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# RESEARCHES OF SELECTED ELECTRIC PROPERTIES OF THREONINE DOPED TGS SINGLE CRYSTALS

**Keywords:** TGS, single crystal, ferroelectrics, electric properties, pyroelectric effect, threonine.



***This paper contains results of the researches upon new pyroelectric material: triglycine sulphate doped with threonine.***

***Because of the future application of the new obtained single crystal as the active element of IR detection, temperature characteristics of electric hysteresis loop parameters and pyroelectric coefficient were investigated.***

***Temperature dependencies of spontaneous polarisation, coercive field and pyroelectric coefficient are presented as well as the measurement systems designed for determination of the mentioned above dependencies.***

## 1. INTRODUCTION

Ferroelectric materials have wide spectrum of application in contemporary electronics. That is why new materials obtaining previously defined properties are desired. Ferroelectric single crystals showing electric response to temperature extortion are called pyroelectrics. The most popular application pyroelectrics found in detection of IR radiation. Because of its unique properties, such as direct conversion of IR to electric current, wide spectrum of operation, high sensitivity, low capacity, low costs of production of large detection areas, no need of additional cooling, pyroelectric single crystals are the only solution in many cases.

One of the best material often examined and practically applied in IR detection is group of ferroelectrics with hydrogen bond. This group of materials includes also Triglycine Sulphate ( TGS) with chemical formula $(NH_2CH_2COOH)_3H_2SO_4$. TGS single crystals present ferroelectric properties along the ferroelectric (010) axis. Pure TGS presents the second order phase transition in and the Curie temperature – 322 K, what makes possible wide application of this material within IR detection within the range of room temperature.One of the most essential features of the detectors based on TGS single crystals are as follows; detectors are active elements of detection circuits where an electric response is proportional to changes of temperature, detectors show a capacitive character and high sensitivity, low noises, high speed of a detection without necessity of cooling. Additionally this material makes possible easy creation of the large detection areas at relatively low costs of a production.

Application of pure TGS, however, faces some problems, as the material is depolarising with time (ageing process reported by many authors) [1-9]. One of the most efficient way to eliminate this disadvantage and obtaining permanent polarisation is doping pure TGS with metal ions or organic compounds. Influence of various dopants on electric properties of TGS single crystals was investigated by many authors [1-9].

This paper presents results of the researches upon selected properties of TGS single crystals doped with threonine – aminoacid with chemical formula $CH_3$-CH(OH)-CH($NH_2$)-COOH. This compound was selected because of its structure, promising effective change of electric properties of new material (4).

## 2. PREPARATION OF THE SAMPLES

Presented Single crystals were grown from water solutions. Solution of TGS was prepared by mixing proper amounts of sulphuric and aminoacetic acids in proportion 3:1. After crystalisation in temperature 305 K crystals were dissolved in temperature 350 K and the solution was purified by filtering. Seeds for regular growth were selected after recrystalisation in temperature 305 K. Seeds were placed in the growth vessel and the regular growth was performed in temperature 308 K. Duration of the growth was 14 days. [5,6]

Obtained single crystals present morphology similar to the pure TGS. Basing on the chemical researches presence of the dopant in new grown material was estimated at the level of 0.08 %. Single crystal was cut into samples perpendicular to (010) axis. Samples were mechanically treated and after attachment of silver electrodes selected electric properties of the samples were investigated

## 3. HYSTERESIS LOOP PARAMETERS MEASUREMENTS

Researches upon parameters of the hysteresis loop were performed in the computer measuring system presented in fig. 1. A screenshot from the software designed for the measurement process is presented on fig. 2. This software makes possible measurement of hysteresis loop parameters such as spontaneous polarization $P_S$ (fig. 3) and coercive field $E_C$(fig. 4)

