THE THERMOELECTRIC MATERIAL FOR TRANSFOMATION OF THERMAL ENERGY

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ABSTRACT

It was obtained the single-phase thermoelectric material $AgSbTe_2$. It was carrying out the temperature dependencies of thermoelectric properties in 80-350K temperature intervals. The obtained relatively high value of specific sensitivity of $AgSbTe_2$ is allowed to use this material as p-type sensing stuff for transformation of heat energy.

Keywords: thermoelectric material, heat radiation, figure of merit, specific sensitivity

I.INTRODUCTION

In connection with the perspective of the thermoelectric way of direct conversion of thermal energy into electric energy, it is important to find semiconducting materials whose parameters ensure high efficiency values of the thermoelectric devices.

As is known, the main requirements imposed on heat detectors, in the final accounting, are connected to selection of a stuff used as a sensibility element. Depending on what areas the receiver will work in, the requirements of a used thermoelectric stuff vary also. If the stuff will be used in devices of cooling, the main requirement is the high value of thermoelectric figure of merit - Z, determined as

$$Z = \alpha^2\sigma/\kappa \quad (1)$$

where α – thermal power, σ - electrical conductivity, k - heat conduction of a stuff [1]. If the stuff will be used in devices of a reception, of heat radiation, the main requirement is the high value of specific sensitivity δ, determined as $\delta = \alpha/\kappa$ [2].

The given work is devoted to research of thermoelectric properties of a sample $AgSbTe_2$.

II. EXPERIMENTAL RESULTS AND DISCUSSION

$AgSbTe_2$ is one of the promising p-type semiconductor for the thermoelectric generation and its properties have been investigated by several authors [3-5].

It is known that single-phase of $AgSbTe_2$ is not stable at room temperature and the crystals prepared by usual method contain the precipitates of Ag_2Te [3,4].

The single –phase crystal was obtained by as follows: $AgSbTe_2$ alloy, surrounded by graphite powder in order to ovoid cracks was sealed in evacuated quartz tube and then melted at about 800^0C. Lowering down the alloys from the end gradually to region of ambient temperature of about 500^0C in the furnace and then quenched into ice bath.

The electrical conductivity, thermal conductivity and thermoelectric power were measured in the range of temperature 80-350 K.

In fig.1 are presented the temperature dependencies of electrical conductivity, thermal conductivity and thermoelectric power of measured sample. As it is seen from a fig.1, thermal power with increase of temperature rise, reaching the maximum value in 350 K region. Thus the heat conduction slowly increases with temperature.

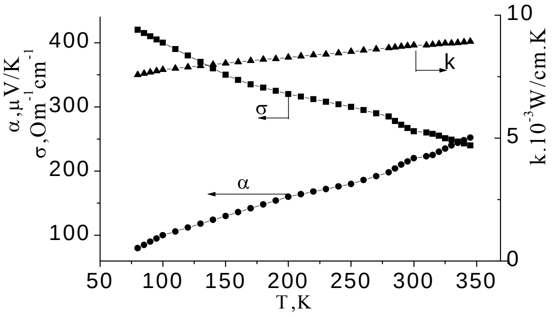

Fig.1. The temperature dependences of a specific conductivity σ, thermal power α and heat conductivity k of $AgSbTe_2$

As is known [1] there are three fundamental requirements for desirable thermoelectric materials. The first requirement is the development of a high electromotive force per degree difference in temperature between junctions in a circuit containing two thermoelectric junctions. This property is referred to as the thermoelectric power of the material (α), and may be defined as dU/dT, where dU is the potential difference induced by a temperature difference dT between two junctions of an element made of the material. As is seen from fig.1 the value of the thermal power at the room temperature region is high. The second requirement is a low thermal conductivity (k), since it would be difficult to maintain either high or low temperatures at a junction of a thermoelement if the material conducted heat too readily. As is seen from fig.1 the investigated sample as so the other Ag-Sb-Te system specimens [5,6] has a very low thermal conductivity. The third requisite for a good thermoelectric material is high electrical conductivity (σ). This requisite is apparent since the temperature difference between two junctions will not be great if the current passing through the circuit generates excessive Jolean heat.

A quantitative approximation of the quality of a thermoelectric material may be made by relating the above three factors in a figure of merit Z. The obtained value of Z by relation (1) at room temperature was $1,8.10^{-3}$ K^{-1}.

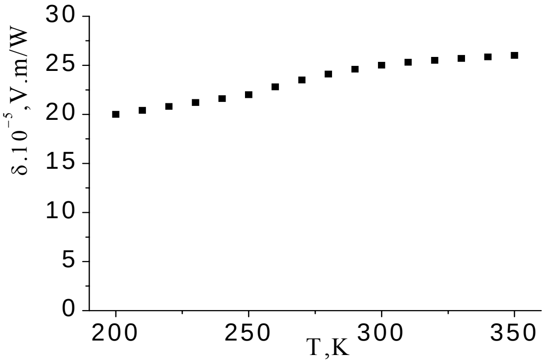

Fig. 2 The temperature dependence of specific sensitivity of $AgSbTe_2$

However, the value of specific sensitivity δ, determined as $\delta = \alpha/\kappa$ was higher than other thermoelectric materials [1]. In fig.2 is presented the temperature dependence of specific sensitivity of $AgSbTe_2$. As is seen, the specific sensitivity reaches the maximum value also in temperature area 300-350K and is remained nearly constant in widely temperature interval.

III. CONCLUSION

It allows using this stuff as a p-branch in different head detectors. The rather high value of a Zeebek factor (200-300 μV/K) at room temperature gives value for specific sensitivity 1,2 times more, than in samples of a system Bi-Te.

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