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ABSTRACT

of the dissertation for the degree of Doctor of Sciences

ELECTROPHYSICAL PROPERTIES OF A^3B^6 LAYERED CRYSTALS AND THEIR TERNARY ANALOGS RADIATED BY γ-QUANTUMS AND ELEKTRONS

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Applicant:	**ALEKPER ALIGEYDAR ISMAILOV**

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The dissertation work was performed at the "Crystallophysics" laboratory of the Azerbaijan Ministry of Science and Education Institute of Physics

Scientific advisers: Doctor of Sciences in Physics and Mathematics,
Associate Professor **Solmaz Nariman Mustafayeva**

Doctor of Sciences in Physics and Mathematics,
Professor **Gudrat Isag Isagov**

Official opponents: Corresponding member of ANAS,
Doctor of Sciences in Physics and Mathematics,
professor **Oqtay Abil Samedov**

Doctor of Sciences in Physics and Mathematics,
professor **Rena Cumshud Gasimova**

Doctor of Sciences in Physics, Associate
Professor **Mekhriban Shirin Hasanova**

Doctor of Sciences in Physics, Associate
Professor **Rashad Nizamaddin Rahimov**

Dissertation council ED-1.14 of Supreme Attestation Commission under the President of Azerbaijan operating Azerbaijan Ministry of Science and Education Institute of Physics

Chairman of the dissertation council:
Academican
________________ **Arif Mammad Hashimov**

Scientific secretary of the
Dissertation council:
Doctor of Sciences in Physics,
Associate Professor
________________ **Rafiqa Zabil Mehdieva**

Chairman of the scientific seminar:
Doctor of Sciences in Physics and Mathematics,
Associate Professor
________________ **Talat Rzaqulu Mehdiev**

INTRODUCTION

State of the art and actuality of the topic.

Recently the effects of external factors on physical properties of layered crystals and their triplicate analogs A^3B^6 (A - Ga, In, Tl, B - Se, S) are intensively studied. These monocrystals have a broad banned lane, small stroke and crystal cage structures with strong anisotropy. Thus, in these monocrystals there is an ion-covalent between the atoms and a Van-der-Vaalus connection between the layers. The presence of local levels in malaria is one of the main features of these crystals. The formation of local levels is due to structural defects in crystals. The high concentration of local levels in the banned zone is a source of energy foramorphous states in terms of energy structure. One of the characteristics of amorphous materials deformed and even broken the existence of chemical communication media. The whole of these causes the substance's accumulating properties. These defects increase the density of local levels near Fermi levels. The levels created by various defects in the substance play a major role in changing their physical properties . The reason for the study of these crystals is that they are sensitive to the effects of their physical properties on the wide and external factors. Radioactivity measurements in designing and measuring light-emitting crystals of crystalline layers A^3B^6 and optical radiation sources, detector, nonlinear optical transducers, space apparatus measurement systems and nuclear reactors can be used to create sensitive devices that are needed for your device.

Electrical, dielectric, photoelectric, optical and many properties of A^3B^6 crystals and their triple analogs, as well as complex compounds based on them, have been studied since the 1970s and some important results have been obtained. Numerous experiments have been carried out that the temperature transition in the $TlGaSe_2$ and $TlInS_2$ crystals of the $A^3B^3C^6_2$ group with monoclinic modification occurs as the phase transition occurs, i.e., the transition to the segnetoelectric phase (according to Tc~107K and 210K) relative to the intermediate temperature. 120K and 216K respectively). Therefore, it is of interest to study the physical properties of $TlGaSe_2$ and $TlInS_2$ crystals with monocline modifications. In this dissertation the physical properties of crystals $TlGaSe_2$ and $TlInS_2$ with monocline modification were studied. In addition, A^3B^6 (A = Ga, In, Tl; B = Se, S) layered crystals and their triple analogs have always been in the spotlight of researchers. They can also be used to create more sensitive devices for radioactive measurements in nuclear reactors. However, these crystals have always been in the spotlight of researchers because of their unique properties.

A^3B^6 type of crystals and their triple analogues, as well as many of the compounds they contain,

based on the physical properties of the compound have been studied and some important results were obtained.

However, since these crystals have unique properties, they are always in the spotlight of researchers. The effects of electromagnetic waves on the frequency dependence of the dielectric properties of the above crystals, the different levels of additives, γ-quanta and electron capture, as well as the physical properties of polar crystals have been studied in literature. Unlike previous studies, the effects of γ -quanta and electron flood irradiation on physical properties of samples taken from both physical and physical properties in the same crystals in the same crystals as A^3B^6-based monocrystals have not been studied and the difference between them has not been explained.

The object and subject of the study Single Crystals GaS, GaSe , GaSe<Tl>, InSe, InSe<Sn>, $TlGaS_2$, $TlGaSe_2$, $TlInS_2$. The effect of external factors on the electrical properties of crystals at constant and alternating current was studied.

Matter of investigation. Study of γ-quantum and electron radiation flow effect on electrophysical properties of obtained crystals in constant and alternating fields.

Goals and objectives of the study is determination of the mechanism of effect of additives, temperature, electrical field tension and velocity, γ-quanta and electron flood to the transfer phenomena and dielectric coefficients of A^3B^6 layered crystals and their triplicate analogs and experimental materials expansion of application areas.

To achieve this goal, solve the following **issues has been**:

- A^3B^6 of layered crystals of various chemical elements and their triple doped analogues perfect large and single-monocrystals;
- In the constant current, the electric current of γ- quanta and electron floods at the temperature range of 100-300K GaS, GaSe, GaSe < Tl > , InSe, InSe < Sn > and their triplicate analogs $TlInS_2$, $TlGaSe_2$, $TlGaS_2$ monocrystals determining the conductivity mechanism;
- alternate current at room temperature $f=5\cdot10^4–3,5\cdot10^7$ Hz frequency range γ- quanta with rad dose and $(2\cdot10^{12}–10^{13})$ hand / cm^2 dose and $(5\cdot10^4–2,25\cdot10^6)$ GaSe, GaSe <Tl>, $TlInS_2$, $TlGaSe_2$ and 2 single crystals dielectric coefficients and electro transmission mechanism for determining $TlGaS_2$,
- Investigation of injection and thermoactivation currents in TlS and $TlInS_2$ monocrystals in fixed current and determination of local level parameters,
- Constant current TlS single crystals at room temperature, and $f=5\cdot10^4–3,5\cdot10^7$ Hz frequency range and the electrical properties of the dielectric determination of the conductivity mechanism,
- $TlGaS_2$ monocrystals, a long-term reduction mechanism of constant electric field current, study of thermoactivation current and isothermal current relaxation.

The main provisions of the dissertation.

1. Occurrence of hopping conduction with variable length in localized cases near the Fermi level in the direction perpendicular to the layers, in the layered p-GaS monocrystal that was unirradiated in a uniform electric field and irradiated with a $2\cdot10^{12}$-10^{13} el/cm^2 dose electron beams, at temperatures of 140-238 K, the formation of non-activated hopping conductivity in the T = 116-140 K temperature range, the determination of the increase of dielectric permittivity and the decrease of electrical conductivity with the increase of radiation dose when irradiating GaS with an electron beams in an alternating electric field, compensation of radiation defects with deep dopant centers at

small frequencies (~10^4 Hs);

2. Occurrence of hopping conduction activated in localized cases near the Fermi level in the temperature interval 167-250 K, in the direction perpendicular to the layers in undoped and doped GaSe (1,2 and 2,5 mol%Tl) monocrystals in a uniform electric field and not activated at temperatures 111-167 K, determining the increase in the density of local states with the increase in the amount of thallium in GaSe, and decrease in the average distance of hopping and their activation energy;
3. Determination of the occurrence of relaxation losses in GaSe<Tl> single crystals irradiated with γ-quanta in the $5 \cdot 10^4$-$3,5 \cdot 10^7$Hs interval;
4. In the T = 111-200 K temperature range, the existence of long hopping conductance that varies near the Fermi level, in the direction perpendicular to the layers in the uniform electric field, in the undoped and (0,2 and 0,4 % Sn) doped InSe monocrystals, determination of a significant change in the parameters of localized states in their forbidden bands when irradiated with D_γ=100 krad dose γ-quanta;
5. In layered TlS monocrystals, in a uniform electric field, in the direction perpendicular to the layers, at temperatures of T < 230K, the occurrence of hopping conduction with variable length in local cases located near the Fermi level, observation of non-activated hopping conduction at high voltages (F > 10^4 V /cm);
6. Determining the compatibility of the current conductivity in TlS monoclinic crystals with the Lampert injection mechanism;
7. In TlS monocrystals with a monoclinic structure, the occurrence of dielectric losses at frequencies f=$5 \cdot 10^4$-$3,5 \cdot 10^7$ Hs due to electrical conductivity, determining the compliance of the conductivity mechanism with $\sigma_{ac} \sim f^{0,8}$ Mott's law;
8. Explaining the quadratic region of Volt-Ampere characteristics in $TlInS_2$ single crystals by the injection mechanism;
9. When $TlInS_2$ monocrystals are irradiated with γ-quanta with a dose of 50 krad, the formation of polar domains at a voltage of 34-50V and the formation of a negative differential resistance in Volt-Ampere characteristics of the crystals;

10. When $TlInS_2$ monocrystals are irradiated with γ-quanta with a dose of 10^4-$2,25\cdot10^6$ rad and accelerated electrons with a dose of $6\cdot10^{12}$ el/cm^2, their dielectric permittivity increases due to the increase of radiation defects, and at high doses, its decrease (10^{13} el /cm^2) occurs due to the migration of radiation defects;
11. The long-term decrease of the current in $TlGaS_2$ is caused by a localized level with a depth of E_t=0,14 eV.
12. When $TlGaS_2$ monocrystals are irradiated with γ-quanta and electron beam, determining that dielectric losses occur due to electrical conductivity in the frequency interval of $f=5\cdot10^4$-$2\cdot10^7$Hs, and that dielectric losses occur due to relaxation losses after frequency $2\cdot10^7$ Hs.
13. The strong dependence of the dielectric permittivity of $TlGaSe_2$ on the dose of γ-radiation and the frequency of the alternating electric field make them a promising material for creating varicaps and γ-radiation dosimeters;
14. γ-radiation durability of electrical conductivity of $TlGaS_2$ monocrystals indicates their durability to radiation and creates prospects for use in space technology.

Scientific novelty of research.

A^3B^6 layered crystals of their triple analogues forbidden zo-related ments in many ways, established (additives, temperature, variable electric field, frequency, γ - quanta and electronic flood) parameters of the local levels were determined, dielectric coefficients were determined, dielectric losses were adjusted. The effect of the electrical properties of the defects have been identified, for example, the electrical properties of media and electronic flow caused by γ-quanta not explain the difference, as well as their applications have been found.

1 In A^3B^6 laminated crystals and thei ternary analogues there have been determined local level parameters by various methods (additions, temperature, constant and variable electric field, frequency, γ-quantums and electron flow), permittivity values, effect of defects on electric properties. The difference of effect of γ-

quantums and electron flow on electric properties of sample are explained and their fields of application are revealed.

