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Thermal Rollover around 460-mW Observation in Single-Lateral Mode 780-nm Laser Diodes with Window-Mirror Structure

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Abstract

Thermal rollover phenomenon in narrow stripe 780-nm AlGaAs laser diodes with window-mirror structure has been observed. It occurs around 460 mW at room temperature. The stable lateral mode operation up to 350 mW has been also realized. This is the first time observation of thermal rollover and the highest power record among the narrow stripe LDs with the wavelength of 780 nm. This LD is suitable for the next generation high speed (48x-) CD-R/RW drives necessitating 250 mW class LDs.

Introduction

A recordable or rewritable optical disk system is a promising external memory for PCs. CD-R/RW drives with 650 MB capacity have been already widely spreading, and writing speed of the drive is the most important interest for PC users, because they tend to handle a lot of information such as pictures of digital still camera. High-power, high-efficiency 780-nm LDs are strongly required for the CD-R/RW drives to increase the writing speed. A shorter pulse width of recording signal with higher laser output power enables higher writing speed. The required power is expressed as an experimental rule, which is proportional to the square root of writing speed [1]. The drives with writing speed of 48 x require the output power in excess of 250 mW. We have reported the 160 mW class 780-nm LDs with window-mirror structure for CD-R/RW [2,3]. In this paper, we demonstrate a high-power (over 350 mW) single-lateral-mode operation ,and a thermal rollover around 460 mW of 780-nm LD by improvement of window-mirror region.

Laser Structure

A schematic drawing of this LD is shown in Fig. 1. This LD has a real-refractive-index waveguide inner stripe structure for high efficiency operation. The maximum output power of LD, consisting of AlGaAs based material, is limited by catastrophic optical damage (COD). In order to improve the COD level, we have adopted a window-mirror structure at facets. The window-mirror structure was formed by impurity-induced disordering of DQW active layer. To disorder the DQW active layer, Si was selectively implantatied at window-mirror region. Length of the region is 20 μm. If the leakage current comes into the window-mirror region, it may cause the facet degradation. Therefore we have adopted proton implantation technique with high dose density in order to avoid the current leakage at the window-mirror region.

The cavity length of the LD including the window-mirror region is 900 μm. The front and rear facets are coated to be 8% and 90%, respectively. The LD chip is mounted on a heat sink with a junction-down configuration.

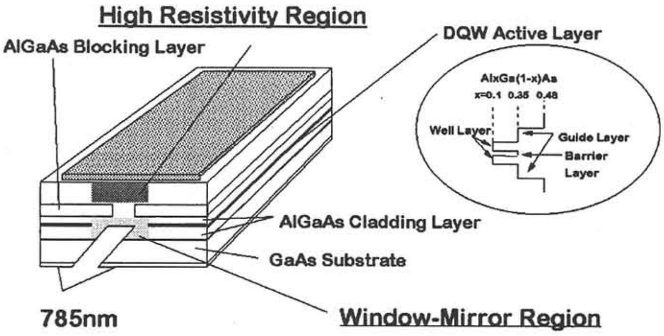

Fig.1 Schematic drawing of the window-mirror LD

Characteristics

Figure 2 shows the continuous-wave (CW) light output power versus current (P-I) characteristics of this LD in comparison with that of the window-mirror LD without the leakage current blocking at the window-mirror region. The latter one has the same active layer structure and facet coating, but its cavity length is 800 μm, and it is mounted with a junction-up configuration [3]. It is thought that the COD level is not affected by these differences dramatically. The newly LD shows the thermal rollover phenomenon around the output power of 460 mW, while one without the leakage current blocking degrades at 310 mW. This indicates that the non-leakage-current-injection structure by the proton implantation is effective to improvement of the COD level even in the window-mirror structure LDs. The kink-free P-I curve up to 360 mW is also realized.

The output power dependence of the far-field patterns of this LD is shown in Fig.3. There is no steering in the horizontal far-field distribution up to 350 mW. This indicates that single-lateral mode operation is maintained even at high power of 350 mW. At 350 mW, the beam divergences perpendicular and parallel to the junction plane [full-width at half-maximum (FWHM) power] are 16.9 ° and 11.2 ° (aspect ratio: 1.5), respectively.

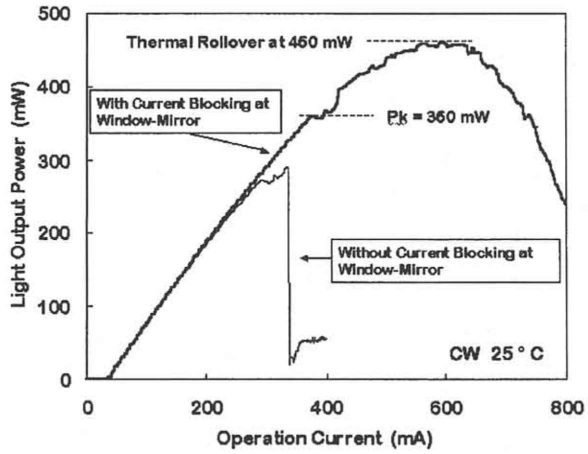

Fig.2 Light output power versus current characteristics

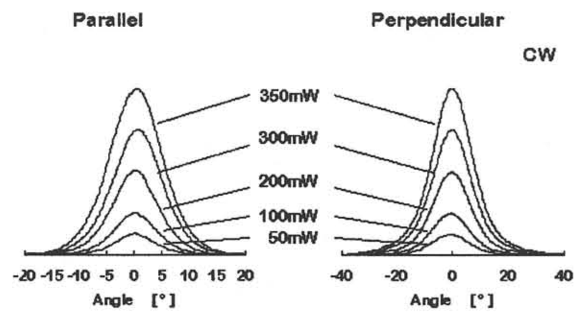

Fig.3 Output power dependence of the far-field patterns

The temperature dependence of P-I characteristics in CW and pulsed condition are shown in Fig.4. The maximum output power excess 220 mW at 70 °C is achieved even in CW condition. The P-I curves at high temperature show the thermal rollover, and no COD occurs. In actual CD-R drives, LD is operated in pulsed current. In pulsed condition (50% duty cycle, equivalent to the recording pulse of CD-R/RW), the linearity of the P-I curve improves even at 75 °C, and the light output power of 300 mW is achieved at that temperature.

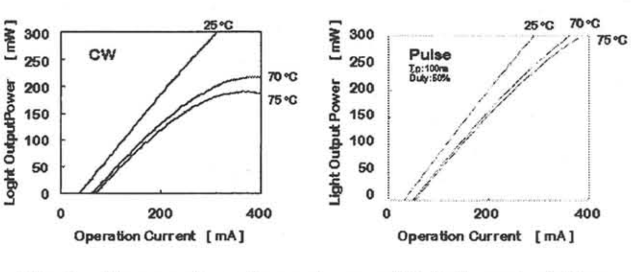

Fig.4 Temperature dependence of P-I characteristics

Summary

In summary, we demonstrate the high-power (360 mW) at room temperature single-lateral-mode operation of 780 nm window-mirror LD with the non-carrier-injection structure. This LD shows no COD, and thermal rollover phenomenon around 450 mW. To the best of our knowledge, this is the first time observation of thermal rollover and the highest power record among the narrow stripe LDs with the wavelength of 780 nm. This LD is suitable for the next generation high speed (48x-) CD-R/RW drives necessitating 250 mW class LDs.

References

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