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Photosensitivity spectrum of long diodes with varied band base under the realization of galvanomagnetorecombination effect

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Abstract - *In this paper, the results of investigation of the spectral characteristics of the injectional photodiodes with a varied base are presented under the condition of the existence of Galvanomagnetorecombination (GMR) effect. This is the redistribution majority and minority charge carriers within the volume of the semiconductors in the presence of the magnetic field and the formation of non equilibrium electron hole plasma [1].*

Résumé - *Dans ce document, les résultats des investigations sur les caractéristiques spectrales de l'injectional des photodiodes avec une base variée sont présentées sous réserve de l'existence de l'effet de recombinaison Galvano magneto recombination (GMR). Il s'agit de la redistribution des porteurs majoritaires et minoritaires au sein du volume des semi-conducteurs en présence du champ magnétique et de la formation de non équilibre des électrons trous dans le plasma.*

Key words: Spectral characterizes – Photosensitivity - Magnetic field - Varied band – Injectional – Photodiodes – Recombination effect.

1. INTRODUCTION

Photosensitivity $p^+ - \gamma(\Pi) - n^+$ of structures with long bas functioning in the double injection regime may be exceedingly high on the expense of the photoelectric effect of the injectional strengthening [2].

If the base of the diode represented solid solution of variable composition, then the form of spectral characteristics of the photosensitivity depends on the light intensity and the strength of the established field of the varied bands [3]. The spectral characteristics deformed also under the influence of the magnetic field [4].

The sample investigated ware of the structures $n^+ (Al_x Ga_{1-x} As)$ - $p (Al_x Ga_{1-x} As)$ - $p^+ (Ga As)$ obtained by liquid epitaxy method (Fig. 1).

The width of the forbidden band of base semiconductors made on the basis varied of solid solution $p(Al_x Ga_{1-x} As)$ in the region of direct band composition $Eg(z)$ varied by a linear law.

Injecting n^+ - p hetero junction is situated at $z = 0$, $p - p^+$ contact at $z = d$.

The base is characterized by the following parameters

Length	$d = 30 \div 40$ µm
Width	$l = 0.5$ mm
Height	$h = 0.1$ mm
Electron diffusion length	$L_n = 6 \div 80$ µm

The forbidden band in the region $n^+ - p$ Contact

$Eg_{min}(0) \neq Eg_{max} = 1.95$ eV in the region p - p^+ Contact

$Eg(d) = Eg_v \approx 1.4$ eV

Hole concentration equilibrium $P_0 = 6\,10^{14}$ cm^{-3}.

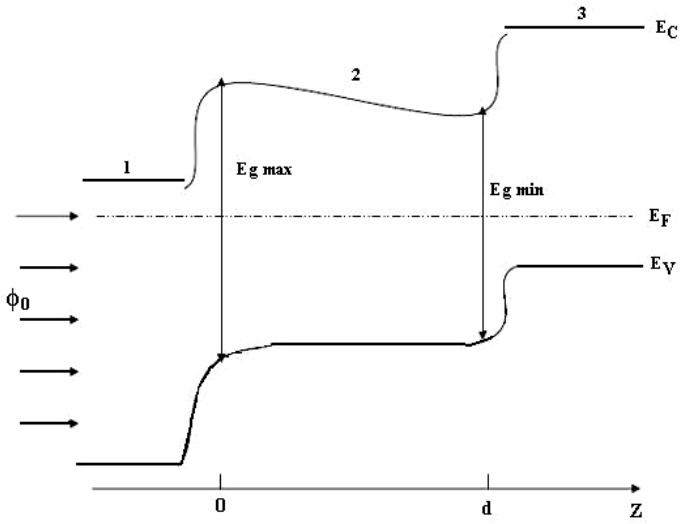

Fig. 1: Diagram energy band injectional photodiode
1. $n^+(Al_x Ga_{1-x} As)$ - 2. p $(Al_x Ga_{1-x} As)$ - 3. $p^+(Ga As)$

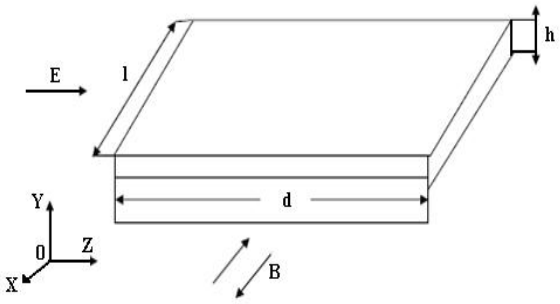

Fig. 2: Base of photodiode

Light projection on the sample was by the torque of the wide band n^+-region parallel to the current axis. On one of the boundaries XOZ a region of high speed recombination was created. A magnetic field make on perpendicular axis YOZ. A study the dependence of differential voltaic photosensitivity $S = dv/d\Phi$ on the spectral composition (where v voltage of the diode and Φ the light intensity). This is measured in the current generator regime at $T = 77$ °K.

The measurement of direct volt-amper characteristics in the absence of light showed the high level injection [$\Delta n(z) > P_0$] under which the modulation of the integred volume conductivity of the varied band semiconductor occurs due to non equilibrium charge carriers correspond to $I > 1$ mA.

The presence of a wide band 'window' and varied band field determines the important difference of the studied structures from the characteristics of the injection photodiodes on the basis band semiconductors the spectral characteristics of photosensitivity $S_V(h\gamma)$ measured at current $I \approx 1.5$ mA is selective (Fig. 3, curve 1).

It corresponds to the non equilibrium charge carries generated by light at the high ohmic region of a base $p - p^+$ contact ($h\gamma_2 = 1.4$ eV). This region is unmodulated by the charge carriers from the $n^+ - p$ junction.