1. GaS single crystals with the energy 4 MeV and radiation dose $2 \cdot 10^{12}$- 10^{13} e/cm^2 brings about the formation of radiation defects. Given defects compensate for structural defects in single crystals. While increasing electron beam dose in GaS single crystals the permittivity increases, the dielectric loss tangent and permittivity variable decrease.
2. There has been found out localization radius being the fundamental parameter of GaS single crystal theoretical calculation and monoklinic modified TlS. It makes up a=58 Å for InSe single crystal and a=33 Å for monoclinic modified TlS.
3. It is established that in TlS single crystals at voltage 10^4V/cm and $T \leq 230$K the hopping conduction in the vicinity of Fermi level is taken place. It goes to the nonactivated hopping conduction at high values of voltage 10^4V/cm.
4. In the frequency range $f=5 \cdot 10^4 - 3 \cdot 10^7$Hz of TlS single crystals the permittivity decrease ~6 as much as relates to charge carrier relaxation, dielectric loss is accounted for by electroconductivity at $f>10^6$Hz. Up to $f=3,5 \cdot 10^4$-10^6Hz $\sigma_{ac} \sim f^{0,8}$ of charge carriers in localized states within the frequency range 10^6-$3 \cdot 10^7$Hz in the vicinity of Fermi level has been determined.
5. In VAC of $TlInS_2$ and monoclinic modifield TlS single crystals the change of current dependiing on the voltage in nonlinear sections of VAC is related to the field effects. It is shown that coduction current is carried out by one-carrier injection mechanism in both crystals.
6. While exposing white light on $TlInS_2$ single crystals the one-carrier injection current is valid and light effect causes current increase limited by space charges. In this case the dependence of photocurrent on the voltage decreases nearby the voltage when the traps are totally filled and the intersection of VAC and photocurrent is taken place.
7. In $TlInS_2$ single crystals nonirradiated and irradiated by γ-quantums dielectric loss tangent decays hyperbolically up to frequency values $f<10^7$Hz. In this case dielectric loss is due to the

electroconductivity but it does not depend on frequency values $f>10^7$Hz.

8. In $TlInS_2$ single crystals nonirradiated and irradiated by γ-quantums the electrocoductivity σ_{ac}~$f^{0,8}$ is carried out by hopping conduction mechanism at $f<10^7$Hz, goes into superlinear dependence at $f<10^7$Hz.
9. While irradiating $TlGaSe_2$ single crystals by γ-quantums with the dose D<50 krad the electroconductivity decreases. Crystal defects caused by this radiation are related to the compensation of the initial defects. At the expense of radiation defects at D>50krad the rise of minority carrier concentration increases the electroconductivity.
10. It is established that by increasing electron flow dose in $TlGaSe_2$ single crystals the real and imaginary parts of permittivity, the dielectric loss angle and electroconductivity decrease in alternating electric field. Before and after irradiation by fast electrons within $f=5\cdot10^4-3,5\cdot10^7$Hz the dielektric loss angle is characterized by maximum in both cases (before and after irradiation) that is evidenced by the presence of relaxation loss.
11. Electroconductivity in p-GaSe and p-InSe high ohmic crystals does not depend on γ- irradiation dose. By Mott theory while penetrating defects into the material with high specific resistance the density of local levels and the distance between the jumps decreases.As a result of irradiation in GaSe single crystals with hole conductivity the acceptor levels rise and reach the maximum at 130 krad and the crystal transition from low resistance state into the high resistance one by hopping conduction is taken place. The radiation in InSe crystal with electron conductivity resulting from acceptor levels are compensated for by the dose 220 krad. By dose 220krad the acceptor levels become critical and the crystalgdoes gradually from low resistance state to the high resistance one.
12. While irradiating $TlGaS_2$ single crystals by electron flow dose $2\cdot10^{12}$ e/cm^2 and $6\cdot10^{12}$ e/cm^2 the dielectric loss within $f=5\cdot10^4-2\cdot10^7$Hz is accounted for by the electroconductivity, the dielectric loss within $f=2\cdot10^7$-$3,5\cdot10^7$Hz is accoubted for by the

relaxation. While irradiatino $TlGaS_2$ single crystals by electron flow dose 10^{13} e/cm^2 the dielectric loss is accounted for by electroconductivity within all the frequency ranges under the investigation.

13. In $TlGaS_2$ single crystals irradiated by electron flow dose $2\cdot10^{12}$ e/cm^2 and $6\cdot10^{12}$ e/cm^2 the electroconductivity σ_{ac}~$f^{0,8}$ at f= $5\cdot10^4-2\cdot10^7$Hz occurs by hopping conduction mechanism, at f=10^7Hz it goes into the linear dependence.

Theoretical and practical significance of research is that, A^3B^6 of layered crystals and their three counterparts from the effective development of new scientific and technical information in electronic devices can be used. It allows the crystals to control the characteristics of electrical measurements in fixed and variable current, their prohibited strip and other important physical parameters. In particular, the mechanism of γ-quantum, electron flood, temperature, different interest and compostion additives, frequency, constant and variable current influences on the parameters of the local levels in the energy spectrum of the crystals were selected and their legality was determined. Individuals are important physical data for the use of these crystals as active elements in semiconductor electronic devices and devies. Data obtained from the investigation of the mechanism of influence of external factors on electron processes in such crystals can be used for theoretical researches of physical processes in analogical systems, prediction of parameters and calculation of parameters. The crystals included in these groups can be used in microelectronics, optoelectronics, nanoelectronics, nanomaterials, radio and photoelectronics, as well as in non-linear optical sensing devices; can be used as an active material in the preparation of photorealifier, frequency rectifier, as well as semiconductor recording devices, γ-quanta, electronic flood detectors that can operate without cooling.

Approbation of the dissertation work. I tire of scientific and practical results and compilations of foreign and national scientific journals, published the following symposia and conference materials, as well as laboratory and Physics at the institute's seminars:

1. XX international scientific-technical conference on photoelectronics and night vision devices, Moscow, may 27-30, 2008, p.180-181.
2. Abstracts of the 4th Euroasian Conference, Nuclear Science and its Application, Ankara, Turkey, 14-17 october 2008, p.180-181.
3. 4th Euroasian Conference, Nuclear Science and its Application, Ankara, Turkey, 14-17 october 2008, p.183-184.
4. 2ndInternational symposium on the manipulation of advanced smartmaterials, Osaka sangyo university- the 80th anniversar, Japan,28-29 may 2008, p-51.
5. 17th International Conference on Ternary and Multinary Compounds (ICTMC-17), 2010, p.77.
6. XXI international scientific.-tech. on photo electronics and night vision devices, Moscow, 25-28 may, 2010, p.201.
7. 7th International Conference on “Technical and Physical Problems of Power Engineering”, Near East University Lefkosa,TR Northern Cyprus, 7-9 july 2011, p.321-323.
8. 61st International Conference on Nuclear Spectroscopy and the Structure of the Atomic Nucleus, Sarov, 10-14 october, 2011, p. 199-200.
9. 19th European conference on Thermophysical properties, Thessaloniki, Grecee, 2011, p.372.
10. 2012 IEEE International Conference on Oxide Materials for Electronic Enginering (OMEE 2012), Lviv, Ukraina, 3-7 september, 2012, p.167-168.
11. XXII International Materials Research Congres. Symposium 7E,Low-Dimensional Semiconductor Structures, Cancun, Mexico, 11-15 August 2013, p.60.
12. 8th International Conference. Fundamental and applied problems of physics, Saransk, 21-23 october, 2013, p. 105-109.
13. VI International Scientific and Practical Conference "Actual problems of science of the XXI century" Moscow, 30 january, 2016, p.106-108.
14. II International Conference «Зимові науковı читання»

м. Киів 31січня 2017, p.96-101.

15. Radiation and chemical safety problems International Scientific-Practical Conference Abstracts book, Baku, 05-06 november, 2019, s.83.

Name of the organization where the dissertation is performed.

The dissertation work is performed at the Laboratory of the crystal physics, Institute of Physics Ministry of Science and Education.

Content of the dissertation. Dissertation works consists of 395600 characters (439152 characters including the literature): in the general characteristics of the case 32 901 characters, six chapters; chapter I includes 42641 characters, chapter II includes 55447 characters, chapter III includes 51851 characters, chapter IV covers 80650 characters, chapter V includes 53926 characters, chapter VI includes 33634 characters, Results includes 8376 characters, List of abbreviations and conventions includes 3 174 characters and Literature with the 288 cited references, 111 figures and 20 tables. A list of published works on the content of the dissertation is given at the end of the abstract.

SCOPE OF THE DISSERTATION

The introduction included information on the relevance of the subject, the purpose of the case, the issues resolved to achieve the goal, the scientific novelty and practical value of the work, the main provisions of defense, the dissertation and publication of dissertation materials, as well as the brief content of separate chapters .

The first chapter The A^3B^6 layered crystals of their triple analogues of single crystals of purchase and for measuring the sample preparation has been devoted here to these groups, which include crystals methods of information about was given. It was noted that single crystals can be used in different ways 1. Bridgeman method, 2. Fixed gradient with low speed cooling. Variants have been prepared for the research from single crystals obtained.

A^3B^6, which is part of their triple-layered crystals similar electrical properties of external factors studied. Semiconductors in different substances are more sensitive to high energy particles. Although these crystals have many defects, they are still very sensitive to electromagnetic, infrared, x-ray, γ - and electron beams . They are more interested in it .

Effects of γ-quanta and accelerated electron flood emissions of A^3B^6 layered crystals and their triplicate analogs were studied. The specimens were radiated in the RXUND-20000 (directly affecting radiation chemical device) with γ-quanta. The mean energy of the γ -quanta is 1.25 MeV. γ-radiation spreads at a rate of light, it can only be protected by thick lead or concrete layer. Depending on the course of the study, the dose of radiation given to the samples was $D_\gamma = 5 \cdot 10^4 - 2.25 \cdot 10^6$ rad.

As a source of impact of the electronic flood, the ELU-4 (Electronic Line Accelerator-4) device with energy of 4 MeV was used. Examples of layered crystals and their triplicate analogs of A^3B^6 were radiated from electrons from $2 \cdot 10^{12}$ to 10^{13} el / cm^2. β-irradiation or electron flood has great penetration ability. These rays go through the skin and penetrate the depth of 2 cm.

A^3B^6 of layered crystals and their three counterparts have high resistance as they themselves are dielectric. There is also a loaded particle with some weak links in a dielectric. The particles in the material with the effect of the electric field create an electric current as a result of a regular flow. This affects the physical properties of single crystals.

Chapter Two A^3B^6 triple-layered crystals and their analogues of fixed and variable alternating current electrical, dielectric and photoelectric properties have been devoted to the study of research methods. Resonance method was used in the constant current with variable current compensation method. The tension and the accuracy of the current are determined by the high-resistance resistor RUOC measuring 0.02-0.5. The electrical properties of layered crystals and their triple analogues included in the A^3B^6 group in the constant temperature range of 77-411K temperature, Hole ratio, thermocouple and at room temperature at variable current ($5\cdot10^4$-$3{,}5\cdot10^7$ Hs) in the frequency range, the following are taken into account. When measuring electrical properties in the constant current, the error was composed of 3-4% and the error rate was 7%.

IC, TSC, etc., which provides information on the parameters of local conditions in the prohibited zones of layered crystals and their triplets of A^3B^6 the names of their methods. With the help of these methods, it is easy to explore the complex spectrum of local conditions.

