EFFECT OF ELECTRON IRRADIATION ON PB_{1-X} MN_X TE EPITAXIAL FILMS

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ABSTRACT

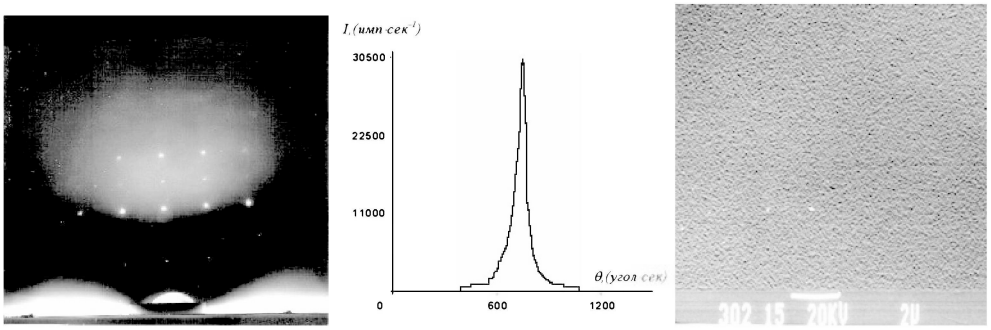
There has been studied the effect of electron irradiation on photoelectrical and optical properties of Pb_{1-x} Mn_x Te ($0.01 \le x \le 0.05$) epitaxial films containing $0.5 \div 1$ at, % of gallium with thickness $1 \div 5$mcm, obtained by the method of molecular beams condensation on substrates BaF_2 (III).

1.INTRODUCTION

Of recent years the epitaxial films of indicated solid solutions obtained on different substrates widely draw the researchers attention and they are intensively studied [1-3].

It is known that for creation of various devices of IR technique, multielement matrices, IR-photo-receivers and their successful application in modern optoelectronics it is necessary to obtain films with stable composition, perfect structure and predetermined reproducible electrophysical, photoelectrical and optical properties.

The problem of obtaining films with perfect structure requires selection of such substrates which thermal examine coefficient (TEC) would be close to TEC of film material. The values of a substrate and a film lattices parameters will play not unimportant role in this problem. The maximum possible coincidence of parameters of lattice and TEC of substrate and grown epitaxial film is desired. The obtaining epitaxial films of lead holcogenides as substrates along with A^4B^6 usually dialectical substrates are also used. The most suitable dielectrical substrate for preparing Pb Te, Pb_{1-x} Mn_x Te epitaxial films might be served barium fluoride (BaF_2) with FEC $\alpha = 18 \cdot 10^{-4} deg^{-1}$ and $\alpha = 6.19 +$. The main dignity of dialectical substrates is the possibility for carrying out electrical isolation of separate functional elements in creating multielement structures.



a) b) c)

Fig. 1. Pb_{1-x} Mn_x Te(x=0,01) electronogramme of epitaxical films (a), roentgendiffractometer curve (b), electronucroscopy (c).

In connection with the abovementioned the aim of the present work was the study of electron irradiation effect on photoelectrical and optical properties of Pb_{1-x} Mn_x Te (Ga) ($0.01 \le x \le 0.05$) epitaxial films grown on dialectical substrates BaF_2. For solution of a set task by the method of molecular beams condensation in

vacuum 10^{-4}Pa the structurally perfect Pb_{1-x} Mn_x Te (Ga) epitaxial films have been obtained with the required chemical composition, thickness and electrophysial parameters.

The films structural perfection was checked by electromyography electron microscopic and X-ray difractometric methods.

From estimation of electron grams and swinging curve of X-ray diffraction the crystalline lattices parameters have calculated and on their basis the corresponding chemical composition of the obtained films have been determined.
The condensation rate was set by temperature of main source Pb_{1-x} Mn_x Te (Ga). Regulating the temperature of main and additional compensating sources succeeded in obtaining high- resistance films of n, p- type conductivity with concentration n, p (77 K)= $5 \cdot 10^{15} \div 2 \cdot 10^{16}$ cm^{-3} and charge carriers mobility M (77 K)=$2 \div 3 \cdot 10^4$ cm^2 /V –sec. the charge carriers mobility values also evidence high crystalline perfection of the films obtained.

