Influence of the thermal gradient factor in the processes of absorption and emission on the ceramic material used in the biosensor production

Rodríguez P. Omar[*]Castillo H. Jairo E.

Facultad de Ingeniería Escuela de Ingeniería Electrónica
Universidad Central Bogotá Colombia

Abstract

In the process of production of ceramic biosensor whose base is the ceramic material, the previous but important controls are made on the parameters of temperature, pressure of having pressed, humidity and particle - size. This controls are made on raw samples by different methods in order to determining the electric properties like conductivity, permitivity, polarization other, at the same time with: pressed degree, apparent density (AD) and mechanical resistance.In the following development, a theoretical method is presented to calculate influence of the thermal gradient factor in structures $(SiO_2 - BeO) - (Fe_2O_3)/(Al_2O_3)$ used in the biosensor technique.

Key words

Relative permitivity; apparent density (AD); conductivity; mechanical resistance; polarization;thermmal gradient factor

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[*] Director Group of Solid State and Optoelectronics

Introduction

Among the multiple properties and characteristic electromagnetic, chemical and other of registration instruments as the sensors; that they can be used to analyze biolectrical signs , this the form of absorption and thermal emission of these devices. In the process of production of ceramical biosensor whose base is the ceramic material, the previous but important controls are made on the parameters of temperature, pressure of having pressed, humidity and particle - size. This controls are made on raw samples by different methods[1], the same thing that: compactación degree, apparent density (AD) and mechanical resistance.[2]. Of another side, the superficial and volumetrial characteristic of the biosensor, is in certain advantageous form for the detection of different types of signs, as the muscular mioelectrical signs, since depending on the problem that one has and of the type of information that is wanted to analyze, the structural organization of the atoms in the sample of the sensor indicates the form and thermal behavior of the same one and its answer efficiency then, to the stimulate.

For the analytical description of the geometric elements in the volume of the sample of amorphous material, the factors: structural and of atomic dispersion, they drive to quantify the electromagnetic and thermal behavior of of the structure [3].

The present work developed a theoretical method to calculate the thermal current flow and the thermal conductivity of an amorphous material, as it is it the structure: $(SiO_2 - BeO) - (Fe_2O_3)/(Al_2O_3)$.

The theoretical model used to determine the influence of the structural factor in the process of propagation of the heat for ceramical material under the influence of an uniform electric field is the statistic of Maxwell - Boltzman, that it allows to analyze the solution of the movement equations for many bodies and their interaction.

In this model it is necessary to keep in mind that, if dielectric material is a mixture of phases (air, water, solid), the electric permitivity is a different property of simulating. Since, it is subjected being to the direct action of an electric field, the polarization will be a function of: humidity, atomic structure, porosity degree, pressure and the internal energy that is in turn a function of bands structure. First of all, the one numbers of normal vibrations whose frequencies are included in the range of w until $w + dw$, it´s defined as:

$$dN(w) = \frac{w^2 dw}{2\pi^2} \left(\frac{1}{v_1^3} + \frac{1}{v_2^3} \right) \tag{1}$$

Where: v_1;v_2 are velocities of longitudinal and traverse phase respectively

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For an amorphous system, these propagation velocities are different, those that can be calculated in turn as:

$$\begin{cases} v_1 = \dfrac{n_1 q}{j_1} \\ v_2 = \dfrac{n_2 q}{j_2} \end{cases} \tag{2}$$

Where: n_1 - number of atoms in the perpendicular way of propagation; j_1 - perpendicular density of current; n_2 - number of atoms in the traverse way of propagation; j_2 - transversal density of current; q - density of electric load for unit of volume

In this theoretical model's position, it is necessary to stand out that atoms located will exist outside of it lines of propagation, for that these they will be constituted in centers of reticular dispersion, for what the current density can calculate as a function:

$$j(r)_i = \sigma_{ij} f(r) E_j \tag{3}$$

Where: $f(r)$ - dispersion factor of grain; this factor was calculated in (rodríguez); σ_{ij} - conductivity tensor; E_j - electrical field generated by the wave electromagnetic incident on the sample.

If one makes an analytic analysis of the propagation of the electromagnetic wave (OEM) in the sample:

$$\begin{cases} T(x+dx) = T_o + \nabla T dx \\ j(y+dy, T) = j_o + \nabla j dy \end{cases} \tag{4}$$

Where: ∇T - thermal gradient; $\nabla . j$ - divergence of the current density

Being also inclusive j a function of the temperature T, then:

$$j(y+dy, T+dT) - j_o = (\nabla . j) dy + \nabla j_T dT \tag{5}$$

Where, ∇j_T - thermal gradient of the current density

But;

$$\begin{cases} dT(x+dx) = \nabla T dx \\ j(y+dy, T+dT) - j_o = \sigma \Delta E \end{cases} \tag{6}$$

Where, σ - electric conductivity of the sample; ΔE - variation of the electric field in the sample

Keeping in mind (6), one can evaluate and to calculate the constant of electric permitivity of the loamy material having the volumetrical relationship(air/sample; solid/sample; water/air) that determine in certain measure the hardness of the ceramic material and with the relationship:

In consequence:

$$\sigma\Delta E = \nabla.jdy + \nabla j_T.\nabla Tdx \tag{7}$$

Where: σ - dielectrical tensor of the raw ceramic material.

Counting with which: σ, it can be defined like a lineal combination of two processes; the first one has relationship with the polarization of the ceramic samples with a degree of humidity but in presence of an external field and the second term, with the drying polarization.

The system of equations (7) lead to determine the behavior of the thermal current in an amorphous material, as the ceramic structure that occupies us, this currente can evaluate as:

$$I(T) = \int_\tau (\nabla.[\sigma(f(r) - 1)E])d\tau \tag{8}$$

Where: τ is the integration volume and $f(r)$ is the estructural function

Conclusions

1. The structural factor determines the local distribution the electric charge and with this the properties of transport of the amorphous materials, as those that occupy us. 2. The graphs (4) and (5), they show the experimental thermal behavior of the current in compound $((SiO_2 - BeO) - (Fe_2O_3)/(Al_2O_3))$

Graph 1. Behavior of the structural factor in a raw ceramic material

2. Recent data obtained in the laboratory of Estado Sólido y Optoelectrónica de la Escuela de Electrónica en la Universidad Central, demonstrate that the structure of bands of this class of materials this strongly influenced by the degree of relative humidity in the sample and the structures of grain.

Graph 2. Effective section of dispersion

3. The behavior of the electric field in the granular border depends strongly on the dimensions of the vacancies and the same structure of grain, for what the conduction currents fall with the recombination in these areas.

Graph 3. Behavior of the electric field in the granular border

4. The graphs (4) and (5) demonstrate the behavior of the thermal current in ceramic materials with made up of BeO, that in turn produce an important influence in the granular structure and the mechanisms of transport

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