Here are also the methods of measuring dielectric properties. Important information about semiconductors was obtained by measuring dielectric ratios in the constant and variable electric field . Dielectric penetration of solid dielectrics is calculated by the following formula

$$\varepsilon=\frac{kd}{S}C_{\varepsilon}=\frac{C_{\varepsilon}}{C_0} \qquad (1)$$

d-dielectric sample thickness, S-side area, k-proportionality ratio, C_0- position in the vacuum , C_{ε}-capacity after dielectric distribution between cats.

If the polarization of the dielectrone is diminished in the high-frequency area, the relapse loss occurs. Looking at the mechanism of relaxation loss, it enables us to explain the temperature and frequency dependence of tgδ, which is different from the corresponding relative maxima.

A^3B^6 is placed in the UTRECS-RTR cryostat system to protect the samples made of crystalline layers and their triple analogs from the effects of the external environment, designed to measure electrophysics, dielectric and photoelectric properties. It allows measuring the temperature of the object of physical research at a temperature range of 80-300K with accuracy of 0.01K.

Chapter III is devoted to the study of electrophysical properties of stable crystals of A^3B^6 and their triplicate analogs. It has been shown that, since comparative analysis of the experience in the dissertation work is conducted, all researches were conducted before and after the practice.

Effects of "Tl" and "Sn" additives on the p-GaSe and p-InSe monocrystals have been studied. The electric field was applied crosswise to the natural layers of GaSe<Tl> (0; 1; 2; 2,5 at.% Tl) single crystals. The electrical measurements were performed in the temperature range 111–250 K on samples placed into a cryostat with a temperature stabilization system (the stabilization accuracy is 0.02 K). It is found that layer GaSe <Tl> single crystals exhibit a variable range hopping conduction along the normal to their natural layers at temperatures $T \leq 250$ K in a dc electric field. Estimations are made for the density of states near the Fermi level ($3.4\cdot10^{17}$– $9.6\cdot10^{18}$ $eV^{-1}cm^{-3}$) and their energy spread (0.07–0.16 eV), the average jump distance (90–205 Å).

We studied also the composition dependences of parameters of localized states in GaSe <Tl> single crystals. It was shown that the introduction of thallium reduces the mean hop distance and activation energy of hoppings in GaSe. The electrical conduction and density of localized states near the Fermi-level increased with increasing composition of thallium in GaSe single crystals.

During the steady-state currents in tallium sulphide monocrystals, the change in dc-electrical conductivity at different temperatures in the range of 120-286K was investigated.

The dependence of log σ on 1/T in TlS samples at temperatures $T \leq 230$K is characterized by a monotonic decrease in the activation energy with a decrease in the temperature. This behavior of the dc-conductivity in TlS at low temperatures suggests that charge transfer occurs through the variable-range-hopping mechanism, provided the current is transferred by charge carriers at the states localized in the vicinity of the Fermi level. This is also confirmed by the temperature dependence log $\sigma \sim T^{-1/4}$. The slope of this curve (T_0) allowed us to estimate the density of localized states near the Fermi level. The density of states N_F was found to be equal to $2.8\cdot10^{20}$ eV $^{-1}$ cm $^{-3}$. The scatter of the localized states is estimated as $\Delta W = 0.02$ eV and the localization length is estimated as a =33 Å from our experimental results. We calculated also the hopping distance in TlS : R = 44 Å at T = 120K. At the temperature T = 120K and in high electric fields (F >10^4 V/cm), the activation energy of conduction becomes zero. The activationless conduction also exhibits hopping nature, which manifests itself in the hopping of charge carriers over spatially more distant but energetically more closely located centers without phonon absorption. The average hopping distance in TlS at high electric fields and low temperatures was found to be equal to 78 Å.

Frequency dependence of the dissipation factor ($tan\delta$), the permittivity (ε'), and ac conductivity (σ_{ac}) across the layers in the frequency range $f = 5\cdot10^4 \div 3\cdot10^7$ Hz was studied in layered TlS single crystals of monocline structure at T = 300 K.

Fig. 1 shows the frequency dependences of real (ε') and imaginary (ε'') parts of complex dielectric permittivity for TlS. As the frequency is raised from $5 \cdot 10^4$ to $3 \cdot10^7$ Hz, ε' decreases by a factor of 7; ε'' decreases by one order. That is, the $\varepsilon'(f)$ and $\varepsilon''(f)$ dispersion curves are characterized by a significant drop over the entire frequency range studied. The observed monotonic reduction in the dielectric permittivity of the TlS single crystal with increasing frequency (Fig. 1, curves 1, 2) attests to the relaxation nature of the dispersion.

The experimental frequency dependence of the dissipation factor tan δ for TlS single crystal at frequencies $5\cdot10^4 - 3 \cdot10^7$ Hz is characterized with a monotonic descending (Fig. 2). The hyperbolic decrease of tan δ with frequency is evidence of the fact, that conductivity loss becomes the main dielectric loss mechanism at studied frequency range. Frequency-dependent 300-K ac-conductivity of TlS crystal (Fig. 3) follows the relation $\sigma_{ac} \sim f^{s}$ with s = 0.5 at $f = 5 \cdot 10^4 – 10^6$ Hz; and s = 0.8 at $f \geq 10^6$ Hz.

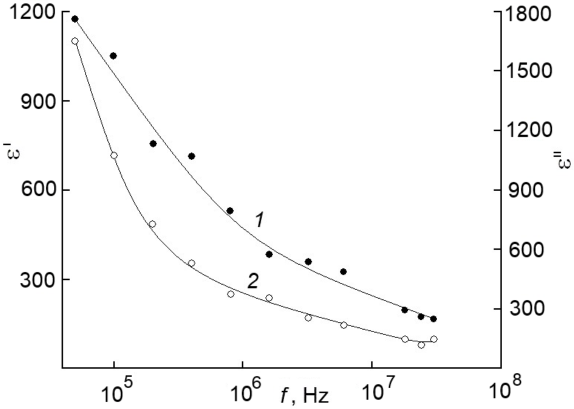

Fig. 1. Frequency dispersion of the real (*1*) and imaginary (*2*) parts of complex dielectric permittivity of the TlS single crystal at *T* = 300K.

Conduction-band ac conductivity is known to be mainly frequency-independent up to 10^{10}–10^{11}Hz. The observed $\sigma_{ac} \sim f^{0.8}$ behavior suggests that the conduction is due to carrier hopping between localized states in the band gap of the material. Such states may be localized near the edges of allowed bands or near the Fermi level. However, under typical experimental conditions, conduction through the states near the Fermi level always prevails over that through the states near band edges. Therefore, the observed $\sigma_{ac} \sim f^{0.8}$ behavior in TlS attests to hopping transport through the states localized near the Fermi level:

$$\sigma_{ac}(f) = (\pi^3/96)\cdot e^2 \kappa T N^2_F a^5 f\,[\ln(\nu_{ph} / f)]^4, \qquad (2)$$

where e is the elementary charge and k is the Boltzmann constant, N_F is density of localized states near the Fermi level, a is the localization length, ν_{ph} is the phonon frequency. According to Eq. (1), ac conductivity varies as $f\,[\ln(\nu_{ph}/f)]^4$. Therefore, at frequencies $f \ll \nu_{ph}$, σ_{ac} is approximately proportional to $f^{0.8}$.

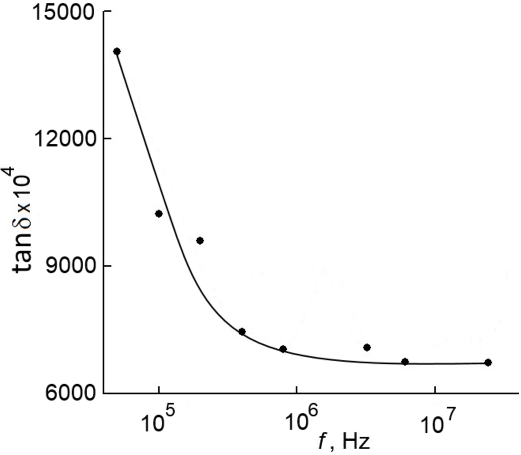

Fig. 2. The dissipation factor tan *δ* for TlS single crystal as a function of frequency.

Using Eq (1) and our obtained experimental $\sigma_{ac}(f)$ data, we evaluated the Fermi-level density of states, $N_F = 3.1\cdot10^{19}$ eV^{-1}cm^{-3}. When calculating N_F, the localization length was taken as $a = 33$ Å, which was obtained from experimental results of hopping dc- conduction study of TlS, and $\nu_{ph} = 10^{12}$ Hz. According to the hopping conduction theory, the average ac hopping length is determined from the formula

$$R = (1/2\alpha)\ln(\nu_{ph}/f) \qquad (3)$$

Here, α is the decay constant of the wave function of the localized charge carrier $\Psi \sim e^{-\alpha r}$ ($\alpha = 1/a$). The value R calculated for TlS single crystal using Eq. (2) is 185 Å. In TlS single crystal R is 5.6 times greater than the average distance between localization centers. Using this value of R and the formula

$$\tau^{-1} = \nu_{ph}\exp(-2\,\alpha R), \qquad (4)$$

we evaluated the mean hop time of charge carriers between localized states in the band gap of TlS: $\tau = 6.5\ 10^{-8}$ s. Using the relation

$$\Delta E = 3/(2\pi R^3 N_F) \qquad (5)$$

we estimated the energy spread of localized states ΔE near the Fermi level of TlS single crystal: $\Delta E = 2.4\,10^{-3}$ eV.

Fig. 4 presents the pressure dependences of the conductivity of TlS single crystal at temperatures 294, 333 and 345 K (curves 1, 2 and 3). It is evident from Fig.4 that pressure leads to increase of conductivity (σ) along the layers of TlS single crystals. Measurements permitted to evaluate the pressure behavior of σ, which may be written as

$$\ln\sigma(\mathrm{P}) = \ln\sigma(0) + \beta\,\mathrm{P}, \qquad (6)$$

where $\beta = d\ln\sigma(\mathrm{P})/d\mathrm{P} =$ 1.08–1.22 GPa^{-1} at T = 294–345 K. Assuming that the electrical conductivity changes with pressure according to the equation

$$\sigma(\mathrm{P}) = \sigma(0)\exp(-\gamma\mathrm{P}/2k\mathrm{T}), \qquad (7)$$

where $\gamma = dE^{i}_{g}/d\mathrm{P}$ is the pressure coefficient of the indirect band gap, one can easily find

$$\gamma = 2k\mathrm{T}\beta\,, \qquad (8)$$

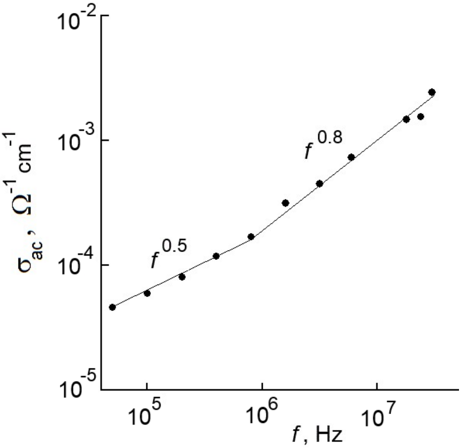

Fig. 3. Log – log plot of 300-K ac-conductivity against frequency for the TlS single crystal.