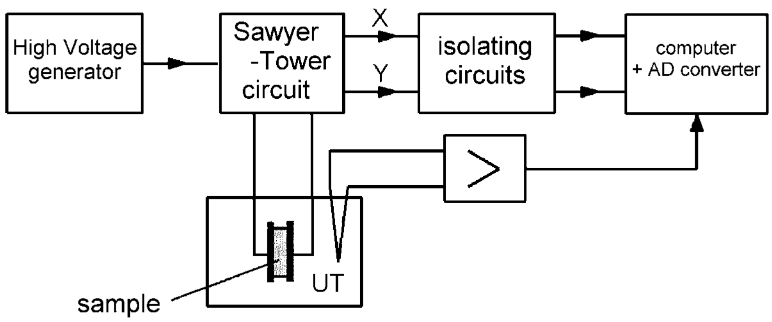


*Fig. 1. Computer measurement set for spontaneous polarisation and coercive field temperature dependencies measurements*

A screenshot from the program for hysteresis loop measurements is presented in fig. 2.

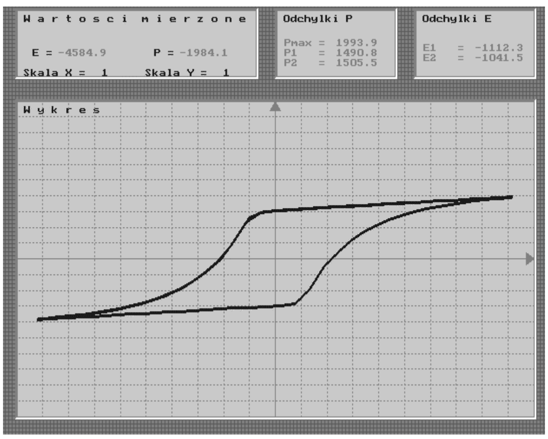


*Fig. 2. Screenshot from the software for hysteresis loop measurements*

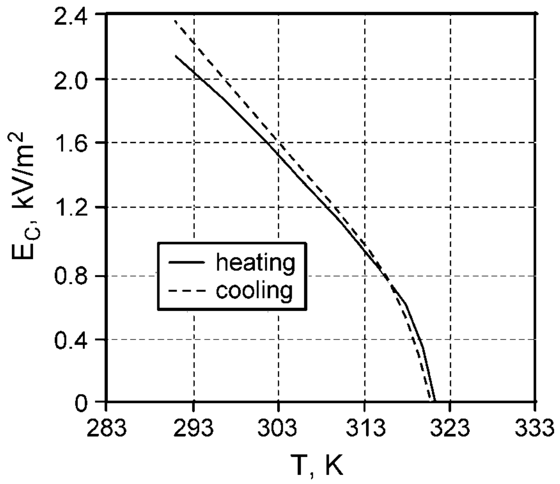


*Fig. 3. Temperature dependence of Ec for the sample of TGST10*

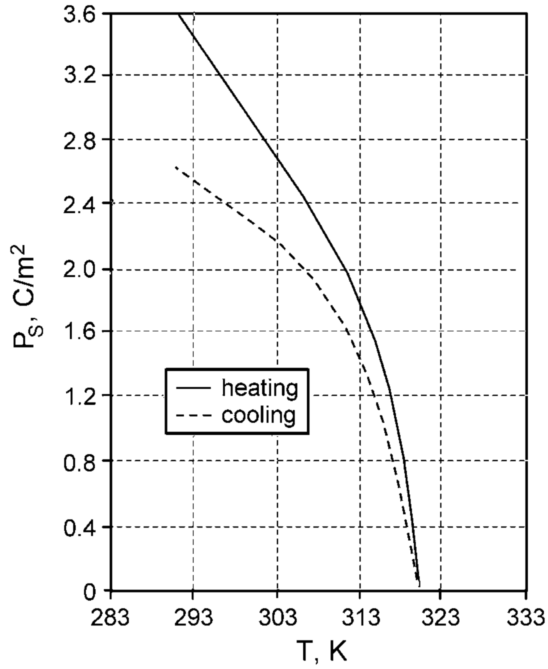


*Fig. 4. Temperature dependence of Ps for the sample of TGST10*

## 4. PYROELECTRIC CURRENT MEASUREMENTS

In order to determinate the possible range of application of the new material, as the active element of pyroelectric detector it is necessary to establish the pyroelecric coefficient values.

