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Lasing-Wavelength-Change-Suppression 980 nm Pump Laser Diodes for Metro Applications

Kazushige Kawasaki, Kimio Shigihara, Hiromasu Matsuoka, Yasuhiro Kunitsugu, Tetsuya Yagi, Etsuji Omura,and Yasuo Mitsui

High Frequency and Optical Semiconductor Division, Mitsubishi Electric Corporation
4-1,Mizuhara, Itami, Hyogo 664-8641, Japan
Phone:+81-72-780-2523, Fax:+81-72-780-2663, E-Mail:kawasaki@lsi.melco.co.jp

1. Introduction

High power 980 nm laser diodes (LDs)[1,2] are used as a pumping source of Erbium doped fiber amplifiers (EDFAs). System construction without Fiber Bragg gratings (FBGs)[3] and thermal electric coolers (TECs) is strongly required in order to reduce cost and power consumption for metro applications. Therefore, high power 980 nm LDs with small lasing-wavelength-changes during various operational conditions are greatly needed in this system.

We have proposed a new technique of lasing -wavelength-change-suppression by means of facet coatings of which facet reflectivity decreases as lengthening wavelength. We confirm that the proposed LDs have less than one-third reduction of lasing-wavelength -change compared with the conventional ones. Moreover, the proposed LDs possess more than 350 mW kink free output power even at 95℃.

2. Suppression method of lasing wavelength change

Fig.1 shows a concept of lasing-wavelength-change -suppression. When the facet reflectivity is independent of wavelength, mirror loss is also independent of wavelength (broken line). In this conventional case, the lasing-wavelength-change between low and high temperatures is expressed as $\lambda_h'-\lambda_l'$. On the other hand, the mirror loss increases as lengthening wavelength (solid line) when the facet reflectivity decreases as lengthening wavelength. The lasing-wavelength-change is expressed as $\lambda_h-\lambda_l$ in the proposed case. The lasing-wavelength -change of proposed LD is smaller than that of conventional LD as indicated in the figure ($\lambda_h-\lambda_l<\lambda_h'-\lambda_l'$).

The conventional LD has the threshold gain of g_h' at high temperature and that of g_l' at low one, respectively. Similarly, the proposed LD has g_h and g_l , respectively. The gain difference between low and high temperatures of proposed LD (g_h-g_l) is larger than that of conventional LD ($g_h'-g_l'$) as depicted in Fig. 1. Therefore, it is expected that the lasing-wavelength-change of proposed LD $(\lambda_h-\lambda_l)/(g_h-g_l)$ is much smaller than that of conventional LD $(\lambda_h'-\lambda_l')/(g_h'-g_l')$, when temperature or/and injection current changes.

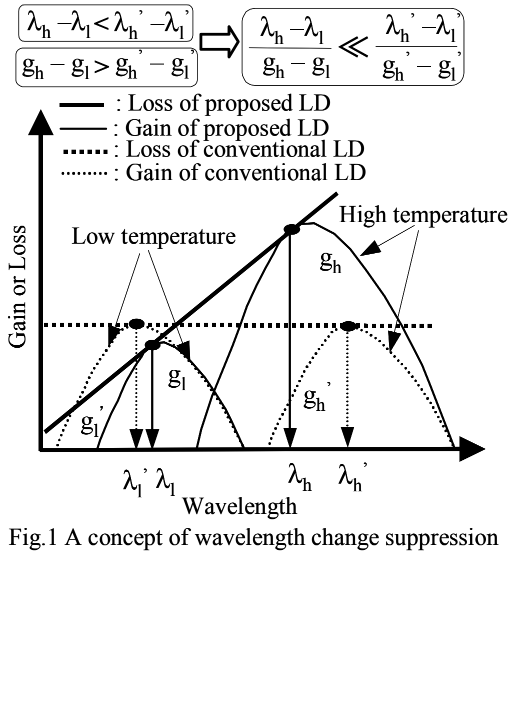

Fig.1 A concept of wavelength change suppression

3. Dependence of facet reflectivity and mirror loss on wavelength

Two 980nmLDs of which front facets are coated to be AR(Anti-reflective), are prepared as examples. Rear facets are coated to be 98% and its value is independent of wavelength around 980nm.

The front facet reflectivity distributions are shown in Fig. 2 as (a)' and (b)'. Mirror loss distributions

