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РФИ  МИКРОСПИАВ  MILLAB
CHANGES IN THE ELECTRO-PHYSICAL PROPERTIES OF MCT EPITAXIAL FILMS AFFECTED BY A PLASMA VOLUME DISCHARGE INDUCED BY AN AVALANCHE BEAM IN ATMOSPHERIC-PRESSURE AIR


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Nowadays various discharges and electron beams are widely used for modification of near-surface layers of materials [1]. Feature of these discharges is the combined effect of dense nanosecond-discharge plasma with the power density of energy contribution of hundreds of megawatts per cubic centimeter, a supershort electron beam with a wide energy spectrum and optical radiation of different spectral ranges of the plasma discharge.

The aim of this work is to study the effect of a nanosecond volume discharge plasma forming in an inhomogeneous electrical field at atmospheric pressure on the HgCdTe (MCT) epitaxial films of the p-type conductivity grown by molecular beam epitaxy.

For experiment, three series of specimens epitaxial CdHgTe films p-type conductivity (p = 1.1 ± 2.5×1016 cm⁻³, μp = 300 ± 500 cm²V⁻¹s⁻¹), grown by molecular beam epitaxy at the Institute for Semiconductor Physics of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk) were prepared. The as-grown specimens were located in a gas diode on a copper anode. Use was made of a Radan-220 generator as a pulse-voltage source forming voltage pulses with the amplitude ~ 230 kV (open-circuit voltage), high-amplitude pulse duration ~ 2 ns (at a matched load), and rise time ~ 0.5 ns. The specimens were irradiated in the pulsed-periodic mode at the pulse repetition rate 1 Hz. The action was realized through 100–1200 pulses for a series of specimens irradiated in air. The electrophysical parameters of the MCT specimens before and after irradiation were found from the Hall-effect measurements using the Van-der-Pauw method. The measurement were performed at a direct current through the specimen (I = 1 mA) for two directions of the current and two directions of the constant magnetic field.

Analysis of the results of measurements of the electrophysical parameters of the MCT epitaxial-film specimens subjected to pulses of a nanosecond volume discharge reveals that upon irradiation by 100–1200 pulses all the specimens exhibit an increase in conductivity. The specimens irradiated by 100 – 400 pulses, however, exhibit a decrease in the Hall coefficient. In so doing, the field dependence of the Hall coefficient is characterized by a shift of the inversion point of the Hall coefficient sign to the region of higher magnetic fields from 0.17 T to 0.28 T.

An increase in the number of volume-discharge pulses up to 600 results in the inversion of the Hall-coefficient sign in the range more than 0.2 T. A still further increase in the number of pulses exposure leads to a decrease in the value of the Hall coefficient. It has been suggested that, on or near the surface of the film formed by a layer of highly conductive n-type, whose parameters are such that the measured field dependence of the Hall coefficient corresponds to the n-type conductivity. Also the lack of relaxation of electrical parameters of irradiated specimens within 3 months is noted.

Thus, our experimental data show that the action of pulses of nanosecond volume discharge in air at atmospheric pressure leads to changes in the electrophysical properties of MCT epitaxial films due to formation of a near-surface high-conductivity layer of the n-type conduction. The preliminary results show that it is possible to use such actions in the development of technologies for the controlled change of the properties of MCT narrow-band solid solutions and production of structures whose structure is heterogeneous with respect to conduction.

REFERENCES


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