THE INFLUENCE OF THE RADIATION BY ELECTRONS ON ELECTROPHYSICAL AND OPTICAL PROPERTIES OF THIN MONOCRYSTAL FILMS $Pb_{1-X}Mn_XTe$

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In the given paper the influence of electron radiation on electrophysical and optical properties of $Pb_{1-x}Mn_xTe$ (x=0.04) epitaxial films, obtained by condensation method of molecular beams on BaF_2 substrates (III).

It is established, that the samples become more photo-sensitive after radiation.

These materials present the big scientific interest and attract the investigators' attention because of the wide use of narrow-band semiconductors $A^{IV}B^{VI}$ in optoelectronic devices. They are used at the production of different devices of infrared technique [1]. The set of the methods for the obtaining of homogeneous epitaxial films of perfect structure of these materials with given thickness, composition and concentration of charge carrier has been treated [2].

The insignificant quantity of refs, dedicated to obtaining, investigation and application of epitaxial films $PbS_{1-x}Se_x$ $PbSe_{1-x}Te_x$ takes place. However, we don't have the works, which are dedicated to the influence of the radiation by electrons on electro-physic properties of thin films $Pb_{1-x}Mn_xTe$.

The crystal structure and physical properties of the films mainly are defined by substrate's parameters. It is desirable the maximal coincidence of lattice parameters, coefficients of thermal expansion of substrate and evaporated film. The use of monocrystal planes of the given compounds or solid solutions in the capacity of substrates allow to achieve the total coincidence of all parameters. From the other side, the epitaxial films and structures obtained on isolated dielectric substrates present big practical interest.

In the given paper the growth peculiarities of epitaxial films $Pb_{1-x}Mn_xTe$ (x=0.04), grown on new-chipped border of BaF_2 (111) and on polished planes (100) by method of condensation of molecular beams, are considered. The choice of BaF_2 in the capacity of the substrate is caused by the fact, that it has cubic structure of CaF_2 type with parameter of elementary cell 6,·19Å, it is gauzy in spectral range 3÷12 mcm, it is dielectric and has well mechanic density and chemically inert.

The epitaxial films $Pb_{1-x}Mn_xTe$ on BaF_2 substrates, obtained by the method of molecular-beam epitaxy [3,4] are also investigated. The film width was near 0.5÷1mcm.

The measurements were treated on the structures, created by two silver contacts, obtained by the evaporation in vacuum. The width of actuation length was 0.5-1.5cm at the gap value from 16 till 64 mcm. The variable air-gap and ohmic structure conductivities can be measured on the standard scheme.

The epitaxial films are grown by the methods of condensation of molecular beams in the vacuum 10^4 Pa. The source of molecular beams were alloys $Pb_{1-x}Mn_xTe$ (x=0,04), before synthesized by corresponding chemical composition.

The additional compensating source of the steams Te in growth process was used with the aim of the obtaining of the films with more perfect structure and needed values of electro-physic parameters. The investigations show, that epitaxial growth takes place at substrate temperature T_n=473÷523K. The films with more perfect structure ($W_{1/2}$=90÷100), width 0,5÷1 mcm are obtained at the condensation velocities 8÷9Å/sec and T_n=613÷653 K.

The initial samples were obtained at the room temperature on linear accelerator of electrons ELA-6 (E=5MeV, $d\Phi/dt$~10^{12}cm^2·sec^{-1}, $\Phi \le 7\cdot10^{17}$cm^{-2}). The temperature dependencies of specific resistance of each sample ρ were measured before and after radiation (fig.1).

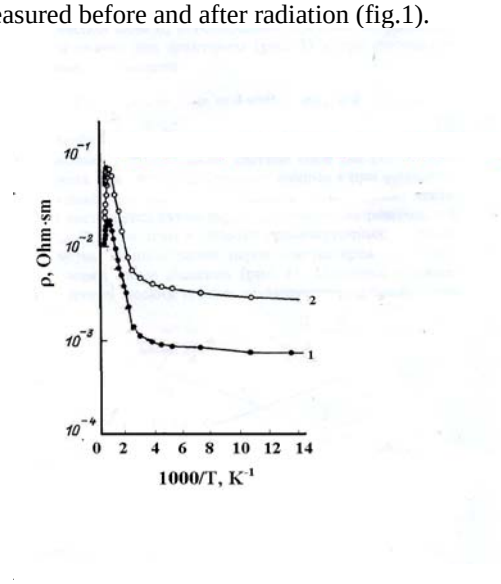

Fig.1. The temperature dependences of specific resistance, radiated by electrons ($\Phi=5\cdot10^{17}$cm^2),
1 - the sample before radiation;
2 – the sample after radiation.

It is established, that all investigated samples have firstly slow decrease, and after slow increase of specific resistance ρ at temperature 77K at radiation by electrons. Moreover, the more significant changes are character for the samples with lowest initial electron concentration.

