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NEW METHODS FOR DETERMINING CLASSIC AREAS OF MICROPARAMETERS FOR ANOMALIC PHOTOVOLTAGE ELEMENTS

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A B S T R A C T

This paper presents the results of experimental studies of the effect of anomalous photo voltage. Ways to study the properties of anomalous photo voltage (APV) elements have been formulated and determined. The results of experimental studies to determine the micro parameters of APN films are presented.

K E Y W O R D S

anomalous photo voltage (APV), magneto -optical properties, photocurrent, micro parameters of APV films, substrate, limiting region, impurities.

Introduction

It is known that in the theory of the effect of anomalous photo voltage, the thickness of the layer is an important parameter, and for this reason, films are often a good means of experimental testing of such theories [1-4]. However, in order to obtain unambiguous results, it is necessary to keep the various structural properties of the films constant. This requires a thorough understanding of the influence of deposition parameters and vacuum deposition conditions. Semiconductor films that are highly structurally disordered (heterogeneity, anisotropy) may differ from bulk samples [5-11]. The reasons for deviations in the parameters of massive samples can be the small thickness of the films, the large surface-to-volume ratio, and possible strong structural disorder (inhomogeneities). A small film thickness can cause phenomena such as the tunnel effect, an increase (increase) in electrical resistance; when the thickness is comparable to the depth of penetration of the magnetic field, changes in magneto -optical properties occur. In addition to an increase in surface scattering of carriers, it leads to an increase in electrical resistance. The results of electron microscopic studies of the layer surface, assessment of the sizes of individual microcrystals and observations of the relationship between the resistance of the layer thickness and the photovoltage values showed that the APN effect is observed in films whose thickness approximately corresponds to the linear dimensions of the microcrystals [12-19].

Naturally, with increasing layer thickness, the shunting effects of the layer volume increase. In the region of small thicknesses, the leakage resistance of individual microcrystallites begins to play a significant role [20-26].

Experiments show that for each (material) APN film there is a limiting thickness region (LOT) at which the APN effect is observed.

The distribution of condensate over a suitable substrate surface depends on the shape of the evaporator and the substrate, as well as the distance and location of the evaporator relative to the substrate. Depending on the shape of the evaporator, evaporation can occur either uniformly in all directions, or in some preferred direction. From this point of view, evaporators can be divided into point and directional. A point evaporator is called an evaporator in the form of a sphere, the diameter of which is small compared to the distance to the substrate and with a temperature that is the same at all points of its surface. To obtain an APN film, it is necessary to strive for a uniform distribution of the film thickness on the surface of the substrate. This distribution is achieved, for example, using a conical point evaporator located at a distance of about 300 mm from the substrate [27-31]. It has been experimentally established that in this case the length of the substrate should be about 20÷30 mm. The limiting region of the molecular flow slope lies in the region of order <0.05. If this condition is met, the photoactive number of microcrystals increases and the process of summation of elementary $\left(\frac{kT}{q}\right)$photovoltages occurs and the APN effect is observed.

The totality of experimental data from magneto -optical studies makes it possible to determine microparameters with an accuracy of an order of magnitude higher than the Hall method. In this regard, the experimental study of the Faraday effect [32-35] can be of dual interest: with a known effective mass, the measured values of the rotation of the plane of polarization can be used to determine the concentration of charge carriers or the ratio between the concentrations of heavy and light holes, and vice versa, if the concentration of carriers is known, then you can find the value of the effective mass. The results of studying Faraday rotation in APN films with isovalent impurities show that the quadratic dependence of the rotation angle of the plane of polarization on the wavelength ($\alpha \sim \lambda^{2}$) actually holds. This dependence was discovered by many authors on a wide variety of semiconductor materials. According to work [6], using simple calculations, the photovoltage in a p - n - p - cell increases linearly with increasing illumination of the film at low light intensities ($I_f = a I << I_S$) and sublinearly as it reaches saturation

$$U_{A\Phi H} \approx \frac{kT}{q} ln\left(\frac{a_1 I_{S2}}{a_2 I_{S1}} - 1\right) \quad (1)$$

where, I_Φ - photocurrent; I_S - saturation current, a_1, a_2 - coefficients that have the meaning of the photosensitive transitions depend on the absorption coefficient æ, film thickness *d*, *carrier* diffusion length L, surface recombination rates, as well as D / L.

Photocurrents through the junctions are proportional to the illumination (J), i.e.,

$$I_{f1} = a_1 J, \quad (2)$$

$$I_{f2} = a_2 J, \quad (3)$$

In particular, with a weak difference, assuming

$$a_1 - a_2 = \eta \bullet a < < a, \; I_{S1} \approx I_{S2} \approx I_S, I_{S2} - I_{S1} = bI_S << I_S \quad (4)$$

we have

$$U_{A\Phi H} = \frac{kT}{q}(\eta + \beta), \quad (5)$$

where $\eta$is the diffraction efficiency; β- the angle between the directions of oscillations in the analyzer in the same ellipse axis, which, when b=0, coincides with the corresponding expression from [6]. According to theoretical and experimental data [5,6], from the expression of the photomagnetic current

$$I_{ФМЭ}^{max} = \frac{qt}{2,72d}\mu L^2 B \quad (6)$$

where, t is the width of the film, d is the thickness of the film.

You can find the value of L $^{2.}$ Knowing the values of μ L and μ L ^{2,} it is easy to determine the mobility μ and the diffusion length of carriers, and with them the diffusion coefficient $Д = \frac{\mu kT}{q}$and lifetime $\tau = \frac{qL^2}{\mu k_0 T}$. From a short section of the photovoltage spectrum under frontal illumination according to the formula

$$U_{ФМЭ}^{нас} = \frac{2kT}{\pi q}\mu NB \quad (7)$$

From the slope of the direct Gaussian-voltage dependence of the PME, one can also find the value of the product and, knowing the number of microphotocells N in APS film. Using values $\mu, N,$ Lfrom the short wavelength region of the spectrum U_{PME} (I_{0}), using the formula

$$U_{ФМЭ} = \frac{4NkT}{\pi q}\cdot\frac{qtI_0 L}{I_S}\mu B \quad (8)$$

It is not difficult to determine the value of the dark saturation current $I_{S.}$

In the above method, the microparameters of ternary alloys with isovalent impurities are determined. The found values of microparameters for samples with a length of 13.4 mm, a thickness of about 0.51 μm and a width of 4.2 mm were: N = $8\cdot 10^{4}$ pcs ; μ=28 cm ^{2}/ V s ; L =$5\cdot 10^{-6}$ cm; τ=$4\cdot 10^{-12}$ s; D=8.15 cm ^{2}/ s. The erst -volt and erst -amp characteristics were measured in short-wave (λ=400 nm, I_0 =$8\cdot 10^{14}$ quantum/cm ^{2} s) light, the saturation current was equal to I_S =$5\cdot 10^{-8}$ Å, which is significant exceeded the values of the short circuit current of the valve photoelectric effect $I_\Phi = 2I_0 = 1{,}6 \cdot 10^{-9}$ Å, the condition $I_\Phi << I_{S,}$ while the lux-volt dependence of the photomagnetic effect was linear, was fulfilled.

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