OPTICAL PROPERTIES OF THE FILMS Bi_2Te_3-Bi_2Se_3

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ABSTRACT

The methods optical reflection (in area 1÷6,5*eV)* and capacit (in the field of 1-3,5 *eV)* spectra of film samples Bi_2Te_3-Bi_2Se_3 of *p*-type with impurity *Tb* and *n*-type conductors with impurity *Cl* are investigated. In dependence of factor of reflection *(R)* from energy *(E)* submitting radiation at 1,1 and 1,45 *eV* more intensive peaks specifying presence of interzoned transitions are observed.

Keywords: optical, reflection, capacity, conductors, film.

I. INTRODUCTION

System Bi_2Te_3-Bi_2Se_3 is the most effective electronic thermoelectric material of refrigerating thermoelements and termoelectrogenerators in an interval of temperatures 200-550*K*. Above 550*K* it concedes to a number middle temperatures materials. For the first time the thermoelectric material on basis Bi_2Te_3-Bi_2Se_3 has been synthesized and investigated by S.Sinani [1]. The best thermoelectric properties possessed structure of 80%(pier)Bi_2Te_3 -20% (pier)Bi_2Se_3 with in the width of the forbidden zone 0.27*eV* at room temperature [2].

Bi_2Te_3-Bi_2Se_3 forms a continuous line of firm solutions. It means, that in chains Te_I -Bi-Te_{II} -Bi -Te_I atoms of tellurium in any quantity (from 0 up to 100 %) can be replaced by their analogue selenium that promotes flexibility of technology, and all over again atoms of selenium replace all atoms Te_{II}, and then atoms Te_I. Bi_2Te_3 –Bi_2Se_3 (structure of 20%Bi_2Te_3) crystallizes in heksogonal to structure with parameters of a lattice a = 4,296*Å* and c=5,988*Å* [3]. Calculations of zoned structure of semiconductors such as $A_2^{IV} B_3^{VI}$, and also a number of experiments on research of optical properties specify that the electronic spectrum in Bi_2Te_3 has three-dimensional character [3]. Thus, value of effective weight electrons the given structure reaches the maximal value $m_n^* = 1{,}2\ m_0$ rather big size of the forbidden zone is the important factor for use of this material in thermoelements up to temperatures 600-650*K*.

II. MAIN PART

At synthesis of polycrystalline samples initial components together with alloying additives are alloyed in quartz ampoules at temperature 1000*K* [4]. At impurity copper as have shown the lead long researches, properties of samples in due course changes [5].

Task of the given work was research of spectra of reflection and capacit films Bi_2Te_3-Bi_2Se_3 *n*-and *n*-type the conductivity, alloyed *Tb* and *Cl.*

In work [6] the way of reception films Bi_2Te_3-Bi_3Se_3 is considered.

Us are received alloyed binary a film by thickness 300*Å* cathodic dispersion on usual glass, on the glass covered with a carbon film, mica and on *NaCl*. On a side (100) stone salts in a range 500-700*K*, tecstureis or crystalleds in a plane (001) parallel to a substrate have been used a film, formed on carbon.

The basic donor - the alloying additive was *Cl*. This impurity was entered with the purpose of change such as conductivity of a material and increase its thermoelectric efficiency. The maximal values $\alpha^2\sigma$ are achieved at alloying structure by chlorine up to 0,3 %(mol.) as $CdCl_2$. In the given work results of researches on massive samples *p*-and *n*-type Bi_2Te_3 are resulted, at normal falling light directed parallel and is perpendicular to a plane break at 300*K* with the purpose of comparison of results of the given work to results of work [4] where various minima of factors of reflection at 1,11*eV*, probably correspond to three different effective weights.

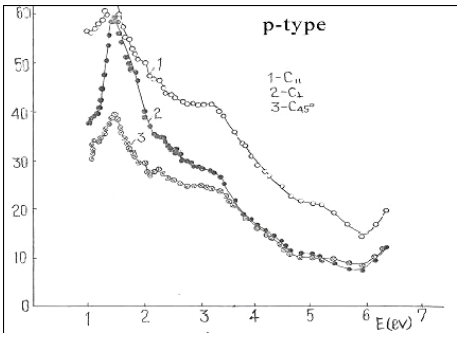

Fig.1. Spectra of reflection of monocrystals p-Bi_2Te_3 with impurity *Se* and *Te:*1-along ($c_{//}$), it is 2-perpendicular ($c_{\perp}$), 3- a direction 45° to an axis *c*.

The reflection spectra were investigated [4] on massive samples Bi_2Te_3 *p*-type as the conductivity, containing impurity terbium and *n*-type the conductivity, containing impurity of chlorine.

In dependence of factors of reflection *(R)* from energy of falling radiation *(E)*, as *p-,* and *n*-type conductivity lengthways ($c//$), perpendicularly ($c\perp$) and in a direction 45º to axis *c* of a crystal at 1,1 and 1.45 *eV* more intensive peaks are observed.

In work spectra of reflection of film samples Bi_2Te_3-Bi_2Se_3 *p*-type as the conductivity, containing impurity terbium, and *n*-type the conductivity, containing impurity of chlorine also have been investigated.

