EFFECT OF ELECTRONS IRRADIATION ON ELECTRO-PHYSICAL AND OPTICAL PROPERTIES OF THIN MONOCRYSTALLIC FILMS $Pb_{1-X}Mn_XTe$

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ABSTRACT

The present work considers the peculiarities of increase of epitaxial films $Pb_{1-x}Mn_xTe$ (x=0,04) grown on freshly broken faces of BaF_2 (ÛÛÛ)and effect of electrons irradiation on electro-physical and optical properties of thin monocrystallic films $Pb_{1-x}Mn_xTe$.

Keywords: irradiation, monocrystallic, epitaxial, film, photoconductivity

I. INTRODUCTION

In connection with wide application of the indicated semiconductors $A^{1v}B^{v1}$ in optoelectronic devices these materials are of large scientific interest and draw the investigators attention. They are used in manufacturing different instruments of infra-red (IR) engineering [1]. there have been developed a number of methods for obtaining structural-perfect uniform epitaksial films of these materials with predetermined thickness, composition and concentration of charge carriers [2].

There are few number of works devoted to preparation, study and application of epitaxial films $PbS_{1-x}Se_x$ $PbSe_{1-x}Te_x$. however we didn't find the publications devoted to the effect of electrons irradiation on elektro-physical properties of thin films $Pb_{1-x}Mn_xTe$.

The crystalline structure and physical properties of films are much determined by substrates parameters. It is desirable the maximum passible coincidence of parameters of lattice, coefficients of substrate thermal expansion and film to be sputtered. The use as substrates of monocrystalline plates of the indicated compounds or solid solutions allows to achieve the full coincidence of all parameters. On the other hand, the epitaxial films and structures obtained on insulating dielectric substrates are of great practical interest.

II. EXPERIMENTS AND DISCUSSION

The present work considers the peculiarities of increase of epitaxial films $Pb_{1-x}Mn_xTe$ (x=0,04) grown on freshly broken faces of BaF_2 (ÛÛÛ) and on polished plates (100) by the method of molecular beams condensation. The choice of BaF_2 as a substrate is due to that it has cubic structure of CaF_2 type with the parameter of elementary unit 6,·19Å, it is transparent within spectral range 3÷12mcm, dielectric, has good mechanical strength and chemically inert.

There have been studied epitaxsial films $Pb_{1-x}Mn_xTe$ on BaF_2 substrates obtained by the method of molecular-radiation epitaxy [3,4]. Films thickness was about 0.5÷1mcm.

The measurements were carried out on structures formed by two silver contacts obtained by sputtering in a vacuum. The width of clearance between contacts was 0.5÷1,0 cm at clearance size from 16 to 64mcm.

Both capacitance and ohmic components of structure conductivity could be measurd by standard scheme.

The epitaxial films are grown by the method of molecular beams condensation in a vacuum 10^4 Pa. Presynthesized alloys $Pb_{1-x}Mn_xTe$ (x=0,04) of appropriate chemical composition served as a source of molecular beams.

With the aim of preparing films of more perfect structure and with required values of electro-physical parameters the additional compensating source of. Te vapours has been used during growth. The researches showed that epitaxial growth occurs at substrate temperature T_n=473÷523 K. The films with more perfect structure ($W_{1/2}$=90÷100), thickness 0.5÷1mcm are obtained at condensation rates 8÷9Å/sec and T_n=613÷653 K.

The starting samples were irradiated at room temperature in linear amplifier of electrons ELU-6 (E=5MeV, $\Phi=5\cdot10^{17}cm^{-2}$). For each sample prior and after irradiation the temperature dependence of specific resistance has been studied. It has been established that in electrons irradiation the specific resistance ρ .Fig 1.

At all samples studied at first decreases slowly and then increases at temperature 77K. The more significant changes being characteristic for samples with the least starting concentration of electrons. The nature of dependences ρ (1/T) of the samples with high starting concentration of electrons doesn't change. Within temperature region close to room one, the activation section appears connected with own ionization of charge carriers.

