Ag_2Te COMBINATION MADE OF SILVER AND TELLURE STUDY OF ELECTROPHYSICAL PROPERTIES

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The article presents the study of the electrophysical properties of Ag_2Te compounds alloyed with silver and tellurium. At the same time, an S-shaped VAX is observed in the p-Ag_2Te crystal, which can be used as a memory element. While studying the electrophysical properties of Ag_2Te compounds alloyed with silver and tellurium, the effect of radiation on them was also studied.

Keywords: Ag_2Te, electrical conductivity, thermoelectric coefficients.
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1. INTRODUCTION

One of the main tasks of modern energy converters is their use in environmental protection. Therefore, these converters are required not to generate toxic waste and radioactive contamination from the working materials. One such material is a binary silver tellurium compound. Silver tellurium compounds belong to the family of narrow semiconductors with low thermal conductivity and high electron conductivity. One of the important features of this combination is that they are defective due to deviations from stechiometry. These defects have a serious impact on electrophysical properties. In the crystallization of the Ag_2Te compound, tetrahedral and octahedral cavities create a large number of defects. Such defects are called structural defects. The main reason for their formation is that silver atoms with high mobility can leave the corner points in these tetrahedral and octahedral cages (inner cages), create a vacancy, move between the corners (on the plane surface of the crystal) and migrate from cage to cage permeability is formed [1]. Ag^+ ions (vacancies) formed in the inner cage play an important role in the formation of the thermal and electrical properties of this crystal. Rather, they (defects) seriously affect the energy spectrum of electrons and phonons in this crystal. As the temperature increases, the number of such defects increases and a structural phase transition occurs at ~ 410K. In this case, the low-temperature monocular structure changes to a cubic structure centered on the high-temperature surface. During this transition, the electrical conductivity (σ) decreases with a jump, while the Hall (R) and thermoelectric (α_0) coefficients increase with a jump [2].

2. METHOD OF EXPERIMENT

In this study was studied the effect of P=150M/rad electron radiation on n and p type Ag_2Te crystals. It was found that the n-Ag_2Te crystal is not exposed to this radiation. In the p-Ag_2Te crystal, S-shaped VAX was observed before and after irradiation. In this case, the threshold voltage decreased as a result of radiation, which was explained by the formation of radiation defects and the inelastic nature of the electron-electron interaction.

The silver tellurium crystal has an abnormally high unipolar ionic conductivity (superion conductivity) (1 $Om^{-1}cm^{-1}$) [3], which is due to the high-velocity migration of silver atoms in its inner cage. It is clear that crystals with such superconductivity can increase or decrease their conductivity, depending on the direction of the external electric field. This means that an external electric field can increase or decrease the energy of defects in these crystals. Since such defects are likely to occur under the influence of radiation, an increase in the concentration of these defects in the Ag_2Te crystal should be observed. To do this, we had to study some of the properties of this crystal before and after exposure to radiation. Samples were taken for 10 days at a dose of 150 M/rad with γ radiation from the C_0^{60} radiation center.

Figure 1.1 and 1.2 shows the volt-ampere characteristic (VAX) of the n-Ag_2Te crystal before and after radiation. In Figures 1.3 and 1.4, these dependencies are given for the p-Ag_2Te crystal.

Figure 1.1 shows that the effect of radiation on the n-Ag_2Te crystal is very weak. Figure 1.3 and 1.4 shows that the effect of p-Ag_2Te radiation is significant. On the other hand, the p-Ag_2Te crystal is VAX S-shaped. If the change in J (V) dependence before irradiation starts at ~ 30mA and 0.85, then after irradiation this change is observed at ~ 0.25mA and ~ 0.2V.

Figure 1.1 shows that the effect of radiation on the n-Ag_2Te crystal is very small.
This problem can be explained as follows: the volume of the crystal (here n-Ag_2Te) is divided into domains formed by different signaling charges (Ag^+ and Te^{-2}). Here, the Ag + cation of the domain does not occupy certain positions, and there is a close regularity for the distribution of loads in one domain.

In this case, because the energy of the domain corresponding to one Ag + cation is large, the energy

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of the other radiation is not enough for its migration, and as a result, the possibility of new defects is less.
On the other hand, if we assume that the main energy of the domain falls on the share of Ag + cation, and the irregularity changes very little due to it, then it can be said that the current radiant energy was not enough to increase the mobility of Ag + cation. This can be explained by the fact that in the Ag_2Te superion crystal, the concentration of defects caused by the migration of Ag + cation before irradiation is so large that (approximately ~ 10^{20-22} cm^{-3} [4]) the defects caused by radiation could not manifest themselves in the general picture.

Figure 1.2 shows that p-Ag_2Te is S-shaped before and after VAX irradiation. However, after irradiation, this picture changes relatively. (straightens). The reason for this can be analyzed as follows: as shown in Figure 1.2, at a threshold voltage of ~ 0.85V, the resistance varies from a relatively low to a high value. Typically, this phenomenon occurs due to the conduction of currents (micro-wires separated by electrical insulation), where [3] the current density in the conductors is greater than the current density per unit thickness. As the voltage increases to ~ 0.85 V, a oscillating process is observed in the lower resistance range, which may be due to the instability of the current in the wires [4].