$TlInS_2$ single crystals are typical representatives of layered wide-band semiconductors which characterized by low mobility of current carriers. Such materials are very perspective for creating on their base of solid state electron devices.

Layered crystals usually contain structural defects, such as dislocations and vacancies. The presence of these defects results in a high density of localized states near the Fermi level.

Studying of charge transport processes in layer $TlInS_2$ single crystal at constant and an alternate current has shown , that at low temperatures ($T < 200K$) and frequencies $f = 10^5 – 10^6$ Hz in them hopping conductivity on localized near the Fermi level states takes place.

In semiconductors with high density of localized states in a vicinity of a Fermi level hopping conductivity in the forbidden zone in a constant electric field and at low temperatures dominates over the conductivity caused by thermoactivated charge carriers in allowed zone.

However, near a room temperature and above charge transport in semiconductors at a direct current, basically, is carried out in the allowed zone.

It was of interest to study non-ohmic conductivity in the allowed zone of $TlInS_2$ single crystal and to establish the mechanism of charge transport, which was the purpose of the present work.

Samples from $TlInS_2$ for measurements are obtained by spalling along C-axis of the natural spall from massive single crystal and have a thickness (200÷280) mkm. $TlInS_2$ samples formed flat capacitors whose plane was perpendicular to the crystalline C-axis. The capacitor plate area was $(4 \div 6)\cdot 10^{-2}$ cm^2. Ohmic contacts of samples are made by Ag paste.

In Figure volt-ampere characteristics (VAC) of Ag-$TlInS_2$-Ag sample are shown at temperatures 293 K (cuvre1); 307 K (cuvre2); 341K (curve3) and 381K (curve 4). VAC's at all temperatures were characterized by enough long quadratic portion ($I \sim V^2$). At temperatures 293, 307 and 341 K the square-law portion was preceded with short ohmic portion ($I \sim V$). And at 381 K in all investigated electric voltages I~V^2. At 293 K the current-voltage characteristic is characterized with super linear portion (I~$V^{6.5}$) after the quadratic portion.

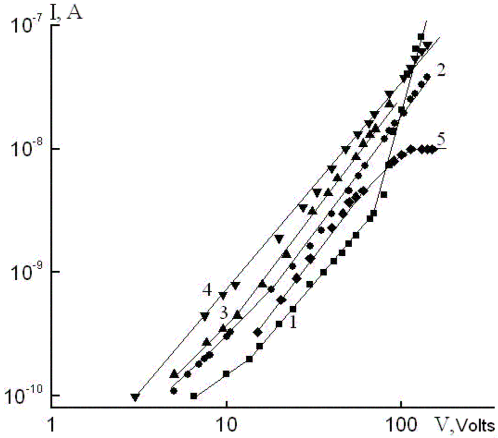

Fig.4. Volt-ampere characteristics of dark-(curves 1, 2, 3, 4) and photo-current (curve 5) of Ag – $TlInS_2$ – Ag system. Curves 1 and 5 are measured at 293 K; 2 – 304; 3 – 341; 4 –381K.

The experimental results obtained in this study were interpreted within the Lampert theory for an electric current limited by the space charge (SCLC).

In semiconductors this theory allows to receive data on local levels in the forbidden zone. Local levels render strong influence on the injection current caused by an external electric voltage. Thus local states define not only change of a current, for example, reduction of an injection current owing to localization of charge carriers, but also form of VAC.

Within the limits of the SCLC theory in semiconductors with traps at times of flight of carriers through the semiconductor, exceeding times of capture for traps, up to a voltage of full filling of traps the current limited by space charge should flow, expression for which is follow:

$$I = \frac{9}{8}\varepsilon\varepsilon_0\mu\theta\frac{V^2}{L^3}, \tag{9}$$

where ε_0 is dielectric constant; ε is dielectric permittivity of a crystal; θ is the capture factor; L is the thickness of a crystal; μ is mobility of charge carriers; V is applied electric voltage. At achievement of a voltage of full filling of traps (V_f) on the VAC of $TlInS_2$ sample there is a portion of abrupt growth of a current (Fig.4 curve1). In this case, determination from experiment $V_{f,}$ we have calculated concentration of traps under the formula:

$$N_t = 1.1 \cdot 10^6 \frac{\varepsilon V_f}{L^2}, \tag{10}$$

$N_t = 10^{12}cm^{-3}$. We also determined the value of equilibrium concentration of the basic charge carriers $p_0=1.67 \cdot 10^{10}cm^{-3}$ in $TlInS_2$ from the relation of the currents corresponding to two voltages V_f and 2 V_f :

$$p_0 = \frac{N_t I(V_f)}{I(2V_f)}, \tag{11}$$

For the sample of $TlInS_2$ single crystal at 293K we have determined also the factor of capture:

$$\theta = 1.8 \cdot 10^{-6} \frac{p_0 L^2}{\varepsilon V_x}, \tag{12}$$

which was equal to 0.17. At calculations for dielectric permittivity of $TlInS_2$ single crystal value ε =10 determined experimentally was taken. In the formula (4) V_x is a such voltage at which concentration of free injected charge carriers becomes comparable with equilibrium concentration, in other words it is a voltage of transition from an ohmic portion of VAC to square-law. Knowing specific dark conductivity of TlInS$_2$ single crystal sample at 293K $\sigma_0 = 10^{-11}\Omega^{-1}cm^{-1}$ under the formula

$$\sigma_0 = p_0 e \mu_0, \tag{13}$$

we have calculated mobility of holes at the voltages corresponding to ohmic portion of VAC:

$\mu_0 = 3.7\cdot10^{-3}cm^2/V\cdot s$. Using experimental results under the formula (1) we have estimated mobility of carries at the voltages corresponding to square-law portion of VAC for TlInS$_2$ single crystal: $\mu = 3.3\cdot10^{-3}$ $cm^2/V\cdot s$. Apparently, both values of mobility, i.e. μ_0 and μ practically coincide.

Knowing values of N_t and θ under the formula

$$E_t = kT \ln \frac{N_p}{2\theta N_t}, \tag{14}$$

where N_p is effective density of quantum states in the allowed zone of a crystal ($\sim10^{19}cm^{-3}$), we have estimated depth of the local level responsible for an injection current: $E_t = 0.44eV$. The level with activation energy ~0.4 eV has been revealed also from temperature dependence of ohmic conductivity across layers of TlInS$_2$ single crystal, and from spectra of a photocurrent.

Absence an abrupt portion on VAC of Ag – TlInS$_2$ – Ag sample at T >300K is connected by that at these temperatures thermal emissions of charge carriers began from a level 0.4 eV to the allowed zone and full filling of traps did not manage to be achieved (Fig.4, curves 2 – 4).

An important feature of the current limited by the space charge is that the electric charge in this case cannot exceed the quantity C_gV, where C_g is the geometric capacitance of the sample and V is the voltage imposed across the sample. For the samples studied in the present work, the geometric capacitance was estimated at $\sim10^{-12}$ F.

The maximum voltage across the sample amounted to 150 Volts. This means that the electric charge of the system Ag – TlInS$_2$

– Ag is equal to $1.5\cdot10^{-10}$ C. The charge per unit area Q_{max} allowed to be transported by the space charge limitations is $3.8\cdot10^{-9}$ C/cm^2.

Illumination of $TlInS_2$ sample in which the current of monopolar injection was supported by white light leads to increase of SCLC (see Fig.4, curve 5).

It testifies that the carriers injected from contact and grasped on traps, absorb photons and are thrown out to the allowed zone. I.e. under influence of light the space charge is redistributed between states on which there is a transport, and states in which there are grasped carriers.

Thus the full space charge in a crystal remains constant; it is determined by the applied voltage and geometry of the sample. It is seen from Figure that a photocurrent limited by space charge (the fig.4, curve 5), also as well as dark SCLC, changes as V^2, that is in the consent with SCLC theory.

Near to a voltage of full filling of traps dependence of a photocurrent on a voltage weakens, VAC's of dark and photocurrent (Fig.4, curves 1 and 5) are crossed, and then the photocurrent is saturated and ceases to depend on a voltage.

Saturation of a photocurrent with an electric field increase speaks about an exhaustion of ohmic contact: in high electric fields contact is not capable to provide any more sufficient number of electrons for establishment of SCLC in volume. I.e. the centers of capture of charge carriers essentially influence on a photocurrent. In this connection, the effects connected with capture of charge carriers determine the sensitivity and operating speed of semiconductor devices.

The experimental results obtained in this study were interpreted within the Lampert theory for an electric current limited by the space charge (SCLC).

In semiconductors this theory allows to receive data on local levels in the forbidden zone. Local levels render strong influence on the injection current caused by an external electric voltage. Thus local states define not only change of a current, for example, reduction of an injection current owing to localization of charge carriers, but also form of VAC. From studying of injection currents in high-resistive layer $TlInS_2$ single crystals following parameters were determined: equilibrium concentration of charge carriers in allowed zone $p_0=1.67\cdot10^{10}$ cm^{-3}; concentration of traps $N_t=10^{12}cm^{-3}$; capture factor $\theta=0.17$; mobility of charge carriers $\mu=3.3\cdot10^{-3}cm^2/V\cdot s$; the depth of trap level responsible for injection current $E_t=0.44$ eV.

Long-time relaxation of current in $TlGaS_2$ single crystal has been studied. The results of investigation of isothermal relaxation currents, volt-ampere characteristics at various temperatures and thermally stimulated currents allowed to reveal the presence of two trapping centers with activation energies $E_{t1}=0.14\div0.16$eV and $E_{t2}=0.32$eV in $TlGaS_2$ single crystal. It was shown that trap level $E_{t1}=0.14$eV is responsible for long-time relaxation of current in $TlGaS_2$ single crystal.

In Chapter IV, the effects of γ-rays on electrophysical properties of A^3B^6 layered crystals and their triplicate analogs were studied.

The effects of γ-rays on the parameters of local conditions in the constant current in the p-GaSe and p-GaSe <Tl> monocrystals were studied. p-GaSe <1at.% Tl>, p-GaSe <2at.% Tl>, p-GaSe <2.5% Tl> and p-GaSe, which are irradiated with γ-quanta in temperature range 111-294K, InSe, n-InSe <0,2 at.% Sn, n-InSe <0,4 at.%Sn> the temperature dependence of electric conductivity in constant current of mono-crystals was investigated. Regardless of the dose of radiation, GaSe has 250K and InSe monocrystals with variable stepped conductivity in the case of a narrow strip of ΔE energy near the Fermi level below 200K. p-GaSe, p-GaSe <Tl>, while crystals at 167K below the temperature, there is an inactivated leap conductivity. Here, the dependence of the conductivity on the temperature is very weak, ie the activation energy gradually approaches to zero.

