# THE ROLE OF RADIATION DEFECTS ON FABRICATION OF SEMIISOLATED MATERIALS

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## ABSTRACT

Data are presented on the radiothermoluminessence (RTL) (80-400K) of InP<Zn> crystals. The RTL curve of the samples shows a peaks at 180 and 310K, with on activation energy of 0.13 and 0.51eV which are due to the radiation defects of antistructural and vacancy types.

**Keywords:** radiothermoluminessence, antistructural, activation energy, crystals.

## I. INTRODUCTION

InP is one of the most perspective semiconductor materials used in optoelectronics. The development of technologies and devices on a basis of InP is obviously important for receiving the information on lattice defects and deep traps of carriers induced by radiating irradiation. Therefore, the finding - out change of material physical properties under influence of irradiation for optimum creation optoelectronic devices of high quality is necessary. Formation of radiation defects and their nature in InAs, GaAs crystals and solid solutions on their basis is investigated by us in works [1, 2]. However, data on formation of radiation-induced defects, their nature in InP crystals are available slightly. The present work is continuation of a cycle of investigations and is devoted to study defect creation and their nature under action of gamma irradiation in InP<Zn> by the RTL method.

## II. EXPERIMENTAL

As subjects of research the InP<Zn> monocrystals received by the Chokhralsky method are used. For the analysis of RTL, samples are prepared as plates with the sizes of 1x2 mm$^2$, 400mkm in thickness. With the purpose of exception impurity pollutions and anhydrous oxygen of a surface, the plates previously were vacuumized at P=10$^{-5}$Pa.

The samples were gamma irradiated to 35kGr at 77 K in $^{60}$Co survey at a dose rate of 1.03Gr/S.Dosimetry was conducted by the Ferro sulfate method. In evaluating the absorbed doze (D), we took into account the electron density of the system and dosimeter solution / /RTL curves were obtained on a TLG-69M thermoluminograph between 80 and 400K at a heating rate of 5K/min. The value of energy of activation is determined with the formula suggested by formula

$$E = \frac{\sigma R T^2{}_m}{\Delta T}$$

Where, R-is the universal constant of gas
T$_m$- is the temperature corresponding to the peak maximum
$\sigma$ -dimensionless quantity in the limit of 2.5 to 3
In this case we used the value $\sigma$ =2.5

## III. RESULTS AND DISCUSSION

In Fig.1 the RTL spectra of the InP <Zn> sample after irradiation with gamma quanta in dozes of 10 kGr (curve 1) and 35 kGr (curve 2) are presented. As it is seen from the figure with increasing of a doze of irradiation the reduction of intensity of peak of radiation is observed, that is related with formation of radiation defects. The peak of the RTL spectrum, $E_a$ =0.13 eV, observable at $T_{max}$ = 180K after irradiation by a doze of 10 kGr (curve 1), with increasing of doze of irradiation up to 35 kGr, is displaced in the side of low temperatures $T_{max}$ = 170K to with energy of activation of $E_a$=0.12 eV (curve 2)

With increasing of a doze of irradiation the occurrence of asymmetry of the high-temperature side of the spectrum was observed, what took place also and in undoped InP [3-5]. It probably is connected with formation of antistructural defects (ASD) (clusters and their interaction between themselves). Reduction of intensity luminescence with increasing of the doze is connected with formation of ASD of $B_A$ ($P_{In}$)

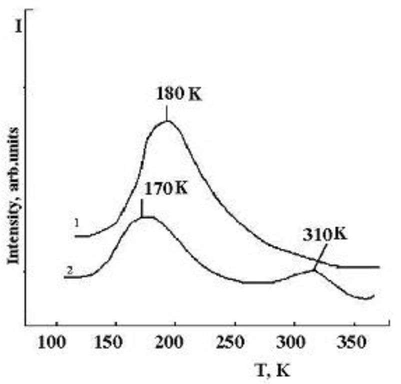

**Figure.1** TL curves of InP <Zn> crystals irradiated with gamma quanta doses of 10 (curve 1) and 35 (curve 2)kGr.

donor type which are capable to compensate acceptor centers [6] $P_{In}$ defect is the reason of effect of optical damping of photo-electrical properties in view of transition of the centre in metastable state [7,8].