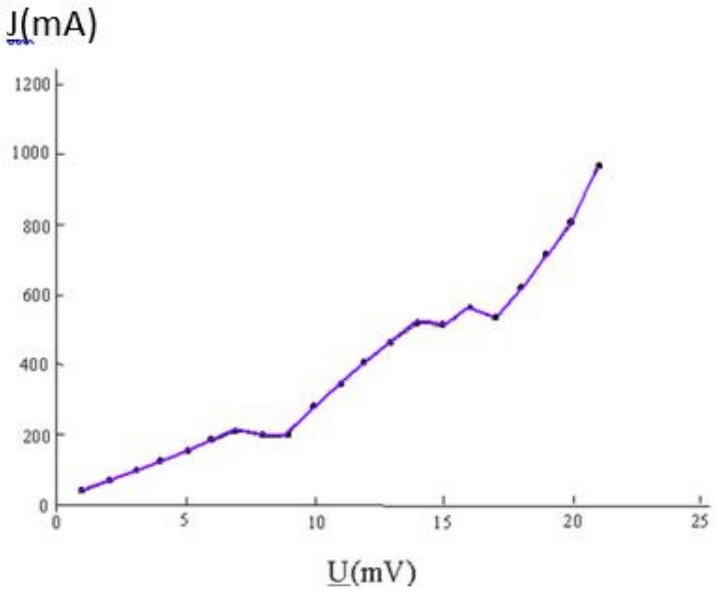

Fig. 1.1. Volt-ampere characteristic of Ag_2Te n-type crystal (before -radiation).

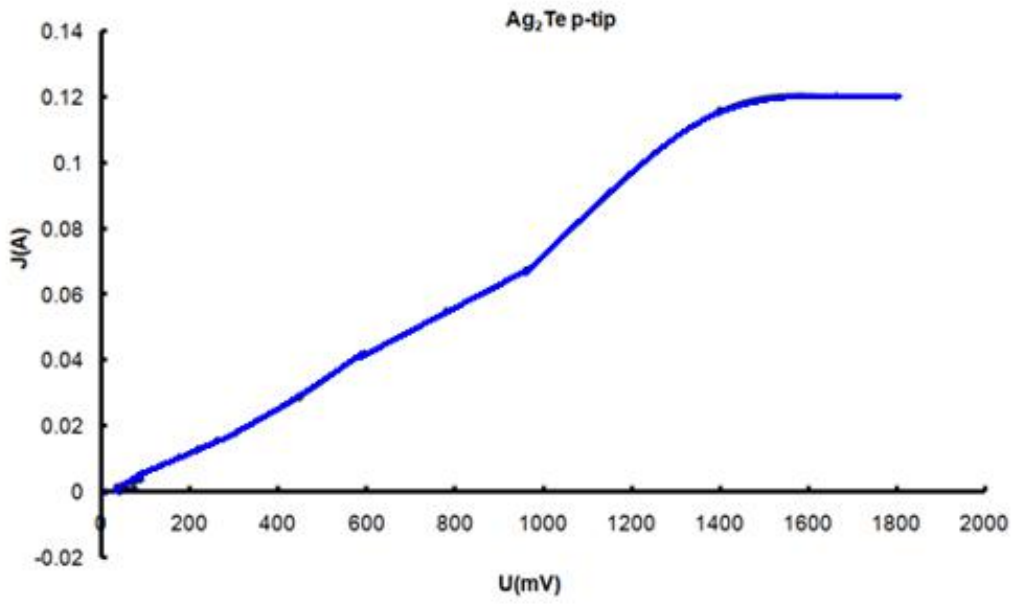

Fig. 1.2. Volt-ampere characteristic of p-Ag_2Te (after irradiation).

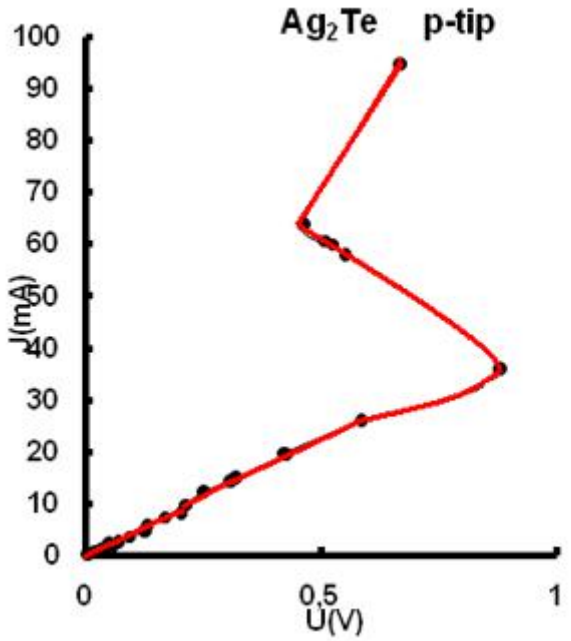

Fig. 1.3. Volt-ampere characteristic of p-Ag_2Te crystal (before -radiation).