Effects of γ-rays on dielectric properties and electric conductivity of the p-GaSe, p-GaSe<Tl> monocrystals were investigated. At 300K temperature, it was determined that the dielectric permeability of the samples with the γ-quanta with the radiation dose $5\cdot10^4$ və $2,25\cdot10^6$krad $f=5\cdot10^4$–$3,5\cdot10^7$Hs was determined dependent on the velocity in the frequency range $5\cdot10^4$–$4\cdot10^5$ the speed of dielectric penetration is reduced by 8 times, then $f= 3,5\cdot10^7$.No significant dispersion was observed in the dielectric domains of radiation samples with radiation doses $5\cdot10^4$ və $2{,}25\cdot10^6$krad at $5\cdot10^4$–$3{,}5\cdot10^7$Hs. Whenever the monocrystals are heated, the dose is collected by the same dose. The dielectric penetration of flared samples with the γ-quanta with a flammation of $f> 3{,}2\cdot10^6$Hs radiation doses of $5\cdot10^4$ and $2{,}25\cdot10^6$ krad in relatively large frequencies does not change as the frequency increases. As the radiation dose is collected at low frequencies, the dielectric penetration decreases. $f> 3{,}2\cdot10^6$Hs dielectric penetration of GaSe monocrystals at Hs frequencies depends on neither the speed nor the γ-radiation dose. The frequency dependence of the imaginary part of the complex dielectric penetration of GaSe monocrystals was also studied in the dose of different radiation. In GaSe, which is irradiated with γ-quanta, the electrical conductivity gradually increases with the law $\sigma_{ac}\sim f^{0,8}$, which is characterized by leakage conductivity.

GaSe and InSe monocrystals have been considered self-compensating. Dose dependence of high-resistance p-GaSe, p-InSe and low-strength p-GaSe <2.5 at% T1, n-InSe<0.4at.% of monocrystals of electric conductivity γ-radiation was studied at room temperature. As the radiation dose increases in high - strength p-GaSe and p- InSe monocrystals , the electrical conductivity is slightly increased. The p-GaSe <2.5 at.% Tl > monocrystals in the first field are observed in the dose dependence of the electrical conductivity of the low-resistant p-GaSe <2.5 at.% Tl> monocrystals. The radiation dose is 0-130 krad radiation defects in the range self-compensated and conductivity in semiconductor is specific. As a result, the Fermi level changes to the center of the banned strip. On the II field, radiation defects increase in radiation after radius of 130 degrees. Thus, in the subsequent increase of defects, the semiconductor passes through the highly resistant state of the leak. In low-resistance n-InSe <0.4 at.% Sn> monocrystals, this event is different in itself. Two areas are observed in the dosage dependence of the low-resistance monocrystals of the electric-conductivity γ-radiation:

In the II area γ - radiation defects in the aftermath of an increase in radiation after 220 krad. Thus, in the subsequent increase in defects, the semiconductor is gradually passing from low resistant to high- strength state. The results obtained from the γ-rays of the p-GaSe and n-InSe monocrystals show that high-strength transition from slow-transition to p-type monocrystals is gradually transmitted in n-type monocrystalline.

The energy spectra of the p-GaSe <Tl>and n-InSe <Sn>monocrystals were irradiated with irradiated and γ□quanta .For this purpose, the unsaturated r-GaSe at the temperature range 111-294K, p-GaSe <1 at% Tl>, p-GaSe <2 at% Tl> and p-GaSe <2.5 at % Tl> and p-InSe , p-GaSe <1at.% Tl>, p-GaSe <2at.% Sn, and n-InSe<0.4at% Sn > and Dγ = 100krad dose, T1 and p-GaSe <2.5% Tl> and n-InSe<0.2 at% Sn, and n-InSe<0.4at% temperature dependence of electric power on samples was measured. Based on the experimental results obtained, the load energy of the loaders was determined. p-GaSe <1at.%Tl>, p-GaSe<2at.%Tl>, p-GaSe<2,5at.%Tl>, n-InSe<0,2 at.%Sn> and n-InSe<0,4at.%Sn>the activation energy of materials is determined.

The effect of radiation with γ -quanta VAX of $TlInS_2$ monocrystals was studied. Initially no irradiated sample Ag–$TlInS_2$–Ag was measured at the temperature of 293 K . The VAX consists of three sections: linear (I ~ V), square ($I \sim V^2$) and a sharp rise area ($I \sim V^5$). Then, the VAX of the monocrystals that are polarized at 50krad dose is measured. This was measured after 24, 48, 120, 144 and 192 hours respectively. As the next time the radiation increases, the VAX of the sample shifts to the left and gradually approaches the non-irradiated sample VAX. Thus, the peak height is gradually decreasing and is less noticeable after 192 hours, and the VAX of an untreated Ag-$TlInS_2$ -Ag sample that has no irradiated and irradiated dose D_γ= 50 krad after 240 hours coincides. This low dose corresponds to the effects of monocrystals on their physical properties.

The effect of γ- ions on the dielectric properties and electrical conductivity of $TlInS_2$ monocrystals in the changing current was investigated. Dependence of dielectric permeability was studied on radiation dose at different frequencies. All of the frequency range of the radiation $1 \cdot 10^4$ rad dose is the highest price in a dielectric. The doses of defects occur in these doses. Radiation $1 \cdot 10^4$ rad dose, then the measured frequency s the cost of dielectric penetration decreases, which is related to the migration and defect of the defects. For the nature of the dependence on the tangential velocity dependence of the dielectric angle angle, as well as in the $TlInS_2$ monocrystals with 10^4-$2,25\cdot10^6$ red dose, the velocity is reduced to the $f = 10^7$ Hs value, and to the relaxation loss at 10^7 Hs the velocity $f = 10^7$ Hs is the same as the value of $\sigma_{ac}\sim f^{0,8}$, and the velocity $\sigma_{ac}\sim f^{1,3}$ superline field equals

Effects of γ- radiation on the parameters of local conditions in the constant current of $TlGaSe_2$ monocrystals were studied. Voltamper specifications of unstained and 30krad, 80 krad dose monocrystals were measured.VAX is composed of $I\sim U^n$, omyk $I\sim U$, truncated square $I\sim U^2$ for all three cases, and I -Up of the sharp uplift of high voltage. We found the prices to explain the experience of spatial loads with limited law- current (FYMC) have used theory. For $TlGaSe_2$ monocrystals to ensure the FYMC regime's integrity, it is necessary to determine the VAX of each of the 3 crystals of different thicknesses. The current density in the FYMC should be proportionate to the inverse of the L^3. The conditions specified in the monocrystals are met. In small dose (30krad) radiation, the severity of the current is less than the current severity of the non-irradiated sample. The difference in small dose irradiation is that the structure defects in the crystals are large. Excess $TlGaSe_2$ monocrystals with a larger dose leads to an increase in electrical conductivity, increase in thickness .

$TlGaSe_2$ single crystals alternating current to explore the effects of radiation are represented . $D_\gamma = 3\cdot10^4$ rad dose of the samples irradiated with a dielectric $5\cdot10^4$-$3,5\cdot10^7$Hz frequency range up to 7.5 from 12.8 decreased. The dielectric penetration of the radiated sample with a dose of $2,25\cdot10^6$ rad takes place intermediate between the dielectric penetration of the dye with $D\gamma = 3\cdot10^4$ rad dose and the irradiated sample. The low dose of the dose decreases the dielectric penetration of the sample in the frequency range learned, increases with a relatively high dose, but is always less than the unbalanced sample.$f>2\cdot10^5$The permeability of the samples at Hs is subject to the law of σ_{ac}~$f^{0,8-0,9}$. As the radiation dose increases, the current in the current flow increases as well. The obtained σ_{ac}~$f^{0,8-0,9}$ legality corresponds to the leakage conductivity in local conditions near the Fermi level.

Layer single crystals of the $TlGaS_2$ compound are wide band-gap semiconductors that exhibit a tendency to polytypism . The physical properties of $TlGaS_2$ single crystals are very sensitive to external actions, such as direct-current (dc) and alternating-current (ac) electric fields and electromagnetic radiation in the visible and X-ray spectral ranges .

In the frequency dependence of dielectric properties and conductivity of single crystals $TlGaS_2$ were studied and the main parameters of the localized states were evaluated. In the effect of **γ**-irradiation on the dielectric permittivity and conductivity of $TlGaS_2$ single crystals at the temperatures 200-370 K was studied. Studied in $TlGaS_2$ single crystals were not as high-resistive, as in, which is associated with the presence of different polytypes of $TlGaS_2$. And the use of samples from different production batches leads to different results. Moreover, in measurements were made at frequencies up to 1 MHz. Therefore, this study presents the results of studying the frequency dependence of real (ε') and imaginary (ε'') components of the complex dielectric permittivity and ac-conductivity of high-resistive ($\rho_{ac} \approx 10^{10}$ Ω cm) of $TlGaS_2$ single crystals at frequencies up to 35 MHz and the effect of **γ**-irradiation on them.

$TlGaS_2$ samples for electrical measurements had the form of planar capacitors. Electrical contacts were made by silver paste. The thickness of the single-crystal $TlGaS_2$ samples was 200 μm. The dielectric properties of the $TlGaS_2$ single crystals were studied by a resonance technique in the frequency range $5 \cdot 10^4$ to $3.5 \cdot 10^7$ Hz, using a TESLA BM 560 Q-meter. During the measurements, the samples were situated in a shielded chamber. All of the measurements were performed in electric fields corresponding to Ohmic current–voltage behavior. The accuracy in determining the sample capacitance and the merit factor ($Q = 1/ \tan \delta$) of the measuring circuit was limited by reading errors. The capacitors were calibrated with an accuracy of ± 0.1 pF. The reproducibility in the resonance position was ±0.2 pF in terms of capacitance and ±1.0–1.5 scale divisions in terms of Q. The largest deviations from the average were 3–4 % in ε′ and 7% in tan δ.

The samples were irradiated on an RKHUND-20000 radiation-chemical facility operating in a continuous mode from a ^{60}Co source. The gamma energy was 1.25 MeV. The irradiation doses were accumulated by sequential exposures for the same sample and amounted to $5 \cdot 10^4 - 2.15 \cdot 10^6$ rad. The dielectric measurements were carried out after each irradiation at 300 K. The permittivity of the $TlGaS_2$ sample was measured at fixed frequencies, first, before gamma irradiation and, then, after gamma irradiation with doses $D_\gamma = 5 \cdot 10^4$, $1.5 \cdot 10^5$ and $2.15 \cdot 10^6$ rad. It has been shown that gamma irradiation of the $TlGaS_2$ single crystal with a dose of $5 \times 10^4 – 2.15 \cdot 10^6$ rad leads to insignificant change of ac-conductivity (σ_{ac}) across the layers and real part (ε') of the complex dielectric permittivity, but to a considerable increase in the imaginary part (ε") of permittivity (Fig. 6).

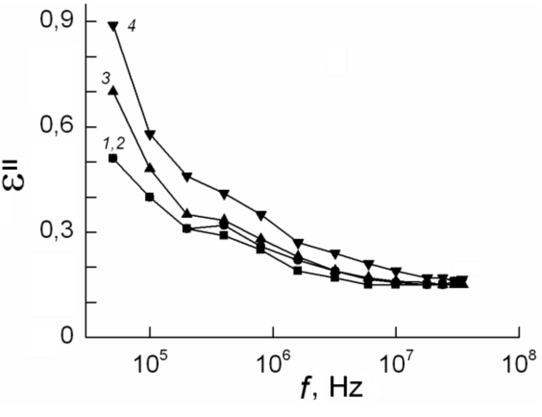

Fig. 5. Frequency dependences of the imaginary part of complex dielectric permittivity of the $TlGaS_2$ single crystal at different gamma irradiation doses D_γ = (1) 0, (2) $5 \cdot 10^4$, (3) $1.5 \cdot 10^5$, and (4) $2.15 \cdot 10^6$ rad.

