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INVESTIGATION OF CLUSTER-TYPE INHOMOGENEITY IN SEMICONDUCTORS

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ABSTRACT

The paper studies the effect of cluster-type inhomogeneity on the properties of AFN - elements from crystalline and thin-film structures of gallium arsenide and gallium phosphide. The effects of birefringence, magneto-optical and electro-optical are studied.

KEYWORDS

AFS - elements, photovoltaic, magneto-optical, electro-optical properties, amorphous and crystalline structure.

INTRODUCTION

In order to determine the effect of non-stoichiometric, non-uniformity of AFN-elements on their photoelectric, magneto-optical, electro-optical and other properties, special methods for obtaining AFN-elements are required. The fact is that in homogeneities are often the causes of the anisotropy of photoelectric effects and their anomalies, especially in strong electric magnetic fields, and can completely distort the measurement results. This makes us take a fresh look at some anomalous results on the AFN - effect [1]. A detailed study of the influence of

inhomogeneity on the properties of AFN - elements has been little studied. We have to state that the problem of creating and controlling in homogeneities on AFS elements has not been solved in the general case. The technology for obtaining AFS-elements with birefringence is considered for the first time. To do this, we have developed a technological measuring system that provides heterogeneity in structure and composition. Heterogeneity in structure and composition is achieved with doping with isovalent impurities during the production of AFS elements. The

weight of the technological cycle of evaporation takes place at a variable temperature and angle of spraying. The temperature control of the deposition angle in the process of obtaining a thin film of AFS elements is carried out continuously according to a linear law using an automatic controller. A specially designed scheme sets the required temperature and deposition angle for the sample, sets the sequence of the operation for supplying isovalent dopants. As a result, in a single technological cycle, heterogeneity is achieved in composition and structure, both on the surface and in the volume of AFS elements.

THE MAIN PART

Knowledge of the degree of inhomogeneity of materials is very important not only in the manufacture of semiconductor devices, but also in the study of the materials themselves. A vivid exemplary material heterogeneity is a polycrystalline structure. It is natural to expect that the properties of the crystals themselves can differ significantly from the properties of the intergranular interlayer. The polycrystalline structure is most typical for thin films of any type, even single-crystal ones, but with a coherent orientation of microblocks. If the crystallites of microblocks can be assigned properties similar to the bulk properties of a given semiconductor, then with respect to intercrystalline layers it can be very different. The formation of intercrystalline layers can be due to the following:

- a) A “hose” to crystallites taken out during their recrystallization and representing various impurities and inclusions;
- b) Foreign compounds formed from the components of the base material and individual impurities;
- c) The usefulness of the composition of the films, characteristic of folded semiconductor compounds, while p-n transitions can occur at the phase boundary;
- d) Precipitation of one of the components of the composition, for example, metal in the compound AIII BV;

- e) The difference in the structure of the phases, for example, amorphous and crystalline;
- f) Oxide of the surface layer of the crystallite;
- g) A depleted layer caused by the capture of carriers by the surface levels of crystallites;
- h) Incomplete contact of crystallites throughout their thickness.

Obviously, the layers can be formed by a combination of the above factors. Often, interlayers can completely determine the semiconductor properties of a polycrystalline material. The complexity of interpreting the results of measurements on polycrystalline materials is aggravated by the fact that often there is no complete clarity about the nature of intercrystalline interlayers and their parameters in a particular material.

It is known that the APV effect is mainly observed in polycrystalline films. The observed anomalies in here are mainly attributed to the influence of intergranular interlayers. Currently, two trends prevail in explaining the nature of the action of interlayers: one is based on the theory of complex electrical circuits; the other is based on the barrier theory [2, 3]. Mastov [4] was one of the first authors who considered the photoelectric equivalent circuit of APV films in the analysis of the PME effect. In the simplified model, the crystallites are separated by high-resistance interlayers. In turn, high-resistance regions can be not only intercrystalline interlayers, but, most likely, microcrystals [5].

Since the interlayers have a certain slope with respect to the substrate plane, the current flowing through the film is forced to cross the interlayer boundary. As a result, charge carriers experience scattering not only on intercrystalline barriers, but also on the barriers of modification layers. Thus, not only the polycrystalline inhomogeneous structure, but the defectiveness of the crystallites themselves are anomaly factors in APV elements. As mentioned above, AFN AFMN and other magneto-optical, electro-optical effects are sensitive to inhomogeneity's in the AFN - element. Therefore, there are doubts about the correctness of the results

of [6-8], in which the APV effect in CdTe films was considered.

In many theories of semiconductor physics, layer thickness is an important parameter, and for this reason films are often a good means of experimentation.

$$V = \frac{(b-1)BL}{\mu(n_0+p_0)(1+\alpha_i)} \quad (1)$$

B - light intensity

L - diffusion length

α_i - surface recombination rate on an illuminated surface

Numerical verification by the method of "Machine experiment" (variation method) showed that in the formation of AFS acting is $N \cdot kT/q$ which is mainly determined by the photo activity of microcrystals [9-10].

CONCLUSION

In conclusion, it should be noted that the source of the elementary photo voltage in the APV effect is a separate microcrystal of the layer; it must be inhomogeneous. The presence of high-resistance intercrystalline interlayers is a necessary condition for the photo voltage in these areas not to be shunted by the low resistance of neighboring microcrystals. When samples are illuminated in homogeneous areas, separation of carriers does not occur. Estimation of the sizes of individual crystals and comparison of the thickness of the layers with the values of photo voltages showed that the highest photo voltages are exhibited by layers whose thickness approximately corresponds to the linear size of microcrystals. Naturally, with an increase in the layer thickness, the shunting effect of the volume increases. In the area of small thicknesses, the leakage resistance of individual micro-junctions begins to play a significant role.

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