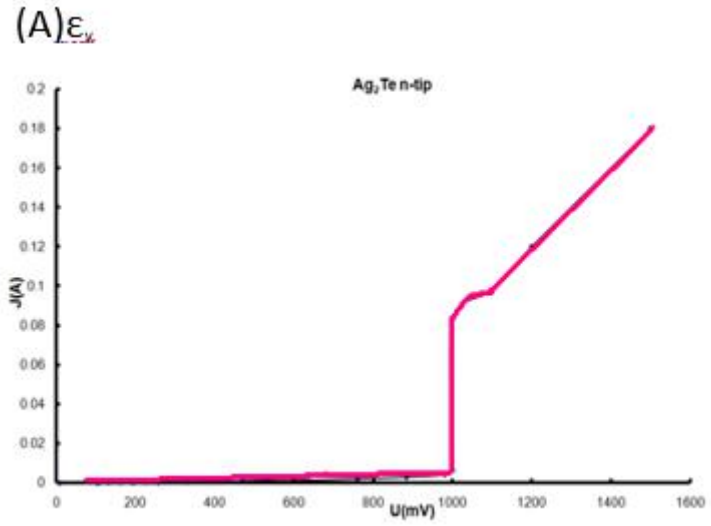

Fig. 1.4. Volt-ampere characteristic of n-Ag_2Te crystal D = 150M / rad (γ −after irradiation).

Here, as the voltage decreases, a "hysteresis" is observed in the VAX, which cannot return to a higher resistance.This means that the opposite effect is observed in the sample, ie the sample returns to a low resistance instead of returning to its previous state (high resistance) at the value of voltage: ~ 0.5V in case I- and ~ 0.3V in case II. In this case, the resistance: ~ 1.8 times in case I, ~ 20 times less in case II. (Before I-radiation, and after II-radiation). This means that the memory effect is different in both cases. The change in threshold voltage after irradiation indicates that in case II there are enough defects and they are electroactive in nature (are electronegative). In both cases, the current density is unstable.

In both cases, one of the main reasons for the instability of the current in the crystal may be related to the coul heat released here. This is due to the temperature dependence of the electrical conductivity inherent in semiconductors:

$$\sigma(T) = \sigma_0 \exp(-\Delta E / K_0 T) \quad (1.1)$$

Here, the ΔE _activation energy of the K_0 - conductor is Bolsman's constant.

In S-shaped VAX, a positive effect is important for instability, which is due to an increase in conductivity due to an increase in current $\Delta E / K_0 T$, which also leads to an increase in current, and as mentioned above, there is a positive negative effect.This process continues until a phase transition occurs due to the heating of the $\Delta E / kT_n = 1$ sample.

For the Ag_2Te crystal $T_n \approx 410K$ [2]. At this temperature, the crystal Ag_2Te undergoes a structural phase transition with a metal-semiconductor transition. This phenomenon (positive negative effect) can be expected in every noise in the sample. In all of these cases, a rotating memory effect is created, resulting in a key that depends on the resistance.

This phenomenon is called the electron-heat effect, which plays an important role in the formation of S-shaped VAX. In this case, the thermomechanical and electrical properties in the sample are in a sense united. As can be seen in the figure, the radiation exacerbated this effect. Another explanation for the S-shaped VAX may be that the electron-electron interaction in the scattering is inelastic. It is known that inelastic interactions occur when the scattering of charge carriers from the lattice ions is weak.

Since the research was conducted at relatively high temperatures, the validity of this assumption is relatively questionable. However, due to the unipolarity of the conduction, after a certain value of voltage (~ 0.85V before radiation and then ~ 0.2V), new defects begin to appear, depending on the direction of the external field, in which case these defects behave like ionic additives. Because the main role in the Ag_2Te crystal is played by Ag +, it can be shown that after a certain value of the electric field, the field energy is greater than the energy of defect formation. During this interval, their concentration increases, and as a result, because they are unstable, they retain their previous positions after the field is cut. Therefore, in this S-shaped interval, the probability of scattering of carriers from Ag + ions prevails. It has been shown that [7] the interaction of ions in superion crystals is inelastic [3]. This also leads to the fact that the electron-electron interaction in the Ag_2Te crystal is inelastic when the charge carriers are scattered from the ion detection center. The fact that the S-shape occurs in a small area after irradiation can be explained by the fact that the defects caused by-γ-rays are more unstable than before.

CONCLUSION

Studies of n- and p-*Ag_2Te* crystals have shown that n-*Ag_2Te* is not exposed to radiation due to its high defect concentration during synthesis. The p-*Ag_2Te* crystal is exposed to this radiation. At the same time, an S-shaped VAX is observed in the p-*Ag_2Te* crystal, which can be used as a memory element.

1. Silver tellurium crystal with a concentration of $3.0.10^{18}$ cm^{-3} can be used as a working material in Ettingganzen refrigerators at optimal temperatures (~ 100 and 300K) in nuclear reactors.
2. The p-Ag_2Te crystal can be used in $\alpha \to \beta$ phase transitions to amplify weak electrical signals in electronics.

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