About Expediency of Use of the Reemission of Photons for Increasing Light Intensity of Multilayer LEDs that Can Be Exposed to Radiation

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Abstract – **On the basis of the obtained experimental regular dependences the probable causes of the degradation of emission of multilayer GaAlAs-LEDs after gamma irradiation are considered.**

Keywords - **Multilayer structures, Optical emitters, Gamma radiation hardness, Degradation.**

I. INTRODUCTION

LEDs fabricated in a GaAlAs - multilayer heterostructures (MLH-structures) have a few advantages. At the expense of forming of the intermediate GaAlAs-layers between the GaAs-substrate and GaAlAs-active region it is possible to achieve the considerable decrease of a defect level in active region, that will lead to magnification of an emission quantum efficiency [1]. As we considered in earlier published paper [2], the additional intermediate layer can be used for reemission of photons. That considerably decreases self-absorption and increases a total emission intensity of LED. Layer-to-layer difference of electronic and emitting properties of MLH-structures affects also characteristic properties of their degradation. Use of MLH-structures allows us to separate degradation processes related to redistribution of an electric charge from degradation that cause increasing of recombination of charge carriers.

II. DISCUSSION OF OUTCOMES OF EXPERIMENT

We carried out experimental investigation of irradiation-induced degradation of GaAlAs MLH-structures at various parameters of exposure of an irradiation by a gamma quanta Co^{60}. The structure of samples and experimental technique are reduced in papers [2,3].

We have measured current-voltage and electroluminescent characteristics of the LEDs before and after of exposure by integral gamma-quantum’s flux with intensity from 10^{16}quanta/cm^2 to 10^{18}quanta/cm^2.

After of radiation exposure of samples we observed the quenching of luminescence at a long wavelength component of a spectrum and some decreasing of intensity of a short-wave component. But, even for various parameters of exposure we have detected no shifting of maximums of a emitting intensity and no modification of a halfwidth of spectrum bands.

Gamma-radiation of such intensity not changes the main mechanism of generation of photons at the recombination kind of emission.

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Absence of additional emission bands in spectrum of the samples is an argument in favour of the fact, that irradiation-induced disturbances are the nonradiative recombination centres, which are decreasing a total efficiency of process of light emitting.

After the exposing by a gamma-radiation we obtained the current-voltage characteristic with the parallel shift to high-currents region. We consider such modifications of the current-voltage characteristic as result of decreasing of a lifetime of charge carriers after the exposing. During an exposure by a hard radiation in a volume of MLH-structure appear irradiation-induced defects, which are an active recombination centres that shorten lifetime of charge carriers.

We did not observe any variations in the values of breakdown voltage after an exposure. This fact indicates that intensity of irradiating, which we used in experiments, is insufficient to produce essential changes in impurity concentration.

As the above statements indicates, after irradiation of MLH-structures the significant increasing of number of a nonradiative recombination centres shorten a lifetime of charge carriers. This can lead to practically full decreasing of emission intensity even at such irradiation integral fluxes at which carrier density does not considerably vary yet.

Thus in contrast to lasers made based on MLH-structures, the irradiation-induced decreasing of total light intensity of MLH-LEDs due to optical losses and decreasing of electrons injection is an unnoticeable effect in comparison with predominating of nonradiative recombination.

III. CONCLUSSION

Obtained experimental information allows concluding that using the additional reemission of photons in intermediate layer for increasing a total emission intensity of LEDs that can be exposed to radiation is not expedient because after the irradiation the reemission long wave component of spectrum is practically completely quenched. That considerably decreases of resistance of LEDs to irradiation-induced degradation.

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