Pyroelectric current temperature dependencies measurements were performed in the measuring system presented in fig. 5.

Basing on these measurements pyroelectric coefficient temperature dependence was calculated using a designed software [6]

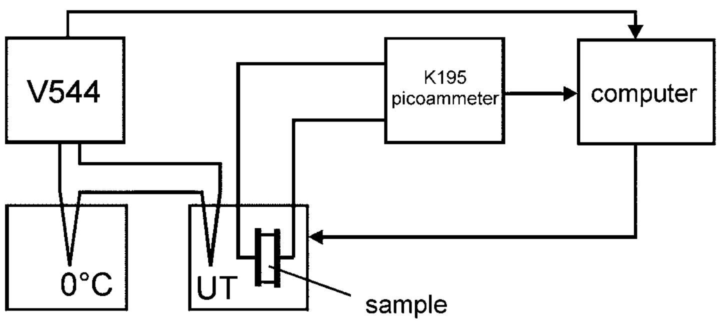


*Fig. 5. Computer measurement set for pyroelectric current temperature dependencies measurements*

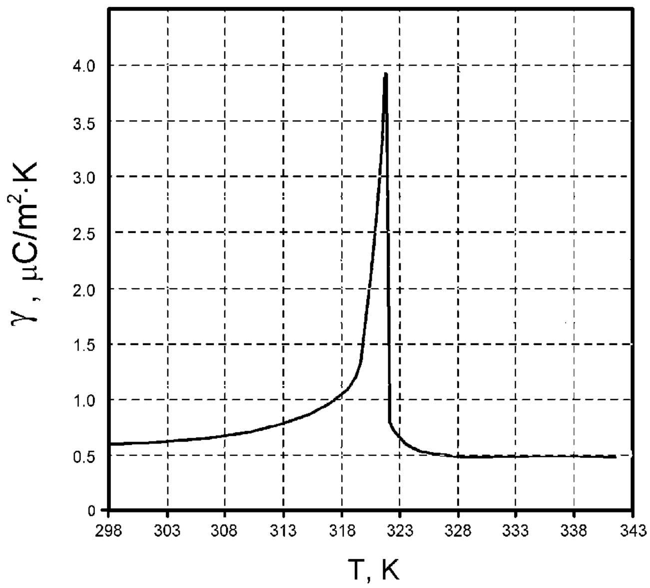


*Fig. 6. Temperature dependence of pyroelectric coefficient for the sample of TGST10*

## 5. DISCUSSION OF THE RESULTS

New obtained material has the phase transition at the temperature $T_C$ 320.2 K. Temperature hysteresis of phase transition is $\Delta T_C$ = 0.3 K. Basing on the shape of the hysteresis loop making use of designed software it was possible to determine spontaneous polarisation (fig. 3) and coercive field (fig. 4). Considerable differences are observed in case of spontaneous polarisation plots in heating and cooling processes. Obtained values of polarisation are comparable with those observed in pure TGS.

Fig. 6 presents temperature dependencies of pyroelectric coefficient calculated from the values of pyroelectric current. [6] Its values and shape of the curve prove that new obtained single crystal can be utilised as the active element of pyroelectric detector.