At high frequencies, however, some noticeable changes of ε″ on γ-irradiation dose were not observed.

In the frequency range 50 kHz–35 MHz ε' underwent almost no variance with frequency increasing, whereas there was a significant variance of ε'', and the accumulation of radiation dose in the $TlGaS_2$ single crystal leads to increase of ε'' dispersion (Fig. 1). The results demonstrate that ε'' dispersion in the $TlGaS_2$ single crystal has a relaxation nature.Frequency-dependent 300-K ac-conductivity of single-crystal $TlGaS_2$ before and after gamma irradiation (Fig. 6) follows the relation $\sigma_{ac} \sim f^s$ with s = 0.8 up to $f = 2 \cdot 10^7$ Hz, and s > 1 at $f = 2{\cdot}10^7 – 3.5 \cdot 10^7$ Hz.

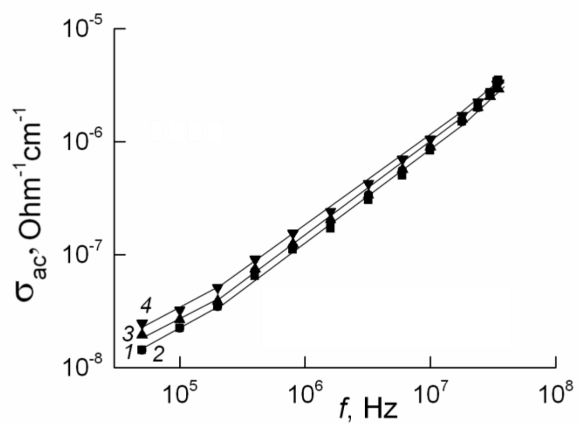

Fig. 6. Log–log plot of 300-K ac conductivity against frequency for single-crystal $TlGaS_2$ at different gamma irradiation doses D_γ = (1) 0, (2) $5 \cdot 10^4$, (3) $1.5{\cdot}10^5$, and (4) $2.15 \cdot 10^6$ rad.

Conduction-band ac conductivity is known to be mainly frequency-independent up to 10^{10}–10^{11}Hz. The observed $\sigma_{ac} \sim f^{0.8}$ behavior suggests that the conduction is due to carrier hopping between localized states in the band gap of the material. Such states may be localized near the edges of allowed bands or near the Fermi level. However, under typical experimental conditions, conduction through the states near the Fermi level always prevails over that through the states near band edges. Therefore, the observed $\sigma_{ac} \sim f^{0.8}$ behavior attests to hopping transport through the states localized near the Fermi level

$$\sigma_{ac}(f) = (\pi^3/96)\cdot e^2\kappa T\, N^2_F\, a^5 f\,[\ln (\nu_{ph} / f)]^4, \qquad (15)$$

where e is the elementary charge and k is the Boltzmann constant, N_F is density of localized states near the Fermi level, a is the localization length, ν_{ph} is the phonon frequency. According to Eg. (1), ac conductivity varies as $f[\ln (\nu_{ph} / f)]^4$. Therefore, at frequencies $f \ll \nu_{ph}$, σ_{ac} is approximately proportional to $f^{0.8}$.

Using Eq (1) and our experimental σ_{ac} (f) data, we evaluated the Fermi-level density of states, N_F. At $D_\gamma =$ 0– 2.15 · 10^6 rad N_F = (7.0–8.4) · 10^{18} $eV^{-1}cm^{-3}$.

According to the hopping conduction theory, the average achopping length is determined from the formula

$$R = (1/2\alpha)\ln (\nu_{ph}/f) \qquad (16)$$

Here, α is the decay constant of the wave function of the localized charge carrier $\Psi \sim e^{-\alpha r}$ ($\alpha = 1/a$).

The value R calculated for $TlGaS_2$ single crystal using Eq. (2) is 81Å before gamma irradiation and 78 Å at D_γ = 2.15 · 10^6 rad. Using this value of R and the formula

$$\tau^{-1} = \nu_{ph} \exp (-2\,\alpha R), \qquad (17)$$

we evaluated the mean hop time of charge carriers between localized states in the band gap of $TlGaS_2$: $\tau = 10^{-7}$ s at $D_\gamma = 0$ and $\tau = 6.7 \times 10^{-8}$ s at D_γ = 2.15 · 10^6 rad. Using the relation

$$\Delta E = 3/(2\pi R^3 N_F) \qquad (18)$$

we estimated the energy spread of localized states ΔE near the Fermi level of $TlGaS_2$ single crystal: ΔE = 0.12–0.13 eV.

Chapter V. In this chapter the influence of electron irradiation on the electrophysical properties of A^3B^6 layered crystals and their triple analogous in direct and alternating electric fields has been investigated. In the monocrystals GaS, GaSe and InSe, electrical measurements were carried out at a constant temperature of 111-294K. Examples $2\cdot10^{12}$-10^{13}el/cm^2 milligrams of irradiated electron flood. The unsaturated and low density of electroconductivity of the monocrystals in the various doses reduces the electrical conductivity as the temperature decreases.

Regardless of the irradiation dose, the GaS monocrystals have a constant leak-proof conductivity that changes around the Fermi level at a temperature range of 140 to 238K, which in turn turns into an inactive leak-free conductivity at temperatures Tl<140K.In GaSe and InSe monocrystals , there is a step-by-step leap convergence thatchanges around the Fermi level, starting at 250K and 200K, regardless of the dose of electron drifting in the perpendicular direction to the natural layers. GaSe monocrystals show that the temperature dependence of the electricity is 167K, after which the activation energy of the loaders is approached to 0, ie, the inactivated conductivity occurs at the temperature range of 167-111K.

$TlInS_2$, $TlGaSe_2$, $TlGaS_2$ monocrystals irradiated with the electrons of $\Phi_{el}=2\cdot10^{12}$–10^{13} el/cm^2 and the temperature drops from 294K to 111K, the electrical conductivity decreases and does not depend on the temperature at different temperatures depending on the chemical composition. It was determined that in every 3 monocrystals there is a step-by-step leap convergence that changes around Fermi levels at temperatures below 200K .

The effect of electron-irradiation on the dielectric coefficients and ac-conductivity across the layers of $TlInS_2$ single crystal in the frequency range $5\cdot10^4 - 3.5\cdot10^7$ Hz was studied. It is shown that electron-irradiation of $TlInS_2$ single crystal with doses of $2\cdot10^{12}$–$2.4\cdot10^{13}$ e/cm^2 resulted in a decrease in the real component (ε') of the complex dielectric permittivity and tangible increase in its imaginary part (ε'') loss tangent (tan δ) and ac-conductivity (σ_{ac}) across the layers at relatively low frequencies. At high frequencies, however, some noticeable changes of ε'' tan δ and σ_{ac} due to electron-irradiation were not observed.

The experimental frequency dependence of the dissipation factor tan δ for $TlInS_2$ single crystal at f = 50 kHz –35 MHz is characterized with a monotonic descending before and after electron-irradiation. The hyperbolic decrease of tan δ with frequency is evidence of the fact, that conductivity loss becomes the main dielectric loss mechanism in the $TlInS_2$ single crystal at studied frequency range.

The investigation of the frequency dependences of ac- conductivity of the electron-irradiated $TlInS_2$ single crystal made it possible to elucidate the hopping charge-transfer mechanism. We evaluated the density and energy spread of localized states near the Fermi level, the average hopping time and the average hopping length in $TlInS_2$ single crystal at various doses of electron-irradiation.

The influence of the $TlGaSe_2$ monocrystals on the dielectric properties and the electrical conductivity of the accelerated electrons has been studied. Dielectric properties and frequency of electrical conductivity were investigated in the range $5\cdot 10^4$ -$3,5 \cdot 10^7$ Hs.

As the radiation dose increases, the dielectric penetration decreases. $TlGaSe_2$ monocrystals are characterized by the maximum torque of the dielectric angle of incidence in the entire frequency range when irradiated by electron floods (irradiated and rashed) in the event of loss of relapse. $TlGaSe_2$ with the electron flood of the monocrystals, as the radiation dose increases, the electrical conductivity decreases. Reduced electrical conductivity of small doses of semiconductors is due to compensation of the primary electrical activity in crystals by the radiation defects of the deep-energetic centers.The influence of the $TlGaS_2$ monocrystals on the dielectric properties and the electrical conductivity of the accelerated electrons was investigated. When the $TlGaS_2$ monocrystals radiate with $2\cdot10^{12}$ - $2,4\cdot10^{13}$ el/cm^{2}electron flood, the actual fraction of the dielectric permeability in the F<10^6 Hs density decreases as hyperbolic. It shows that there is a relapse dispersion. At the upper frequencies (f>10^6 Hs) this difference increases. In the crystals that are irradiated and crystals radiated by electrons of $2\cdot10^{12}$, $6\cdot10^{12}$ el/cm^2, the curve of hyperbolic decreases by $2\cdot10^7$Hs, indicating that the dielectric loss is due to electrical conductivity. At the $f\geq2 \cdot 10^7$ Hs, the dielectric loss is already a loss of relaxation. If the radiation dose is $2,4\cdot10^{13}$ el/cm^2, the entire frequency range is only due to electrical conductivity. Before and after irradiation with electron flood, the frequency $f = 2\cdot10^7$Hs is between ,σ_{as}~f^s , s=0,8 and $f=2\cdot10^7$-3.510^7 Hs. $\sigma_{ac} \sim f^{0.8}$ indicates that the Fermi level has a step-by-step leach conductivity, ranging from local levels.

In Chapter VI , there are studied the influence of light on the electrophysics, properties of the crystalline layers of A^3B^6 and their triangles. Initially, the temperature dependence of the unsaturated GaS, GaSe, InSe monocrystals in the 111-294K interval was investigated. The temperature dependence of electroconductivity of GaS, GaSe, InSe monocrystals after electron flooding was studied. The effects of light on the temperature dependence of the electroconductivity of GaS, GaSe, InSe monocrystals, which were electronically flooded, were studied. The electrical conductivity of chiral monocrystals is increasing with respect to the electrical conductivity of non-irradiated monocrystals. When light falls on the heated monocrystals, the electrical conductivity decreases. Radiation defects arise as a result of radiation. When the light-emitting crystals emit light, the defects generated are actively involved in recombination processes. In the monocrystals GaS, GaSe and InSe, the recombination process is relatively superior to the generation process , thus reducing the electrical conductivity .

Photoelectric properties of p-InSe and n-InSe+0,4at.%Sn monocrystals were studied. Conductivity is increased when A^3B^6 layered crystals and their triple analogs are illuminated by light, and spectral characteristic of photoconductivity of the sample has been studied to determine which wavelengths of this reproduction occur Fig. 7. High-strength p-InSe and low-temperature n-InSe + <0,4 at.% High-strength p-InSe and low-temperature n-InSe+<0,4 at.%Sn> change of their specific resistance when lighting samples of 200 Sn with samples of high-strength p-InSe 40-50 m / l for $\frac{R_T}{R_C}$= 15-20 and low- InSe + <0.4 at.% 50-60 mph for RN and $\frac{R_T}{R_C}$ = 3-5. The spectral distribution curve is calculated based on the energies of the falling quantum energy. Low-resistant n-InSe + <0.4 at.% the maximum longevity of 1.2eV at 1mk is also available. Then the temperature dependence of the samples of darker and photoconferencing of thermally modified samples is shown in the range of 160-433K. The photoconductivity increases at a temperature of 160-370K and takes the maximum value at 370K Fig.8. Then, the photoconductivity is gradually decreasing in the 370-433K range of the temperature. $\sigma_T \sim 10^3/T$ curve consists of two broken lines. According to these curves, the activation energies of the local levels were 0.2 and 0.5eV respectively.

