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Laser-stimulated doping effect on gallium phosphide structure and properties

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A *p-n* heterojunction emitting in the yellow-green spectral region with the intensity maximum at 570 nm and the line halfwidth of 28 nm has been formed by laser-stimulated doping of gallium phosphide with isovalent indium impurity. The current running across the heterostructure did not exceed 4.5 mA at good luminance characteristics. The structure features, current-voltage and luminescence characteristics evidence a considerable contribution of the athermal mechanisms in laser radiation interaction with gallium phosphide.

В результате лазерного легирования изовалентной примесью индия получены *p-n*-гетеропереходы, излучающие свет в желто-зеленой области спектра с максимумом интенсивности 570 нм и полушириной 28 нм. При хороших яркостных характеристиках ток, проходящий через гетероструктуру, не превышал 4,5 мА. Особенности структуры, вольт-амперные и люминесцентные характеристики гетероперехода свидетельствуют о существенном вкладе атермических механизмов взаимодействия лазерного излучения с фосфидом галлия.

The interest in laser-stimulated doping is due to the fact that the method provides a simple way to doped layers at the controlled impurity implantation depth and an acceptable structure perfection. Moreover, the wide possibilities of the irradiation regime variation can provide modified areas of the doped matrix with preset periods of the quasi-bidimensional lattice being formed [1]. Although the mentioned doping method is used in a more and more widening field, many problems of the laser radiation interaction with the film of the metal to be implanted applied on the crystal surface are still open to discussion. This hinders the method use aimed at provision the preset distribution of the dopant and formation of structures with desired properties.

The purpose of this work is to ascertain the controlled doping possibility of gallium phosphide single crystals with isovalent indium impurity atoms using high-power laser pulses with photon energy much less than the gap width of the material to be irradiated, thus providing the laser radiation absorption within the material bulk [2]. A neodymium laser radiation operated in the free generation mode was used for the doping, the laser beam power density was varied within limits of 10^6 to 10^7 W/cm^2. The pulse duration was selected to be of 2 ms that allows to attain the fused layer depth of about 10 μm [3]. The crystals were irradiated from the film side in air at room temperature by a series of pulses scanning the sample surface due to the preset movement of the sample holder perpendicular to the laser beam. The formed irradiated zone had the area of 5×10 mm^2. The laser beam diameter was 150 μm.

330 μm thick plates cut out of *n* type gallium phosphide single crystals grown by Czochralski technique were used as the samples, the cutting plane was (111). In the course of growing, the crystals were doped with sulfur, the concentration of the electrically active impurity was 10^{17} cm^{-3}. To understand more clearly the role of intrinsic defects in the processes occurring under the laser-stimulated doping of gallium phosphide, the structure perfection and