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LPE SEPARATE CONFINEMENT InGaAsP/GaAs AND InGaAsP/InP DH LASERS WITH VERY LOW THRESHOLD

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It has been shown in [1,2] that DH laser with the active region thickness $d_a \simeq 0.02$ μm can be prepared in a rotating variant of LPE. However, in these works the decrease of threshold current densities (I_{th}) in comparison with those typical to DH lasers with $d_a \simeq 0.2$ μm was not obtained. In [3] with a method of liquid epitaxy, InGaAsP/InP DH lasers ($\lambda = 1.3$ μm) with separate confinement (SC) were fabricated with threshold for samples with four facets cleaved 512 A/cm at $d_a = 0.05$ μm. This paper reports for the first time on the fabrication of low-threshold SC InGaAsP/GaAs LPE DH lasers ($I_{th} = 260$ A/cm^2, $\lambda = 0.85$-0.79 μm) as well as on the achievement of threshold 300 A/cm^2 in similar SC InGaAsP/InP DH lasers ($\lambda = 1.25$ μm).

The calculations performed show that the reason for I_{th} to decrease with d_a decreasing in SC DH lasers may be the following: 1) the decrease of the threshold current component required to reach the inverse population; 2) the decrease of absorption losses in the active region especially significant in case of narrow-band gap InGaAsP/InP DH lasers. However, in narrow band lasers with d_a decreasing a relative role of Auger recombination increases and hence optimum values of d_a for these lasers may appear larger than for the wide-band gap InGaAsP/GaAs DH lasers.

The both types of laser structures described above were prepared by a usual LPE method in a modified sliding boat providing to produce InGaAsP layers of the given composition and doping, with thickness from 0.02 to 1 μm. Optimum parameters of laser structures were defined in the experiments on photopumping of isotype SC DH structures using a number of pulsed and continuous lasers (Nd^{+3}, Ar^+- and Kr^+- lasers). For SC InGaAsP/InP DH in accordance with the data [3] minimum values of I_{th} were obtained in the structures with $d_a \simeq 0.06$ um and total thickness of both waveguide layers $d \simeq 0.4$ μm. P-n junction in these structures was produced by Zn diffusion to isotype N-n-N structure. The position of p-n junction coincided with the heteroboundary between up-

per InP-emitter and InGaAsP-waveguide layer. The lowest value of threshold current density in four facets cleaved lasers was 300 A/cm^2. Minimum threshold current was 25-30 mA.

In case of InGaAsP/GaAs DH, wide band emitters were made of n- and p-$In_{0.49}Ga_{0.51}P$ doped by Zn snf Te during the growth process. Undoped $In_{0.25}Ga_{0.75}As_{0.52}P_{0.48}$ waveguide layers and InGaAsP-active region have band gaps 1.7 and 1.43 - 1.57 eV, correspondingly. Lasers with best parameters were fabricated from the structure with d_a = 0.02 μm. For four facets cleaved samples minimum I_{th} was equal to 260 A/cm^2, and for usual broad-area lasers with cavity length L=500 μm, the smallest I_{th} was 530 A/cm^2. Threshold currents in samples of L ≥ 300 μm were small enough (as in case of four facets cleaved InGaAsP/InP lasers mentioned above) to obtain a continuous way operation for broad-area samples. In the laser of 310x140 μm the emitting power per one mirror at I = 1 A was 77 mW. In diodes with L < 500 um I_{th} increased linearly with 1/L; differential quantumefficiency (η_d) increased with 1/L in the same samples. For a lser with L = 300 μm η_d was 25% per one mirror within the interval (1.2-2.5) I_{th}. Emission pulse power with pulse duration 100 nsec at I = 2.5 I_{th} was equal to 0.5 W and the total efficiency of electrical to light power conversion per two mirrors was 20%.

References

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