Based on experimental results, it is possible to prepare high-resolution ionizing receivers in the spectral region of 0.3-2mkm based on them.

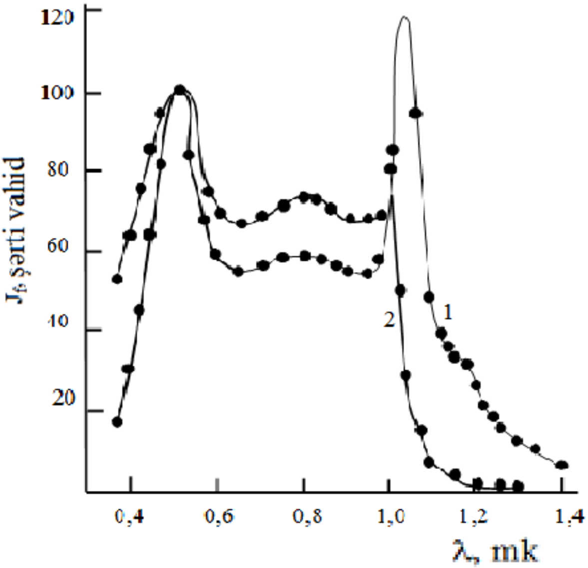

Fig. 7. Spectral distribution of photoconductivity:Curves of 1st high-resistance p-InSe and 2nd low-resistance n-InSe+<0.4 at.%Sn> samples.

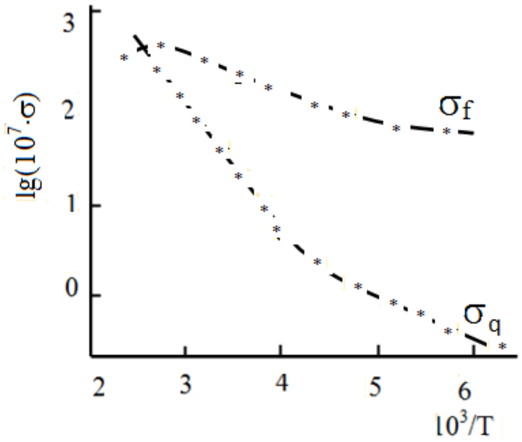

Fig. 8. Temperature dependence of dark and photoconductivity of temperature-treated samples of InSe single crystals: σq-dark electrical conductivity, σq-photoconductivity.

Injection and thermoactivation currents of monosulfide tallium monocrystals were studied. For this purpose, the Ag-TlS-Ag sample was measured at a temperature range of 300-378K VAX. the results were explained in accordance with the FYMC theory. According to the results of the experiment, the concentration of trace in TlS was determined $N_t=1,3\cdot10^{10}$ cm^{-3}. The concentration of the main load bearers in equilibrium has been determined and r = $1.5 \cdot 10^8$ cm^{-3}. The factor of eclipse is calculated and for TlS monocrystals $\theta = 0.12$. Knowing the value of the specific electrical conductivity in the dark TlS sample at 300K, $\sigma_0=5,11\cdot10^{-5}$ $Om^{-1}\cdot cm^{-1}$loaders were detected. The velocity of the holes in the VAX area was calculated and $\mu= 2\cdot10^{-2}cm^2/V\cdot s$

Thermostimulated current (TSC) was investigated to detect local levels in TlS crystals and to compare the values of their deployment depths to the cost of the injection method, b = 0.35 K / h. TSC spectroscopy at peak T = 250K. The depth of this peak was determined by Mott's theory and was 0.48 eV.

$TlInS_2$, $TlGaSe_2$ and $TlGaS_2$ flared with accelerated electron flood the effect of light on the electrical conductivity of monocrystals was studied. For this purpose , the temperature dependence of electrically conductive samples of $TlInS_2$, $TlGaSe_2$ and $TlGaS_2$ monocrystals , which was first uncollected, was investigated in the 100-294K range. Then, all samples are heated with doses of 10^{13} el/cm^2 dose electron. The temperature dependence of the electrical conductivity of the re-scattered monocrystals is measured. It is apparent that the electrical conductivity increases due to defects caused by radiation. $TlInS_2$, $TlGaSe_2$ and $TlGaS_2$ flared with dose electrons of 10^{13}el/cm^2 monocrystals lighted out from the spectrum lamp, and it creates local centers again, which leads to the re-growth of the electrochemicals.

$TlGaS_2$ monocrystals have been studied for long term relaxation. Different tension levels have been determined dependent on the current flow of the Ag-$TlGaS_2$ -Ag sample.

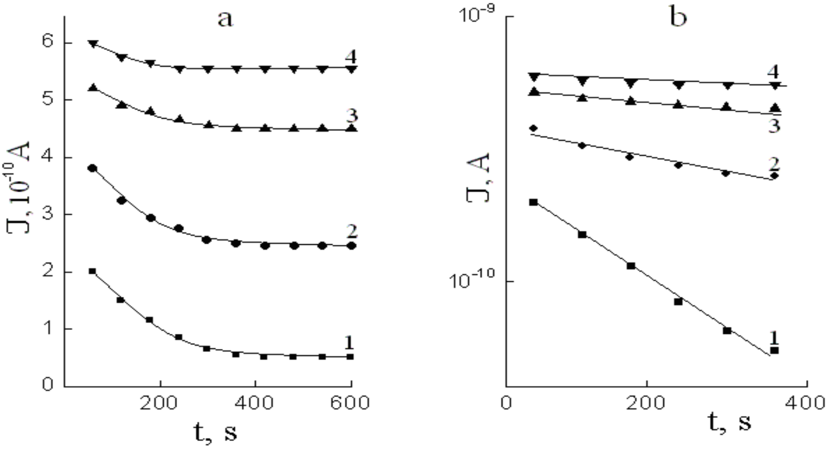

Fig. 9. Ag–$TlGaS_2$–Ag time dependence of the passing current at different values of electric voltage U,V: 1 – 0.1; 2 – 0.5; 3 – 0.9; 4 –1.2; a – in ordinary coordinates; b – semi-logarithmic scale; T = 293

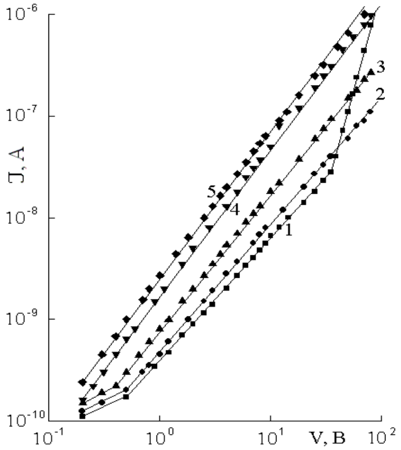

Fig. 10. VAX of Ag–TlGaS2–Ag sample at different temperatures T, K: 1 – 293; 2 – 320; 3 – 350; 4 – 373; 5 – 393.

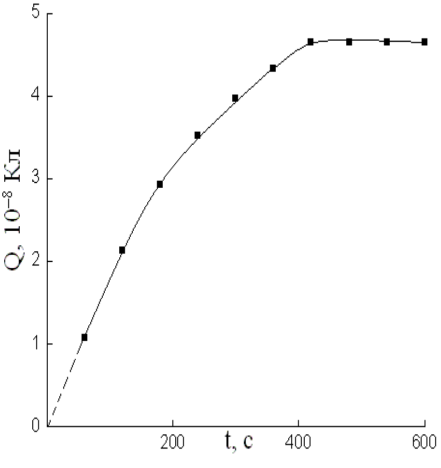

Fig.11. Dependence of the accumulated charge in the Ag–TlGaS$_2$–Ag system on the storage time of the voltage U= 0.1 V and T= 293 K.

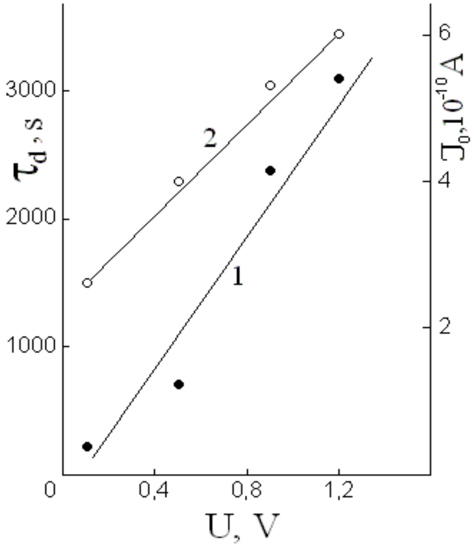

Fig. 12. Dependence of the time constant td (curve 1) and leakage current I0 (curve 2) of the dark current drop at 293K on the applied voltage to the Ag – TlGaS$_2$ – Ag system.

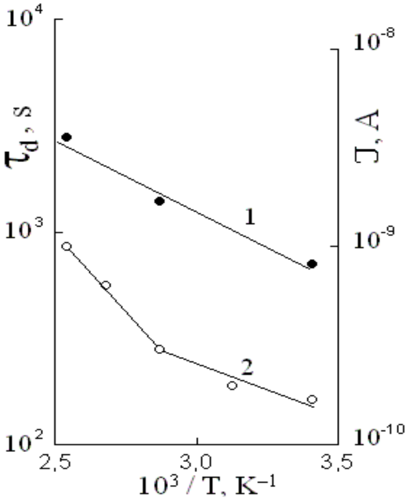

Fig. 13. Temperature dependence of the time constant τ_d (curve 1) and dark current (curve 2) of the current drop at a voltage of U=0.5V in TlGaS$_2$ single crystals.

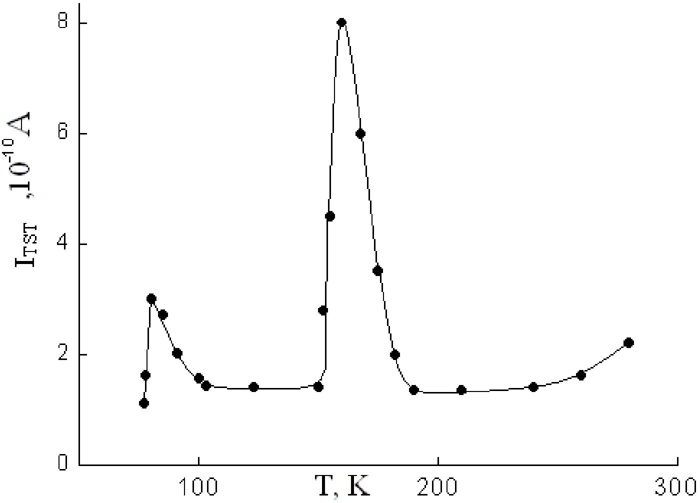

Fig. 14. TSC curve of $TlGaS_2$ single crystals extracted at heating rate b= 0.34 К/s.

