High-power 660-nm AlGaInP laser diodes with a small aspect ratio for the beam divergence

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The objective of this work is to achieve high-power, highly reliable 660-nm AlGaInP laser diodes leading to an increase in the recording speed of recordable or rewritable digital versatile disk (DVD) systems.

The market for optical disk systems is growing rapidly in recent years. Particularly strong growth is seen in recordable or rewritable systems, such as the CD-R. DVD-R, -RW and -RAM systems are the most promising candidates for replacing the CD-R system because of their high recording capacity. High-speed recording is strongly required in such high-capacity systems. High-power operation of the 660-nm-band laser diodes used as the light source is indispensable for high-speed recording. It is also effective for decreasing the aspect ratio of the laser diode beam divergence to increase the laser power on the optical disk, because a small aspect ratio for the beam divergence enhances the optical coupling to an objective lens.

In this paper, we report on high-power 660-nm AlGaInP laser diodes with a small aspect ratio of 1.65 for the beam divergence. These laser diodes have demonstrated stable operation with the highest light output power to our knowledge of 90 mW for a real index guide structure.

The schematic structure of this high-power laser diode is shown in Fig. 1. It has a buried ridge stripe structure with an AlInP current blocking layer [1]. The active layer is a strain-compensated multiple quantum well (SC-MQW) structure, containing compressively strained GaInP wells and tensile strained AlGaInP barriers [2]. The optical confinement factor in the direction vertical to the junction plane is designed to be 0.034 and the refractive difference in the parallel direction is designed to be 3×10^{-3} in order to obtain a small aspect ratio for the beam divergence. We also employed a window-mirror structure to obtain a high catastrophic optical damage (COD) level [3]. The window regions are formed in the vicinity of both facets by Zn-diffusion. The cavity length is 900 µm and the reflectivity of the front and rear facets is 5% and 95%, respectively.

Figure 2 shows far field patterns in the directions vertical and parallel to the junction plane. Full width at half-maximum for beam divergence in the vertical and parallel directions are 16.5° and 10°, respectively, making the aspect ratio 1.65. The threshold current and slope efficiency of this device at 25ºC are 45 mA and 0.85 W/A, respectively. The emission wavelength is 658 nm. Figure 3 shows the life test results under a pulsed condition with a light output power of 90 mW at 60ºC. These laser diodes have been operating for more than 500h.

We believe that these devices will enable DVD-R, -RW and -RAM systems with recording speeds more than 4 times as fast as the standard speed.

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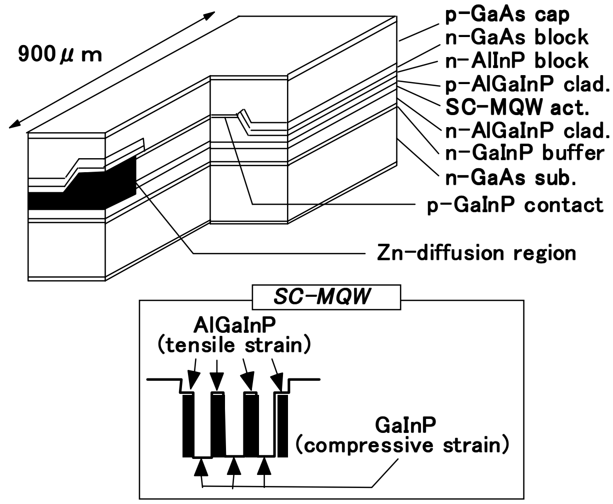

Fig. 1 Schematic structure of the high-power laser diode

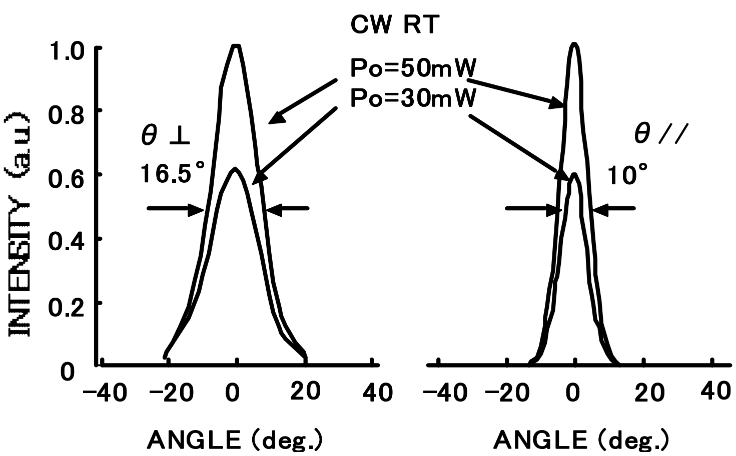

Fig. 2 Far field patterns in the directions vertical and parallel to the junction plane

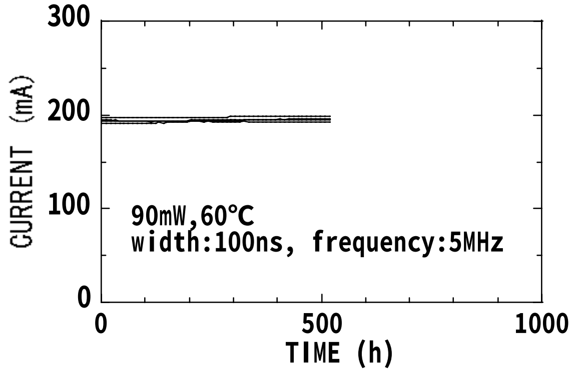

Fig. 3 Result of the life test under pulsed 90mW at 60°C