The character of the dependencies ρ *(1/T)* of samples with high initial concentration of electrons after radiation doesn't change. The activative region, connected with own ionization of charge carrier appears in temperature region, which are close to the room one.

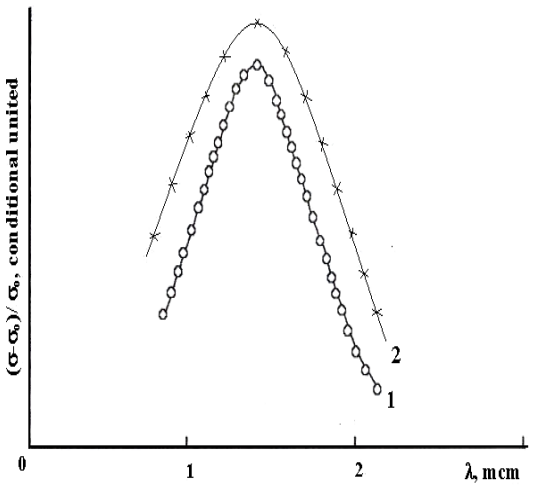

Fig.2. The spectrum of photoconductivity of films $Pb_{1-x}Mn_xTe$ (x=0,04) (x=0,04), fixed at temperature 77K
1 – the sample before radiation;
2 – the sample after radiation.

At the same time the experimental data, obtained [5,6] at the investigation of crystals of *p*-type don't allow to predict with accuracy the change character of melts' parameters of *n*-type at the radiation: in the dependence on the ratio of generation velocities of defects of donor and acceptor character, the radiation of crystals of *n*-type can lead as to the conversion of *p*-*n*-type ($dN_d/d\Phi<dN_a/d\Phi$) , so to the increase of electron concentration in conduction band till the stabilization of Fermi level on energetic level of defects of donor type ($dN_d/d\Phi>dN_a/d\Phi$). Besides, the question about energetic position of radiation level of donor type and character of reconstruction of energetic spectrum of radiated melts at the variation of the content of tin in the melts isn't clear.

That's why the investigation of deep radiation by electrons on electrophysic properties of unalloyed monocrystals $Pb_{1-x}Mn_xTe$ (x=0,04) with the aim of the definition of parameters of energetic spectrum of charge carriers for these materials, clearness of the change character of their properties and in particular, the possibility of the achievement of limit material characteristics in the result of the radiation was the common task of the given paper.

On the base of the treated mode the high-ohmic epitaxial films $Pb_{1-x}Mn_xTe$ of *n*- and *p*-type conductivity with *n*, ρ(77K)=$4\cdot10^{15}\div1.5\cdot10^{16}$cm^3 concentration and mobility of charge carriers μ (77K)=$2.5\div3\cdot10^4$cm^2/V·sec have been obtained. The films with different types of conductivity were obtained by the temperature change of main $Pb_{1-x}Mn_xTe$ and compensating source Te. It is established, that at the above mentioned conditions the epitaxial films are photosensitive at the temperature of liquid nitrogen (77K) (fig.2).

As it is seen from the picture the maximum of spectrum of photoconductivity of $Pb_{1-x}Mn_xTe$ films (x=0,04) is shifted to the side of more short waves in the comparison of the similar spectrums for other compositions of given solid solutions ($0\le x\le0,04$) given in the ref [7], that is explained by the increase of the width of prohibited band with increase of manganese quantity in investigated samples. From the fig.2 it is seen, that the samples were become more sensitive after the radiation.

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Pb_{1-x} Mn_x Te ƏSASLI NAZİK TƏBƏQƏNİN ELEKTROFİZİKİ VƏ OPTİK XASSƏLƏRİNƏ ELEKTRON ŞÜALARININ TƏSİRİ

Bu işdə molekulyar kondensasiya üsulu ilə BaF_2 altlıq üzərində alınmış Pb_{1-x} Mn_x Te (x= 0,04) nazik təbəqələrinin elektrofiziki və optik xassələrinə elektron şualanmasının təsiri tədqiq edilmişdir. Müəyyən olunmuşdur ki, şualanmadan sonra nümunələrin optik həssaslığı artır.

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ВЛИЯНИЕ ОБЛУЧЕНИЯ ЭЛЕКТРОНАМИ НА ЭЛЕКТРОФИЗИЧЕСКИЕ И ОПТИЧЕСКИЕ СВОЙСТВА ТОНКИХ МОНОКРИСТАЛЛИЧЕСКИХ ПЛЕНОК Pb_{1-x} Mn_xTe

В настоящей работе исследовано влияние облучения электронами на электрофизические и оптические свойства эпитиаксиалных пленок Pb_{1-x} Mn_x Te (x= 0,04) полученных методом конденсации молекулярных пучков на подложках BaF_2 (ÛÛÛ).

Установлено, что после облучения образцы становятся более фоточувствительными.

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