TRANSPORT PROPERTIES OF SOLID SOLUTION $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$

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The temperature dependences of the electrical conductivity and thermal power $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$ have been studied in the temperature range of 80-550 K. The temperature dependence of the electrical conductivity passes through a maximum in the region of 200K. A sharp jump in the temperature dependence of the thermal power in the region of 400 K was also found. The *X*-ray structural analysis show, that $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$ has a face-centered cubic structure with a lattice constant a=6.1390Å

Keywords: thermoelectric material, thermal power, electrical conductivity, crystal structure
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1. INTRODUCTION

$AgSbTe_2$ is a promising p-type thermoelectric material operating in the middle temperature range. Deviation from stoichiometry and the introduction of impurities are widely used in the study of $AgSbTe_2$, since this makes it possible to find more suitable compositions for practical application [1-3]. One of the most attractive thermoelectric materials is $AgPbmSbTe_{2+m}$, which can be considered as a combination of PbTe and $AgSbTe_2$ in the form $(AgSbTe_2)(PbTe)_m$. These compounds are called LAST-*m* (lead antimony silver telluride). LAST-*m* compounds have several distinctive properties, which make these compounds attractive. First, both $AgSbTe_2$ and PbTe crystallize in the structure of the cubic lattice, which allows obtaining a series of solid solutions. For LAST-*m* compositions, Vegard's law is satisfied depending on the lattice constant-composition. On the other hand, these compounds have an unusually low thermal conductivity of the lattice. Finally, LAST-*m* materials are thermally stable until they melt (<1200 K) [4].

Note that the study of $(AgSbTe_2)_X(PbTe)_{1-X}$ compositions is also interesting in that both $AgSbTe_2$ and PbTe crystallize in the structure of the cubic lattice, which allows obtaining a series of solid solutions. And this makes it possible to obtain compositions with different concentrations, which affects the electrical properties.

This paper presents the results of the study of structural and transport properties $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$ in the temperature range of 80-550 K.

2. EXPERIMENTAL RESULTS AND DISCUSSION

The studied samples were obtained by fusing the initial components in sealed quartz ampoules with an exposure of 10 hours to 100 K above the melting point with further slow cooling at a rate of 1 K/min. to room temperature.

The obtained results of *X*-ray diffraction analysis of $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$ are shown in fig. 1. *X*- ray diffraction analysis was performed on a BRUCKER-D2 PHASER diffractometer. According to the results of *X*- ray structural analysis $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$, it has a face-centered cubic lattice with a lattice constant a=6.1390$\AA$, and corresponds to the space group Fm3m.

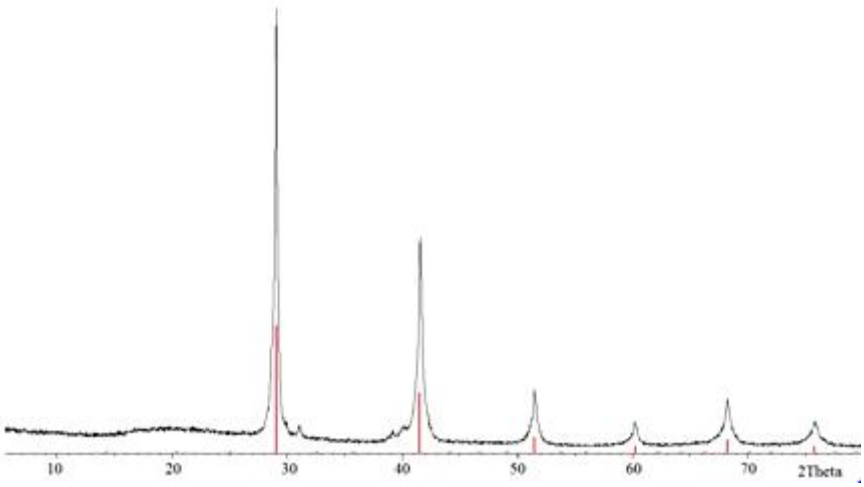

Fig. 1. The *X*-ray diffractogram of $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$

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Electrical measurements were carried out by the four-probe potentiometric method in the temperature range of 80-550K. Potential contacts were deposited with indium. Temperature and temperature gradient were controlled by copper-constantan thermocouples. The sign of the thermal power over the entire temperature range studied is positive, which indicates a hole conduction mechanism. According to the measurements of the Hall effect, the concentration of charge carriers of $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$ was $p = 3.7 \cdot 10^{18}$ cm^{-3}.

