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B—7—3 AlGaAs TJS-lasers With Very Low Threshold Current And High Efficiency

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1. Introduction

In previous papers[1-3], we have reported that TJS-lasers show the excellent characteristics such as the fundamental transverse mode, the single longitudinal mode, long-life over 12,000 hr and low threshold current operation of 40 mA at room temperature. Further reduction of the threshold current of the laser is advantageous for modulation and for reducing the junction temperature rise. In this paper, we present that the TJS-lasers show the very low threshold current of approximately 20 mA and can operate with an upside up configuration.

2. Fabrication

The structure of TJS-laser is shown in Fig. 1. Table 1 shows the parameters of each growth layer. The cavity length with a Fabry-Perot resonator was 250 μm and the width of the active region was approximately 2.5 μm.

3. Results

Figure 2 shows the dependence of the threshold current on the active layer thickness. Each solid line shows the calculated one on the assumption that the threshold current density at the GaAs p-n homojunction are 40,000 and 50,000 A/cm^2, respectively.[4] The threshold current can be proportionally reduced by narrowing the active region thickness and is approximately 20 mA when the active region thickness is 0.2 μm. Our experimental result shows fairly good agreement with the calculated lines as indicated by the dots in Fig. 2.

In the TJS-lasers, the active region is automatically defined by the carrier diffusion length, so it requires no structural fineness in the lateral direction, which leads easy fabrication and excellent reproducibility. Figure 3 shows the output power curve of the six TJS-lsers, which contain Te (2x10^{18} cm^{-3}) in the active region, mounted in pill type packages. The value of the threshold current and the external quantum efficiency of each diode shows good agreement with each other.

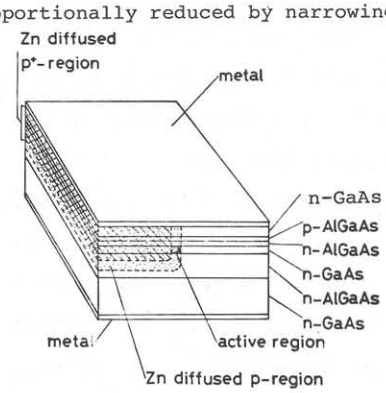

Fig. 1. The TJS-laser structure.

Table 1. Parameters of growth layers.

layer	material	thick-ness (μm)	Al cont. (x)	carrier conc. (cm^{-3})	Dopant
1st	n-GaAlAs	10	0.46	3x10^{17}	Te
2nd	n-GaAs	0.2-0.4	—	1.5x10^{18}	Te
3rd	n-GaAlAs	0.4	0.46	3x10^{17}	Te
4th	p-GaAlAs	0.4	0.46	1x10^{17}	Ge
5th	n-GaAs	30	—	3x10^{17}	Te

This means that the TJS-laser has the advantage of requiring less critical processing than the other DH lasers.

It is expected that these low threshold laser chips mounted upside up on Cu heat-sink can operate continuously at room temperature from the calculation on the assumption that the thermal resistance of the TJS-laser is approximately 250 °C/W. We experimentally confirm this fact. Figure 4 shows the relation between the light output power from the one side and the diode current when the TJS-laser chip is mounted upside up. This figure shows that over 10 mW of the light output power from one side could be obtained and its external differential quantum efficiency is approximately 30%.

4. Conclusion

The results are as follows:

(1) the TJS-lasers of which threshold current is approximately 20 mA can be reproducibly obtained when the active region thickness is controlled to be 0.2 μm,

(2) this result agrees well with the expected threshold current from the threshold current density of 40,000-50,000 A/cm^2 in the GaAs p-n homojunction laser,

(3) the TJS-laser has the advantage of requiring less critical processing than the other DH-lasers,

(4) the TJS-lasers mounted upside up on Cu heatsink can operate continuously at room temperature, so it is possible to set up easily on the heatsink.

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References

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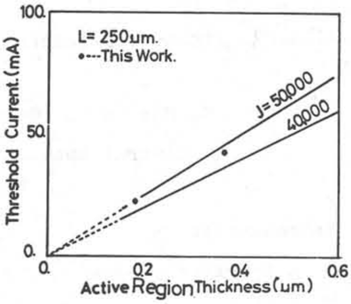

Fig. 2. Relation between active region thickness and threshold current.

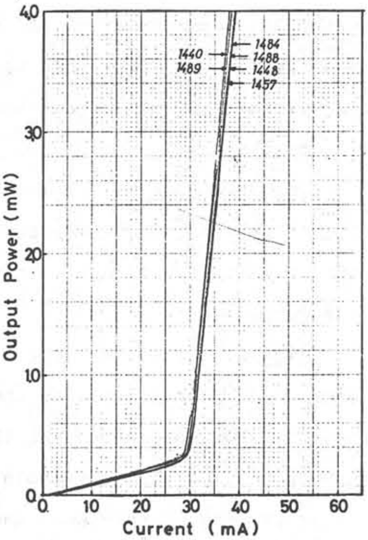

Fig. 3. Relation between diode current and output mounted upside down in a pill type package.

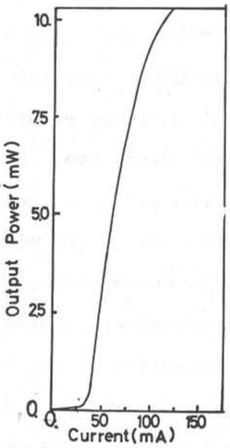

Fig. 4. Relation between diode current and output power from one side at room temperature mounted upside up.