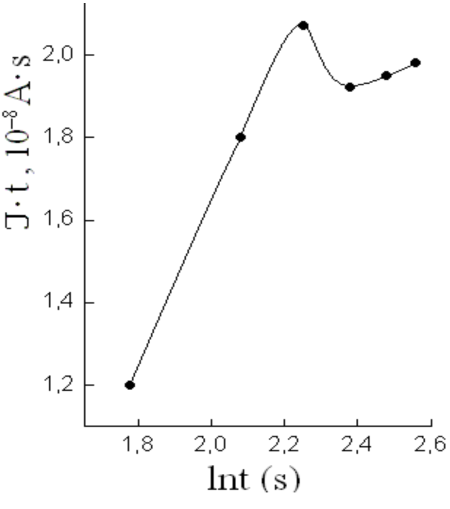

Fig. 15. I·t – ln t characteristic in $TlGaS_2$, U = 0.1 V; T = 293 K.

All of the current relaxation of tension is approximately 6 minutes after the trend becomes stationary. $TlGaS_2$ sample was studied and hysteresis was observed . When the straight-line tension rises, the reverse passage is observed when the tension falls . The fall of the tide can be explained by the fact that the exhausted loaders compensate for the external tension in the partial flow. Ag-$TlGaS_2$-Ag the cost of cargo accumulated in the 0.1V voltage and 293K for the time- model has increased and is saturated after 6-7 minutes fig 9. The fig.11 maximum cost of the Ag-$TlGaS_2$-Ag model is $4{,}8\cdot10^{-8}$ Kl, which is the maximum value of the load density $Q_{max}=2{,}4\cdot10^{-6}$ (Kl/cm^2). It has been established that the long-term relapse of the $TlGaS_2$ sample is that the carriers are trapped by $E_t = 0.14$eV traps fig 14.

Results

1. It has been established that, when GaS monocrystals are exposed to electron flood, the radiation density increases in dioxide, the dielectric penetration increases and the electrical conductivity decreases. This is due to the fact that when radiated by electrons in small frequencies of the variable current, radiation defects are compensated by deep centers, which does not increase the electrical conductivity. In the fogled GaS monocrystals, $f=5\cdot10^4$–10^7 Hs frequency range varies at the local level, with the variable-step leach conductivity of the loaders at the fermion level, at $f>10^7$Hs the velocity dependence of the current intensity depends on linear dependence [28, p.9-12].
2. It has been established that the high density localized levels of GaS, GaSe and InSe and their triplicate analogs, $TlInS_2$, $TlGaSe_2$ and $TlGaS_2$, are caused by the addition of high density localized levels, their enrichment, γ-quanta and electrons. T=140-238K GaS, GaSe T = 167-250K, InSe T = 111-200K temperature. In GaS, T = 111-140K and GaSe at the 111-167K temperature range are activated without activated loose conductivity. It has been shown that, as the radiation dose increases, the electrical conductivity of GaS, GaSe and InSe monocrystals increases and the density of energy states near the Fermi levels decreases, while the average range of leaps and the activation energy decrease [29,s.1040-1043], [34, p.11-12], [36, p.3-5].
3. It has been discovered that, while GaSe and GaSe <0.5at.% Tl> monocrystals in the variable current increase the radiation dose with γ-quanta at low frequencies, the actual part of the dielectric permeability decreases and the imaginary part increases, and the triple increase of electrical

conductivity occurs. The true and imaginary parts of these monocrystalline dielectric permeability at high frequencies ($f > 3,2\cdot10^{6}$Hs) do not depend on speed, as the radiation dose increases, the dispersion of the true part of the dielectric permeability decreases, and the dysfunction of the imaginary part increases. $5\cdot10^{4}$-$3,5\cdot10^{7}$ in the Hs frequency range, there is a step-by-step leap convergence at the local level near the Fermi level [11, s.180-181], [29, p.1040-1043].

4. When you absorb the p-GaSe <Tl> materials, the acceptor levels in the material increase and the permeability passes after a certain dose to be highly resistant to low resistance. In InSe-n-type, the acceptor levels compensate for donor levels and the transitional progression occurs gradually. InSe <Sn > n-type donor and the acceptor levels of compensation levels and the transition occurs gradually [38, p.109-111].
5. Based on physical and photoelectric findings, it has been found that, based on InSe monocrystals, it may be proposed for the preparation of high resolution photofilm ionizing receivers operating at a spectral range of 0.3-2 mkm. [40, p.106-108] .
6. Monosulfid single crystals constant electric field and T $\leq$230K-step rapid temperature change occurs conductivity . This physical event moves to an inactivated leak-free conductivity at the $F \sim 10^{4}$ V / cm tension of the field, with the mean distance R (T) and R (F) decreasing as the temperature and area tension increase. Accordingly T = 120K at the temperature, R (T) = 44Å and T = 232 K at R (T) = 37 Å ; R (F) = 83 Å with the field tension $F = 7.5\cdot10^{3}$ V / cm and the area tension $F = 1,25\cdot10^{4}$ V / cm R (F) = 73 as been determined [10, p.1958-1960].
7. The dielectric permeability of monosulfide monocrystals and the frequency dependence of electrical conductivity indicate that these materials have a strong dielectric relaxation. The cause of the mechanism of dielectric relaxation in the materials is the leakage of loaders between loaded centers. In monocrystals, the dielectric loss at $f<10^{6}$Hs for frequencies occurs at the expense of electrical conductivity, which is replaced by the velocity of the frequency at $f<10^{6}$Hs. The electrical conductivity at the frequency range 10^{6}-$3\cdot10^{7}$Hs is subject to the law of $\sigma_{ac}\sim f^{0,8}$, which is similar to the Fermi level leakage conductor locally at the local level.The resolution density near the Fermi level is $N_F=2,65\cdot10^{20}$ eV$^{-1}\cdot$sm^{-3}, the mean duration of the leaks $\tau=6,5\cdot10^{-8}$s, the

average distance of the leaps R = 78Å, and their localization radius a = 33Å has been made [39, p.158-160].

8. It was determined that $TlInS_2$ monocrystals in variable flux with γ-quanta with $1\cdot10^4$ rad and with electron flood, dielectric penetration up to $2 \cdot 10^{12}$el / cm^2 increases and decreases after dose of $2 \cdot 10^{12}$el / cm^2. The reason for this is the migration, division, distribution of defects in radiation datasheet defects and doses of $1\cdot10^4$ rad and over $2 \cdot10^{12}$el / cm^2, up to a dose of $1\cdot10^4$ and $2\cdot10^{12}$–$2{,}4\cdot10^{13}$ el/sm^2 .Irrespective of the dose of γ-radiation, the dielectric loss of the velocity 10^7Hs is due to electrical conductivity, which is replaced by the loss of the relapse after the 10^7Hs value. tgδ-change in the frequency range learned in the $TlInS_2$ sample, which has been infected with various dose electron floods, shows that the electromagnetic wave bias is bi-directional. When irradiated with γ -quanta, regardless of the dose, the electrical conductivity of the frequency to 10^7Hs is subject to the law of σ_{ac}~$f^{0,8}$, which corresponds to the leak-bearing mechanism of loaders at the local level near the Fermi level. At f>10^7Hs, the velocity dependence of the current intensity on the velocity goes to super-dependent dependence σ_{ac}~$f^{1,3}$ [5, p. 82-84].
9. It was determined that $TlInS_2$ single crystals voltamper characteristics (VAX) nonlinear part of the trend is due to the effects of changes in the area. The concentration of ionized centers in monocrystals is $N_t = 10^{12}$ cm^{-3}, the concentration of the load balancing p_o=$1{,}67\cdot10^{10}$cm-3, the factor of capture θ=0,17, the depth of the ionized centers is Et = 0,44 eV [9, p. 180-181].
10. When $TlInS_2$ monocrystals are illuminated by light, monopoly injection fluctuates as a result of the constrained current flow. For this reason, the monocrystals have a tendency to close the photography tension near the tension [9, p. 181].
11. When $TlInS_2$ is dosed with Dγ = 50 krad dose, the MDR is recorded in the VAX with the effect of γ-rays and it has N-shaped form. The disappearance after 10 days of physical change indicates that the process is rotating. This does not occur when the $TlInS_2$ monocrystals radiate with a higher dose (Dγ= 60, 80 and 100 krad) [17, p. 161-165].

12 .When radiating $TlGaSe_2$ monocrystals with γ-quanta with $3\cdot10^4$dose, dielectric permeability decreases relative to non-irradiated monocrystals, while dielectric penetration increases with $2.25 \cdot 10^4$ doses, but is less than when it is not always rising. The dielectric lossf=$4\cdot10^5$H sis then turned to the relaxation loss after the frequency of the electrical conductivity at f≥$4\cdot10^5$ Hs. Characterization of $TlGaSe_2$ with electrostatic discharge at full frequency intervals when electrostatic flare is flared shows that in both cases (irradiated and rashed) the loss is due to relapse. In $TlGaSe_2$ monocrystals, γ-quanta and electron flood irradiation at the speed of 10^6 Hs, the speed of $\sigma \sim f^{0.5}$ goes from to 10^6 Hs, and $\sigma \sim f$ to $^{0.8}$, with a leap mechanism close to the Fermi level. Strong dependence of dielectric susceptibility of $TlGaSe_2$ on the frequency and dose of gamma radiation make them perspective material for creation on their basis varicaps and dosimeters of gamma-radiation [32, s. 19-23].

13. AC $TlGaS_2$ single crystals γ-irradiation accumulated dose, the real part of the dielectric nufuzlugunun (ε') and reverie part (ε'') brings an increase in dispersion. All doses studied radiation frequency of $2 \cdot 10^7$ Hs and dielectric loss as the price electrical conductivity expense, frequency of $2 \cdot 10^7$ Hs and are replaced by the value of the loss after the relaxation. When electrons are exposed to electrons, the dielectric loss of $2\cdot10^{12}$ el/cm^2 and $6.2\cdot10^{12}$ el/cm^2 is replaced by the electrical conductivity at the rate of $2 \cdot 10^7$ Hs and the frequency of the loss of $2\cdot10^7$ Hs. After Hs value, it is replaced by loss of relaxation. $TlGaS_2$ dielectric loss in high doses (10^{13}el/cm^2) occurs due to electrical conductivity in all frequency ranges learned. The speed of the electrical conductivity varies from $2 \cdot 10^7$ Hs, with a fracture mechanism near the Fermi level, and $\sigma \sim f^{0,8}$, with the velocity of $2 \cdot 10^7$Hs from $3,5\cdot10^7$Hs, and the superline varies by law. In $TlGaS_2$ at 80K and 160K temperatures, E_{t1} = 0.14eV and E_{t2} = 0,32eV two local levels in the existing command variable has been set. There is a long-term decline in the load, which is due to the fact that the load depths of the loaders are trapped by traps E_{t1} = 0.14 eV. Non-sensitivity of dielectric susceptibility of $TlGaS_2$ single crystals to gamma- excitation gives evidence to their stability to radiation and opens perspectives for their applications in cosmic technique [3, 40-43], [31, s. 167-168].

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Address: 131 H. Javid ave, AZ-1143, Baku

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