In dependence of factors of reflection *(R)* films Bi_2Te_3-Bi_2Se_3 from energy of radiation *(E)* for *n*-type of conductivity (fig.2), at 1,1eV and 1.45eV intensive peaks are observed. Repeating two splittings at 1,1eV and 1.45eV in spectrum Bi_2Te_3 authors [3] interpret orbital splitting of a valent zone and a zone of conductivity as backs. For *n*-type films peaks are observed at 3,8 *eV*

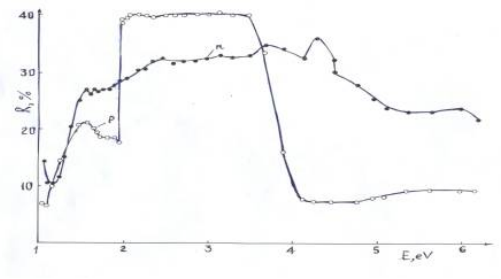

Fig.2. Spectra of reflection of a film polycrystal p-Bi_2Te_3- Bi_3Se_3 with impurity *Tb; n-* Bi_2Te_3-Bi_3Se_3 with impurity *Cl.*

It will be coordinated to the data [4] specifying presence in films Bi_2Te_3-Bi_3Se_3 in an interval 0,2-1,8eV of strong interzoned transitions.

Dependences of a spectrum of reflection film Bi_2Te_3-Bi_3Se_3 *p*-type as the conductivity, alloyed *Tb,* and *n*-type as conductivity an impurity of chlorine from length of a wave, are given on fig.2.

With increase of thickness films up to 3 microns at temperature is higher 500*K* at evaporation a structure change randomly focused polycrystal. We receive alloyed polycrystals by thickness films 0,30; 0,35; 0,40 microns. Thus, at research of spectra of reflection of monocrystals Bi_2Te_3-Bi_2Se_3, both *p*-type with impurity *Tb*, and *n*- with impurity $CdCl_2$ weak and more intensive peaks which contacts transitions in critical points of the Brillouin zone were observed.

From dependence of factors of capacit *(T)* film Bi_2Te_3-Bi_2Se_3 *p*- and *n*-type as conductivity, reduce in figure 3 it is visible, that in the field of 1eV film Bi_2Te_3-Bi_2Se_3 *p*-type conductivity capacits light energy on 16 %, and *n*-type conductivity - 10%. These of a film can be used for manufacturing termobatteries.

It is known, that at manufacturing film termobatteries special coverings with the big factors capacit are required.

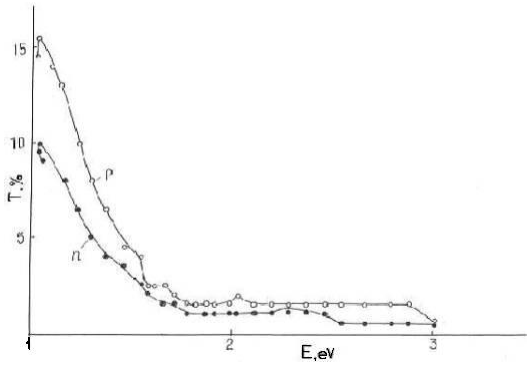

Fig. 3. Spectra capacity a film polycrystal p-Bi_2Te_3-Bi_3Se_3 *with* impurity *Tb; n-* Bi_2Te_3- Bi_3Se_3 with impurity *Cl*

For reduction of influence of oxygen by a film at heigteneds temperatures during its operation and also exception electric abridgement thermoelectric branches at creation of multilayered compact batteries to such coverings the following requirements are presented: continuty at thickness less than 1 microns, high electric durability, low heat conductivity, thermostability. The polymeric coverings widely used in microelectronics in quality stabilize and insulating of coverings, possess a high penetrative voltage (more than 10^6 *V/sm*), specific resistance (more than 10^{10} *Om/Sm*), low specific heat conductivity {æ = (3-4)10^{-3} *Vt/sm*. K} [7], high durability at elastic deformation, high chemical stability various inorganic solvents. On the specified properties polymeric coverings it is more preferable, than inorganic dielectric materials (CuO_2, MgF_2, etc.).

III. CONCLUSION

In summary it is possible to tell, that in dependence of factors of reflection *(R)* of the films p-Bi_2Te_3-Bi_2Se_3 from energy of radiation for *n*-type of conductivity, at 1,1 and 1.45eV, for *n*-type of conductivity at 3,8eV the intensive peaks specifying presence in the films in an interval 0,2-1,8eV, interzoned transitions are observed. Repeating two splitting 1,1 *eV* and 1.45eV in a spectrum are interpreted as back - orbital splitting of a valent zone and a zone of conductivity. From dependence of factors of absorption *(T)* films Bi_2Te_3-Bi_2Se_3, *p*-and *n* type carry out it is visible, that in the field of 1eV film Bi_2Te_3-Bi_2Se_3 *p*-type conductivity absorb light energy on 16 %, and *n*-type conductivity - 10 %.

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