In the case, the influence of the transverse magnetic field the photosensitivity spectrum of the varied band semiconductors in the double injection regime deforms.

If the magnetic field is to directed in such a way that the charge carriers are deflected to the XOZ plane with a non high velocity of the surface recombination (induction $B > 0$). Then the spectrum of photosensitivity is narrowed and maximum of the spectrum is shifted towards the region of the photon with less energies (Fig. 3, curve 2).

When charge carries are deflected by Lorentz force towards boundary XOZ with a large velocity of the recombination ($B < 0$), photosensitivity spectrum becomes extends within the short wave region up to energy $h\gamma_1 = 1.9$ eV (Fig. 3, curve 3) at $h\gamma \approx Eg_{max}$. The signe of the photoresponse changes on the expense of the photovoltaic effect at $n^+ - p$ junction.

The effect of the change of the spectral characteristics of the injectional photodiodes in the magnetic field is explained by the influence of this field on the characteristics of the charge carriers distribution in the volume of the varied band semiconductor.

But when the magnetic field acts with induction $B > 0$ the average concentration of charges carriers within the volume of the base grow up.

The high ohmic part of the base at $p - p^+$ injection contact, which is unmodulated by the injection carriers from the junction becomes narrower and distributed hearer to Eg_{min}. Because of this is reason the graph $S_V(h\gamma)$ becomes narrow and shifted towards smaller $h\gamma$ (Fig. 3, curve 2). Under the influence of magnetic field with $B < 0$ the integral volume conductivity of the base decreases and the region where the strength of the electric field is high it is widened from the (antizapore) antibolted $p - p^+$ contact to $n^+ - p$ junction.

Because of the redistribution of the extreme potential V between the base and injected $n^+ - p$ injection, under the action of the magnetic field, induction current decreases [5].

In this case the magnetic effect is manifest which equivalent the transfer in to lower injection level, when $\Delta n(z) < P_0$ the charge carriers generated the photons partically contribute to photosignals from energy scale $h\gamma_1$ different of $h\gamma_2$ (Fig. 3, curve 3).

The increase in the intensity of the established variable field

$$E\,var = -\frac{1}{Q\,d}\,\Delta Eg$$

On the expense the decrease Eg_{min} leads to a shift of maxima of the photosensitivity in the region of smeller energies.

This using the long photodiodes of varied band semiconductors as a base and realization of GMR effect essentially widens the functional photosensitivity of injectional photo receivers.

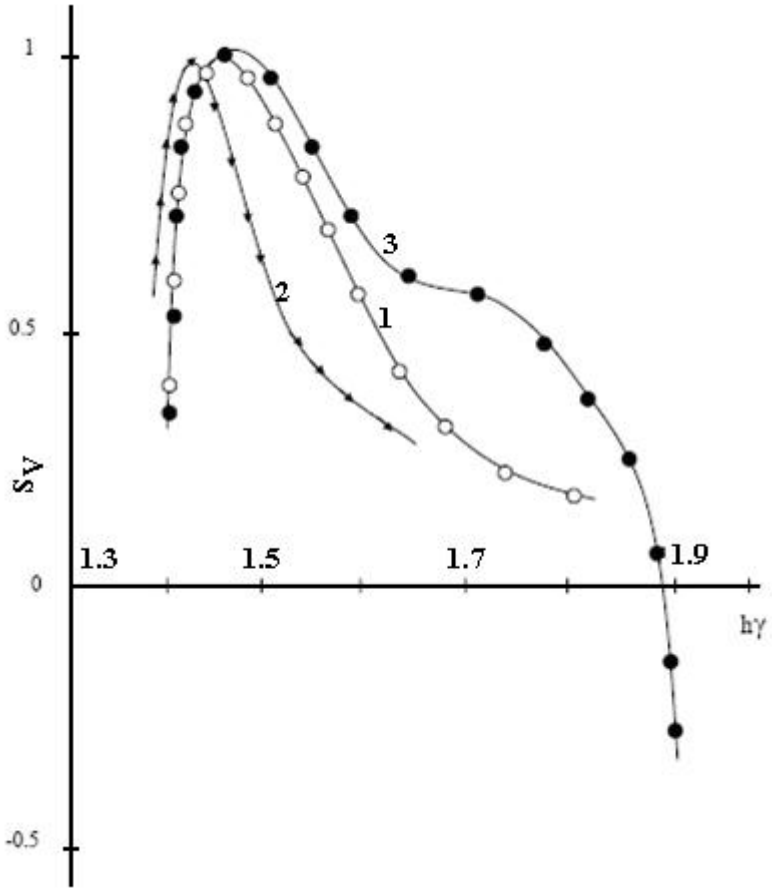

Fig. 3: Spectral characteristics photosensitivity injectional photodiode, inductance field 1 – 0 _ 2 – 0.3 _ 3 - 0.5 Tesla

REFERENCES

[1] A.M. Projeli Vulnious, '*Semiconductors*', p. 73, Moksalas, 1980.

[2] I.D. Ansumova and I.M. Vikuline, '*Semiconductors Photo Receivers*', p. 216, Radio Telecommunication, Moscou, 1984.

[3] G.P. Peka and D.A. Pulmetov, '*Photosensitivity Long Structures Diodes on the Basis Varied Solid Solution Al Ga As*', Physica Technica Semiconductors, pp. 150 – 152, T. 22, 1988.

[4] S.D. Kurmacher and I.M. Vikuline, '*Spectre Photosensitivity Long Diodes*', Physica Technica Semiconductors, pp. 558 – 560, T. 24, 1990.

[5] V.I. Stapheiv and E.I. Karakuchen, '*Magnetodiodes*', p. 216, Sciences Moscou, 1975.