEMICAL COMPOSITION OF THE ELEMENT.

The spectrum shows the presence of chemical elements (Na , Nb, O) of the compound $NaNbO_3$, others (C, Au) is due to the elements with which the sample is coated to make it conductive (condition) and be able to measure in a differential scanning microscope (SEM) .

4. Conclusion

Polycrystalline samples of the new dielectric-ferroelectric $NaNbO_3$ were obtained through standard solid state reaction and their morphological properties carefully studied. The analysis of the chemical composition of the samples $NaNbO_3$ showed that their cationic contents were very close to the nominal ones. To summarize, we have investigated the morphological properties of $NaNbO_3$ in detail.

5. References

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