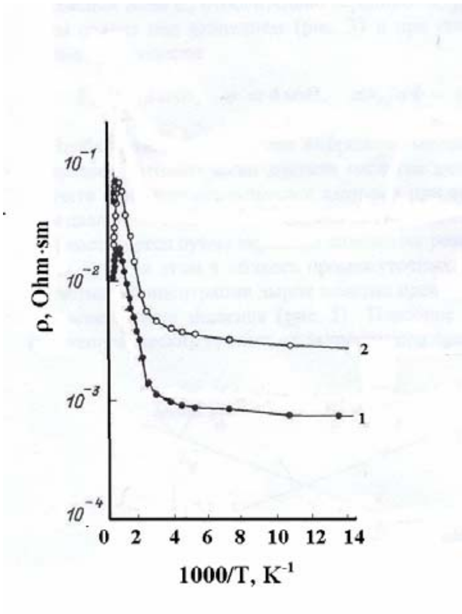

Fig. 1. Temperature dependence of specific resistance of electrons Irradiated ($\Phi=5\cdot10^{17}cm^{2}$)
1.sampler prior irradiation.
2.after irradiation.

At the same time the experimental data, obtained [5,6] in the course of study of p-type crystals, don't allow to predict with enough to predict with enough reliability the nature of n-type alloys parameters change in irradiation depending on ratio of rates of generation of defects of donor and acceptor nature. The irradiation of n-type crystal can lead to both n-p-conversion of conductivity type ($dN_d/d\Phi<dN_a/d\Phi$) and to the increase of electrons concentration in conductivity zone up to the stabilization of Fermi level at energy level of donor type defect ($dN_d/d\Phi>dN_a/d\Phi$). Besides, the points on energy position of radiation level of donor type and nature of rebuilding of energy spectrum of irradiated alloys in variation of tin content in alloy remain uncertain.

III. CONCLUSION

Therefore the general task of the present work was the study of effect of deep electrons irradiation on electrophysical of properties of unalloyed monocrystals n- $Pb_{1-x}Mn_xTe$ (x=0,04) for determination of parameters charge carriers energy spectrum for these material, elucidation of nature of their properties change and in particular, possibility for achievement the limiting characteristics of materials as a result of irradiation.

On the basis of developed regime there have been obtained high ohmic epitaxial films $Pb_{1-x}Mn_xTe$ of n and p-type conductivity with concentration n, ρ (77K)=$4\cdot10^{15}\div1.5\cdot10^{16}cm^{3}$and charge carriers mobility μ (77K)=$2.5\div3\cdot10^{4}cm^{2}/$ B·sec.

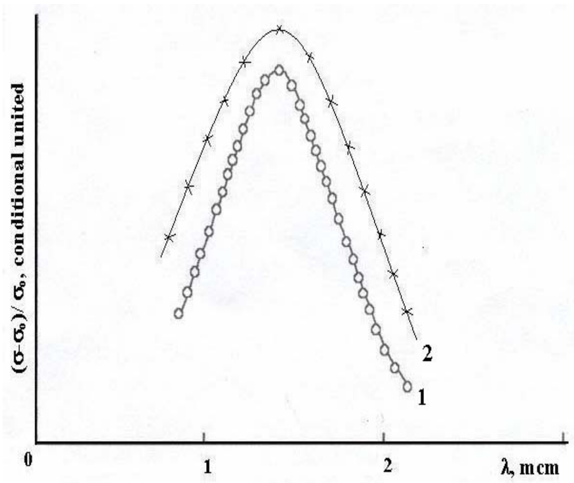

Fig.2. Spectrum of photoconductivity of films $Pb_{1-x}Mn_xTe$ (x=0,04) take at temperature 77K.
1.sampler prior irradiation.
2.after irradiation.

The films with different types of conductivity have been obtained by changing temperature of basic $Pb_{1-x}Mn_xTe$ and compensating source of Te . It has been established that under the above mentioned conditions the epitaxial films are photosensitive at the temperature of liquid nitrogen (77K) (Fig.2.)
As is seen from Fiqure the maximum of spectrum of films $Pb_{1-x}Mn_xTe$ (x=0.04) photoconductivity is shifted towards the shorter wakes in comparison with similar spectra for the other compositions of the given solid solution ($0\le x\le0.04$) carried out in [7], that is explained by increasing width by increasing width of forbidden zone of the samples studied. From Fig.2 is seen that after irradiation the samples become more sensitive.

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