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RELAXATION OF INTERNAL - MECHANICAL STRESSES AS A RESULT OF ULTRA-HIGH FREQUENCY PROCESSING TEST STRUCTURE PT-N-N + GAAS

Annotation

The article discusses the relaxation of internal mechanical stresses as a result of ultra-frequency processing of the PT-N-N + GAAS test structure. It is shown that the relaxation processes in the system under study are not of thermal origin.

Key words: *process, structure, stress, processing, result.*

As you know, the relaxation of internal mechanical stresses (IMT) is one of the main mechanisms of degradation of semiconductor devices, therefore, the study of relaxation processes in device structures created on a plate with contacts, as well as the mechanisms responsible for them, remains relevant, because internal mechanical stresses are present in almost all semiconductor devices. instrument structures [1].

Among the factors that stimulate the relaxation of VMN in devices, various types of operating conditions are known, external influences - radiation, thermal heating, strong electric fields [2].

At the same time, along with degradation phenomena (generation of dislocations, cracking of the active layer, etc.), a number of influences, especially radiation exposure, stimulated the study of gettering effects, which contributed to the development of new technological processes aimed at reducing the HMP and the associated improvement of the parameters of semiconductor structures. used in the creation of microelectronic devices.Among the factors mentioned above, the effect of microwave radiation on the relaxation of HFMs in thin-film semiconductor device structures, especially used for the manufacture of microwave active elements (microwave diodes of various types, field-effect transistors, microwave integrated circuits, etc.), is less studied. As shown earlier in [3], the relaxation of internal mechanical stresses does not always lead to a catastrophic degradation of devices and device structures.

However, despite the sufficiently detailed study of relaxation processes in semiconductor devices and crystals, including surface-barrier structures of Pt-GaAs, performed by professors Yu.A. Tkhorik and K.A. Ismailov with co-authors, they did not study the relaxation of MNP stimulated by microwave radiation. [four]. In this work, such an attempt is made.

For this purpose, before and after microwave treatment, the radius of curvature R of the Pt-n-n + -GaAs test structures, in which 0.14 µm thick Pt was deposited by the electron-beam method, was measured on a P201 profilometer-prlphiolgraph. On the same structures, after each measurement of R, the phase composition of metallization was measured by X-ray diffractometry on an X'Pert PRO MRD diffractometer, and volt-ampere characteristics were measured on diode structures fabricated by photolithography using planar technology.

It turned out that as a result of microwave processing at a frequency of 2.45 GHz, with a specific power of 1.5 W / cm2 for 1-5 s, the radius of curvature on different samples increased 3-4 times compared to the initial one (table).

Table

Influence of microwave treatment time on the radius of curvature R, the value of HMN □ of the test structure and the parameters of diode structures with a Schottky barrier Pt - n- n + GaAs

Structure parameters	**Irradiation time, s**					
	0	**1**	**2**	**3**	**4**	**5**
R, m	2,72	4,32	5,43	4,86	8,91	8,89
□ □10^9, Pa	11,70	7,41	5,89	6,58	3,60	3,59
n	1,15	1,1	1,1	1,1	1,1	1,1
φ_b , B	0,74	0,78	0,78	0,8	0,8	0,8
Jobr, A / cm2, at V = 1V	$2,5\cdot10^{-6}$	$2\cdot10^{-7}$	$2\cdot10^{-7}$	$7,5\cdot10^{-8}$	$7,5\cdot10^{-8}$	$7,5\cdot10^{-8}$

A detailed examination of the data on the dependence of the internal mechanical stresses of the structure on the irradiation time indicates the nonuniformity of the relaxation processes in the sample. One of the reasons for this may be the presence of a real test structure, which includes a heavily doped substrate, an epitaxial film, and a transition layer at the interface between the film - metal and the Pt layer, i.e., it is more multilayer than the two-layer model adopted for evaluations.

X-ray diffraction analysis data confirm this assumption. Along with platinum, the initial sample contains the PtGa2 phase, which was formed during the electron-beam deposition of Pt. According to the Ga-Pt phase diagram, this phase is formed at T = 153 0C [5]. The near-surface GaAs layer can be heated to such a temperature during electron-beam deposition of platinum, if no special measures are taken to limit heating.Microwave treatment for 4 s and 24 s did not lead to a change in the phase composition in the Pt-GaAs contact, just as the general phase composition of metallization practically did not change, including, along with PtGa2, a significant amount of platinum, which indicates the absence of any noticeable heating of the sample.

Note also that the PtAs2 phase, which is often observed during the formation of platinum barriers to GaAs, has not been detected in our case, since it appears at T> 400 ° C [5]. The absence of significant changes in the Pt-GaAs contact after microwave treatment for 24 s is evidenced by the distribution profiles of the components in the contact.

Thus, based on the results of the experiment, it can be concluded that the relaxation of the HMN as a result of microwave treatment of the Pt-n-n + GaAs test structure is carried out in a multilayer structure including a platinum layer - a transition layer, predominantly PtGa2 - an epilayer of GaAs - n + - GaAs substrate.

In this case, judging by the data of Auger electron spectroscopy, one cannot exclude the mass transfer of Pt through the transition layer in GaAs, stimulated as a result of microwave treatment and relaxation of the HMN. This process, like the mass transfer of Pt stimulated by laser radiation, forms a heavily doped thin p + -

GaAs layer in the near-contact region, which causes an increase and a related decrease in the reverse current.

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