The study of photoelectrical properties of these films showed that they were photosensitive at temperature of liquid nitrogen.

It has been established that maximum of films conductivity spectrum in accordance with [4, 5], shifts toward the shorter waves with x increase. This is explained by increasing the width of forbidden zone with growth of manganese amount (x=0.01 ÷ 0.05) in samples under study.

There has been studied the edge of optical absorption of Pb_{1-x} Mn_x Te (Ga) epitaxial films of different chemical composition ($0.01 \le x \le 0.05$) and thicknesses (d=1 ÷ mcm).

For determination of absorption coefficient the optical transmission D(λ) and reflection R(λ) have been measured and by the data obtained the absorption coefficient K (λ) was calculated.

The measurements of reflection spectra showed that reflection coefficient R(λ) was constant along all the measurable IR region of spectrum (0 ÷ 12 mcm) at T=77 ÷ 300K.

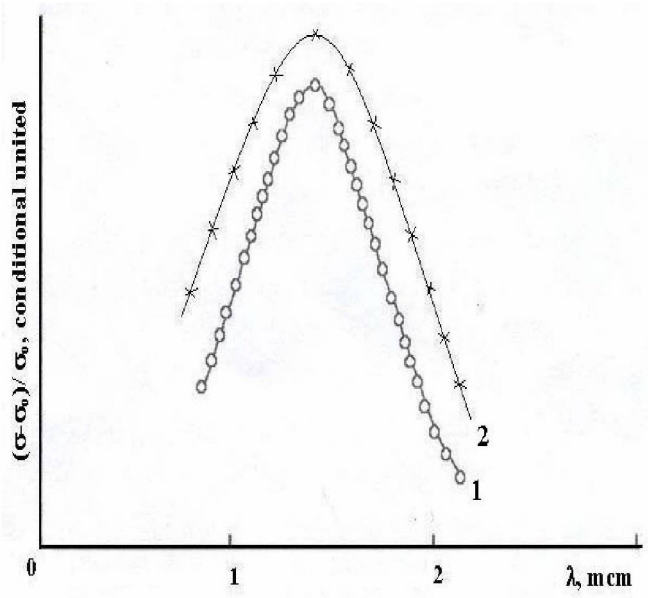


Fig. 2. Spectrum of photoconductivity of films $Pb_{1-x}Mn_xTe$ (x=0,05) take at temperature 77K. 1. sampler prior irradiation. 2. after irradiation.

It has been established that with increasing manganese content in the samples under study the edge of spectral dependence of optical absorption coefficient shifts towards wakes of short length. This seems to be due to the increase of forbidden zone width as a result of manganese quantity growth i8n the samples under study as in case of photoconductivity spectral dependence.

The studies of optical absorption spectra of Pb_{1-x} Mn_x Te (Ga) epitaxial films of different thicknesses (d=1 ÷ 5mcm) showed that absorption coefficient value was almost independent and that was due to the high structural perfections and mirror – smooth surface of the films obtained.

The starting samples were irradiated at temperature 77K in linear electron accelerator ELU-6 (E=5MeV, $d\Phi/dt$-10^{12} cm^3 s^{-1},$\Phi \leq 7 \cdot 10^{17} cm^{-2}$)[6]. The temperature dependence of specific resistance P, concentration and main carries mobility were studied for each sample prior and after irradiation.

It has been established that in electron irradiation at first the slow decrease and then increase of specific resistance P occur at temperatures 77K for all studied samples. The most significant changes being characteristic for samples with the least starting concentration of electrons.
In samples with high starting concentration of electrons the nature of P dependences (1/T) is unaffected after irradiation. In a region of temperatures close to room ones own the activation area appears connected with own ionization of charge carriers.

Therefore the general task of the present work was the study of electron deep irradiation effect on electrophysical, photoelectrical and optical properties of unalloyed Pb_{1-x} Mn_x Te with a view to determine the parameters of charge carriers energy spectrum for there materials, to clear up the nature of their properties change and, in particular, the possibility to attain the materials limiting charge trusties as a result of irradiation.

It has been established that after irradiation the samples become more photosensitive.

2. REFERENCES

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