The temperature dependences of the resistivity and thermal power of the investigated sample are shown in fig. 2 and fig. 3, respectively.

It was found that the temperature dependence of the electrical conductivity passes through a maximum in the region of 200K. Further, in the temperature range 200-400K, the value of electrical conductivity decreases. However, in the region of 400K, the value of electrical conductivity decreases sharply, then passing through the minimum begins to grow.

Three areas can be distinguished in the temperature dependence of the thermal power: *a*) the constancy of the thermal power value in the region of 100–300 K; *b*) an increase in the thermal power value in the temperature ranges 300- 400K and above 450K; *c*) a sharp jump in the temperature dependence of the thermal power in the region of 400K. A comprehensive analysis of the transport properties suggests that acceptor levels are located near the ceiling of the valence band. Electron capture at these levels leads to an increase in the concentration of holes, as a result of which the value of electrical conductivity increases (temperature range up to 200K). Further, in a rather wide temperature range of 200– 400K, strong scattering of charge carriers on acoustic phonons takes place, as a result of which the value of electrical conductivity decreases with increasing temperature. A sharp jump in the temperature dependences of the thermal power and electrical conductivity at 400K is due to the presence of the second phase Ag_2Te.

The ternary compound $AgSbTe_2$ crystallizes in a face-centered cubic structure of the NaCl type, in which the Ag and Sb atoms are disordered in the places of Na. At the same time, both Ag^+-Ag^+ atoms and Sb^{3+}-Sb^{3+} atoms can be located adjacent to each other. Energetically more beneficial are the Ag^+-Sb^{3+} location. According to [5], $AgSbTe_2$ contains regions ordered and disordered by Ag and Sb atoms. Such structural disorder can lead to precipitation of the Ag_2Te phases, which strongly influences the temperature dependences of transport coefficients.

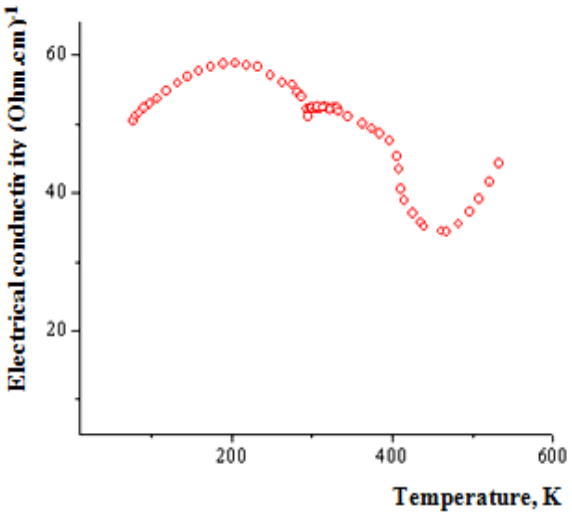

Fig. 2. The temperature dependences of the resistivity of $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$

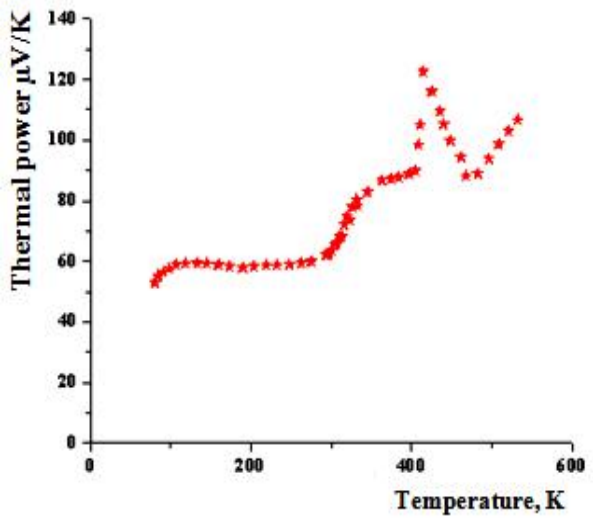

Fig. 3. The temperature dependences of the thermal power of $(AgSbTe_2)_{0.8}(PbTe)_{0.2}$

3. CONCLUSION

A sharp jump in the temperature dependences of the thermal power and electrical conductivity at 400K is due to the presence of the second phase of Ag_2Te, due to the energetically more favorable arrangement of Ag^+ -$Sb3^+$ atoms with temperature.

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