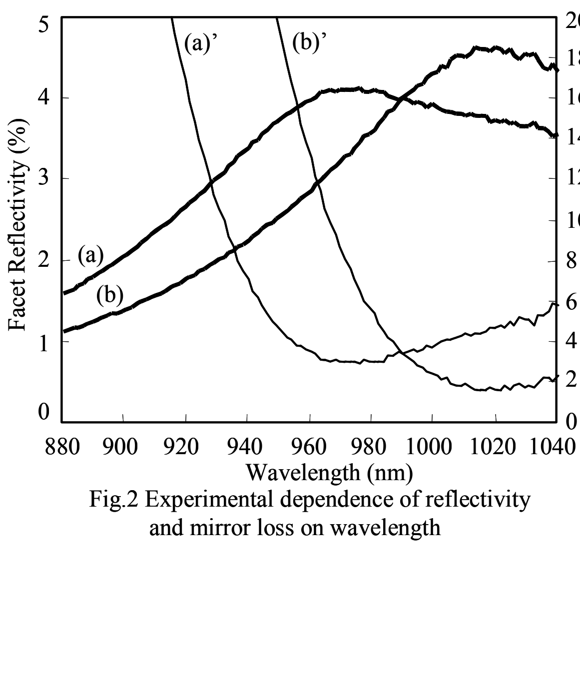

Fig.2 Experimental dependence of reflectivity and mirror loss on wavelength

corresponding to the facet reflectivity distributions are also shown in the same figure, which are symbolized as (a) and (b). Type (a) shows almost constant mirror loss around 980 nm wavelength (conventional LD). Type (b) has the large increment of mirror loss around the same wavelength(proposed LD).

4. Device characteristics

Fig. 3 shows dependence of lasing-wavelength on operation current for the two kinds of LDs. Ambient temperature was used as a parameter on measuring the wavelength. Lasing-wavelength-change between 15 ℃ -100 mA and 95℃-600 mA for conventional LD(a) and that for proposed LD(b) are 37.4nm and 11.7nm, respectively. It is estimated from the figure that the larger increment of mirror loss contributes the smaller wavelength change.

Fig. 4 shows typical dependence of light output power versus current (P-I) characteristics on ambient temperature (proposed LD). Very stable operations are obtained from room to high temperatures without kinks. It is thought that the proposed LDs are suitable for metropolitan applications because the kink free output power is greater than 350 mW even at 95℃ and the lasing –wavelength-change is very small.

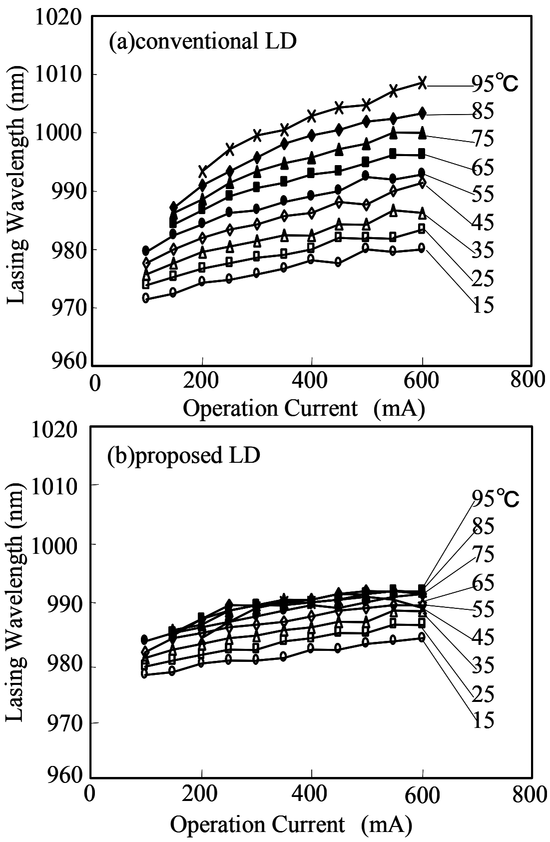

Fig.3 Dependence of Lasing Wavelength on Operation Current and temperature corresponding to Fig. 2

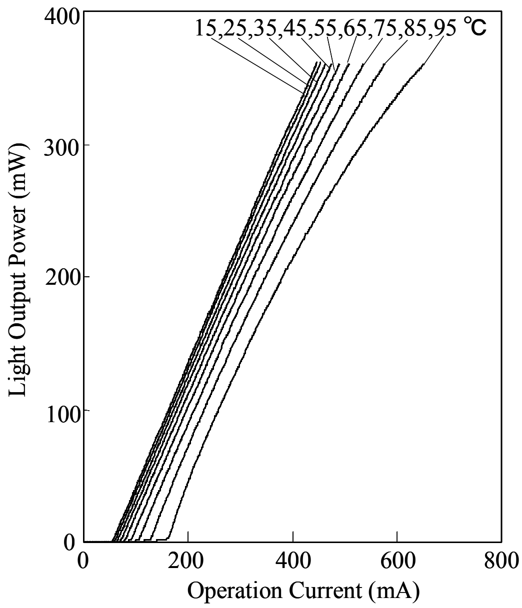

Fig. 4 Dependence of P-I characteristics on temperature

5. Conclusions

We have proposed the new method of suppressing the lasing-wavelength-change by means of facet coatings of which facet reflectivity decreases as lengthening wavelength. Less than one-third wavelength-change -suppression was achieved. In addition, more than 350 mW output power was easily obtained even at 95℃. It is believed that this technique is very effective to suppress the lasing –wavelength-change during operation. Therefore, the proposed LD is suitable for metropolitan applications, because the LDs are able to eliminate fiber Bragg gratings and thermal electric cooler.

6. References

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