Prediction of authors C.Myles and O. Sankey [9] for deep levels created by vacancy antistuctural defects ($V_{In}In_P$) pairs on a nature concerns to defects in crystals with structure of zinc – blender. These deep levels caused in vacancy antistructural defects pairs are inside width of the forbidden zone.

It is possible to note that ASD, formed under irradiation of $A^3B^5$ monocrystals, have more complex structure than the centers formed at growth of a crystal [10, 11]. These defect levels can considerably influence on electrical and optical properties in these materials. The levels $E_a$=0,13eV formed along sphere of Coulomb potential lay inside the forbidden zone [9]. $H_3$ hole traps correspond to charge states of ASD $P_{In}$ namely, $P_{In}^0$. As is marked in [13], the level of $P_{In}^0$ defect located near the middle of the forbidden of zone, similarly to EL2 level in GaAs, promote reception doped semiisolated InP.

Peak appearing with increase of a doze of irradiation at 310K with energy of activation of $E_a$=0, 51 eV (curve 2) corresponds $H_3$ hole trap [12]. The EL2 level with $E_a$=0,52eV is found out also in GaAs crystal, irradiated with electrons [14].

Situations of levels of the $P_{In}$ multistage centers relatively the valence band were received by the authors [15] by research by the method of no stationary spectroscopy of deep levels transient spectroscopy (DLTS).

The received experimental data have allowed us to make the circuit of levels of thermal activation energy of radiation defects in InP, which is given on Fig. 2.

As it is seen from the scheme, the level of $P_{In}^0$defect with energy of activation of $E_a$=0,51eV is located near to the middle of the forbidden zone. $P_{In}$ large density can be achieved, apparently, by deviating of composition of an InP sample from stechiometry in the side of metalloid surplus.

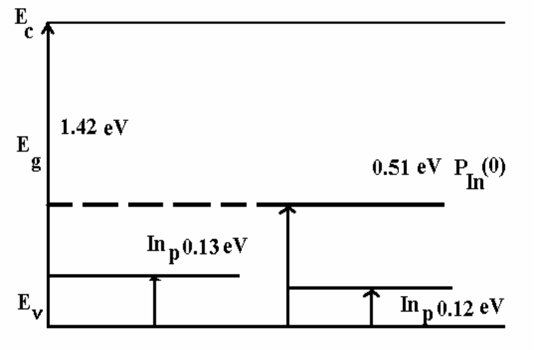

**Figure 2.** The scheme of levels thermal activation energy of radiation defects in InP<Zn>.

It has the basic importance at fabrication semi isolated materials for super high frequency (SHF) electronics on a basis of previously irradiated i-InP undoped monocrystals.

The found out levels with $E_a$=0,13eV and 0,12eV in the crystals gamma irradiated by dozes D=10kGr and D=35kGr, respectively, is connected with formation of the M-centers in positive threefold charged state vacancy and antistructural effects of $V_{In}In_P^+In_P^{++}$ type [14].

In process of increase a doze of irradiation the peak RTL intensity at 180K $E_a$0,13eV 2,5 times, that is connected with formation of radiation defects, serving the centers of nonradiative recombination. Simultaneously, there is a displacement in low temperature region by 10K that results in reduction of energy of activation on 0,01eV (see the scheme). The observable change of a situation of peak, probably, is connected with change of $P_{In}$ steochiometry. Occurrence of $P_{In}^0$ (0,51eV) level and the displacement of InP level is interconnected.

Thus, by the RTL method it has been revealed that under irradiation with gamma quanta crystals of InP doped by zinc, it is induced $P_{In}$ radiation defects of donor type, serving the centers of nonradioactive recombination that is the reason of reduction of RTL intensity.

## IV. CONCLUSIONS

1. The opportunity of application of the RTL method at study of radiation defects in crystals InP <Zn> has been shown. In these crystals the radiation defects of vacancy and antistructural types with energy of activation of
$E_a$= 0, 51 and 0,13eV are found out.
2. It has been established that the reduction of intensity of highlighting peak at temperature T=180K ($E_a$=0,13eV) in process of increase of doze of gamma irradiation is connected with formation of the centers of without radiation recombination.
3. It has been revealed that the formation of $H_3$ (T=310K, $E_a$=0,51eV) hole traps results in displacement of $E_a$=0,13eV level.

The observable features allow assuming about an opportunity of fabrication of semiisolated materials for SHF technology on a basis of InP, previously irradiated with gamma-quanta without doping.

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