## 6. REFERENCES

[1] *STANKOWKA J., CZARNECKA A., Investigation of the Ageing Process and Domain Structure of TGS-Group Crystals, Ferroelectrics 1989, vol 98 pp. 95-103*

*[2] STANKOWKA J., CZARNECKA A., The Effect of D-Phenylalanine Admixture on Electric Properties and Domain Structure of TGS Crystals, Ferroelectrics 1997, vol. 190, pp 71-76*

*[3] WEI SHI, XUN SUN, Properties of LU-TGS Crystal Grown Above Curie Temperature, Ferroelectrics 1999, vol. 221 pp. 123-127*

*[4] PROSZAK W., TRYBUS M., WOŚ B., Technology of obtaining a New Glycin Compound Monocrystal for Active Elements of Pyroelectric Detector, XXIV International Conference IMAPS – POLAND 2000, 25 –29 September 2000, Rytro*

*[5] PROSZAK W., TRYBUS M., WOŚ B., New Ferroelectric Material for IR Detectors Based on Triglycine Sulphate. Doped with Serine with its Dielectric Properties, International Conference on Solid State Crystals, 9-13 October 2000, Zakopane*

*[6] PROSZAK W., Active elements of the pyroelectric detectors based on the TGS monocrystals doped with Serine, Conference Systems of Optical Security, October 2001, Warszawa*

*[7] ARAVAZHI, S.; JAYAVEL, R.; SUBRAMANIAN, C., Growth and characterization of L-alanine and L-valine doped triglycine sulphate crystals Materials Research Bulletin Volume: 32, Issue: 11, November, 1997, pp. 1503-1513*

[8] NOVOTNÝ J.; PROKOPOVÁ L.; MICKA Z.,TGS single crystals doped by Pd(II) ions Journal of Crystal Growth Volume: 226, Issue: 2-3, June, 2001, pp. 333-340

[9] MOHAN KUMAR, R.; MURALIDHARAN, R.; BABU, D.RAJAN; RAJENDRAN, K.V.; JAYAVEL, R.; JAYARAMAN, D.; et. al.Growth and characterization of l-lysine doped TGS and TGSP single crystals Journal of Crystal Growth Volume: 229, Issue: 1-4, July, 2001, pp. 568-573

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# MECHATRONIC SYSTEM FOR PRESSURE CONTROL



***The mechatronic system, that has been presented in this article, is a force adjustment system through pressure control. As a practical application of this system is the adjustment of the pressing force on a technological line for manufacturing rubber carpets on a textile support.***

***The main condition, required by the technologic process, is to maintain a constant value for the pressing force during the entire process, in order to maintain a constant thickness of the rubber carpet.***

***The mechatronic system is formed from two sub-systems, a hydraulic actuating sub-system and an electronic driving system (servo-controller). The electric signals from the transducers are sent to the servo-controller, for processing. The servo-controller compares the signals with pre-programmed values and drives the electromagnets from the proportional directional valve. By driving the proportional directional valve, the hydraulic system is driving the hydraulic cylinder, resulting the real pressing force, required by the parameters of the technological process.***

## 1. INTRODUCTION

Electro-hydraulics systems for physical parameters adjustment (like force, torque, speed, pressure, flow control) can be found in hydraulic actuation systems, which are frequently used in making of mobile or stand-alone machinery in various fields of activity.

This article is referring to a mechatronic force adjustment system through pressure control.

A mechatronic system for force adjustment through pressure control can be found at a technological rubber band line with textile support (fig.1.b). A line like this is used to manufacture rubber carpets with textile insertions (with various uses in many technical fields).

Depending on the market requests, rubber carpets with textile insertions are manufactured in various sizes.

In order to obtain a constant thickness, the pressure force must be also constant.

A constant value for pressure force is obtained by adjusting the pressure in the pressing cylinder. Pressure control is made by a mechatronic force adjustment system thorough pressure control.

## 2. HYDRAULIC SYSTEM STRUCTURE

The hydraulic actuating system is represented in figure 1a. This system contains a pumping group, a proportional directional valve and a hydraulic cylinder. On the supply circuit is mounted an accumulator tank which smoothes the flow of the fluid and on the cylinder circuit is the group of valves for over-pressure discharging. On the same circuit we can find the pressure transducers ($P_1$ and $P_2$) and a movement transducer (x).