STUDY OF LARGE-SCALE INHOMOGENEITIES IN N-GAAS AND THEIR INFLUENCE ON THE HOMOGENEITY AND CHARACTERISTICS OF HR GAAS:CR IONIZING RADIATION SENSORS*

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Large-scale inhomogeneities are understood as a dislocation grid and accompanying local inhomogeneities with a nested structure of the "bubble" type. Local inhomogeneities of the "bubble" type (defects) have a diameter of up to 1 mm. The presence and characteristics of such defects are determined by the technology and conditions for growing n-GaAs crystals, as well as the parameters of post-growth high-temperature annealing of the crystals.

By the time the report was published, local inhomogeneities of the "bubble" type were discovered in n-GaAs grown by the Czochralski method (LEC) and were absent in crystals grown by the vertical gradient freeze method (VGF).

"Bubble" type local inhomogeneities can be identified by:

- Destructive method – etching the surface of the plate with Sirtle etchant (DSL – diluted Sirtl light etching) (Fig. 1).
- Non-destructive method – mapping the plate in near-infrared radiation (1030-1150 nm).
- Mapping the counting rate of quanta with sensors made of appropriate HR GaAs:Cr wafers (HR – high resistivity).

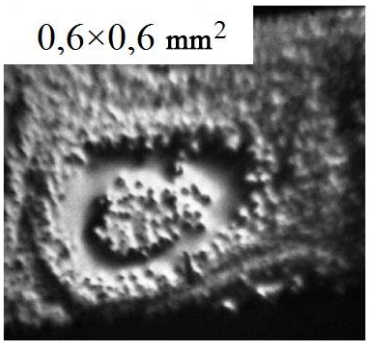

Fig.1. Local inhomogeneities with a "bubble" structure.

The "bubble" type defect has a complex structure, including central, peripheral and intermediate areas. In the central and peripheral areas there are objects in the form of bumps with a base diameter of 10-20 μm. The intermediate region has the appearance of a ring in which there are no bumps. In addition, the intermediate region is characterized by a higher etching rate in the DSL etchant compared to the central and peripheral regions. It can be noted that the intermediate region has a higher transmittance in the near IR. The increased absorption of IR radiation in the central and peripheral regions is due to a higher concentration of electrically active defects and deep impurity levels of chromium compared to the central part of the cell.

The defects affect the properties of the HR GaAs:Cr material, which is obtained by compensating n-GaAs with chromium, and the characteristics of ionizing radiation detectors made from HR GaAs:Cr wafers. Large-scale inhomogeneities have the influence on the count rate and spatial resolution of detectors. In areas of the detector where "bubble" defects are detected in the material, the count rate value decreases from 2 to 4 times.

To reduce the number of defects, it is possible to use post-growth annealing of crystals and additional high-temperature annealing of n-GaAs wafers before the process of compensating the wafers with chromium. Additional high-temperature annealing of the wafers leads to a decrease in the concentration of macroscopic defects and in their contrast in transmitted IR radiation.

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