Extended Abstracts of the 1999 International Conference on Solid State Devices and Materials, Tokyo, 1999, pp. 272–273

Invited

High Power Laser Diodes for EDFA Pumping

Akihiko KASUKAWA

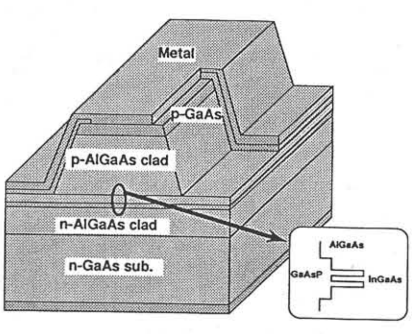
Yokohama R&D laboratories, The Furukawa Electric Co., Ltd.
2-4-3, Okano, Nishi-ku, Yokohama 220-0073, Japan
Tel : +81-45-311-1219 Fax : +81-45-314-5190
e-mail : kasukawa@yokoken.furukawa.co.jp

Introduction

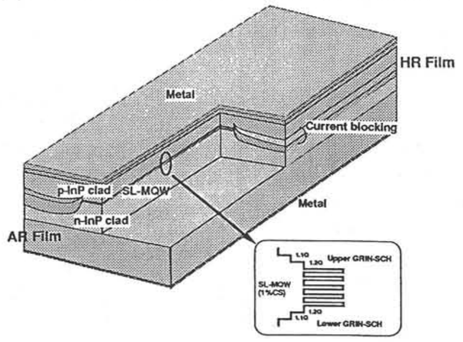
Wavelength-division-multiplex (WDM) systems are introduced in order to manage increasing demands for large capacity. Total throughput transmission capacity of over 100Gbps or more can be realized using a developed 2.5Gbps technology. EDFA is one of the key components in order to construct high dense WDM system. In this paper, high power narrow stripe lasers emitting at 980nm and 1480nm are reviewed for the application of EDFA pumping.

Device performance

Schematic diagram of 980nm and 1480nm lasers are shown in Fig.1. Ridge waveguide (RWG) structure is used for GaInAs/AlGaAs 980nm and buried heterostrcture (BH) is used for GaInAsP/ InP 1480nm lasers. Structural optimization should be made in terms of high performance [1,2] and high reliability [1].



(a) GaInAs/AlGaAs 980nm RWG laser



(b) GaInAsP/InP 1480nm BH laser
Fig.1 Schematic diagram of 980nm and 1480nm lasers

Much efforts have been devoted towards high quantum efficiency for low power consumption, narrow beam divergence for high coupling efficiency into single-mode fiber, facet passivation for high reliability, especially for 980nm. There are two different mechanisms for limiting maximum light output power for 980 and 1480nm lasers. One is catastrophic optical mirror damage (COMD) and the other is power saturation due to leakage current and thermal effect. The former is commonly observed in 980nm lasers, especially transverse-mode stabilized narrow stripe lasers.

Figure 2 shows a typical L/I curve of our 980nm laser. No initial COMD is observed, and output power is limited due to the thermal effect. The light output power of over 400mW is obtained, with a high kink current of 400mA. The typical output power of 200mW is obtained at a current of 250mA. The FWHM of FFP's parallel and perpendicular to the junction plane are 11° and 23°, respectively. Both high kink current and narrow far-field pattern are favorable for high fiber coupling.

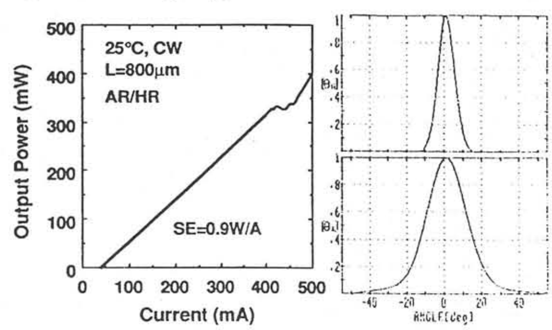


Fig.2 L-I characteristics of a 980nm laser

MTTF of 500,000 hours is predicted under 200mW operation at 25°C [3].

Figure 3 shows the L/I curve of a 1.2mm-long 1480nm laser. An extremely high power of 360mW is obtained [4], which is the maximum output power ever reported, to our best knowledge. Our approach for high power operation is the optimization of the composition and thickness of GRIN-SCH

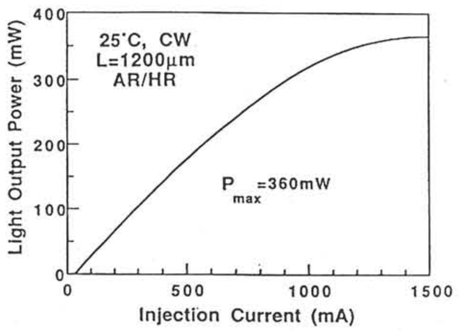


Fig.3 L-I characteristics of a 1480nm laser

structure, together with the optimization of BH structure grown by MOCVD. The MTTF of more than 1,000,000 hours is predicted at 25°C.

Module performance

Conventional pig-tail modules as well as fiber-Bragg-grating modules for wavelength stabilization are fabricated both for 980nm and 1480nm. A 2-lens coupling scheme is used for 1480nm laser modules, and a lensed fiber coupling scheme is used for 980nm laser modules. Figure 4 shows the coupled power characteristics of 1480nm lasers. Coupled power of over 320mW was achieved, which is the highest power, to our best knowledge [5]. Nearly circular output beam obtained on our lasers, as well as optimum optical design in the package enables us to get very high coupling efficiency of over 80%. Extremely high output power of 250mW was commercially available. Over 200mW coupled power was attained in modules with FBG for wavelength stabilization [6].

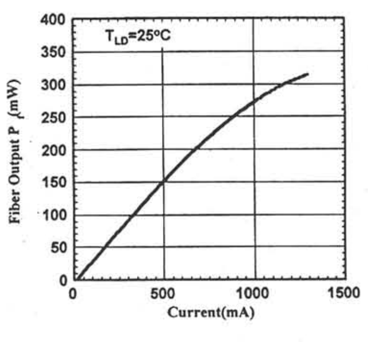


Fig.4 Coupled power characteristics of 1480nm lasers.

Figure 5 shows the coupled power characteristics of a 980nm laser module. A device design for the very high kink current as well as high coupling efficiency of approximately 75% leads to very high coupled output power of over 230mW [7]. High power 980nm and 1480nm pump laser modules can extend the variety of EDFA applications.

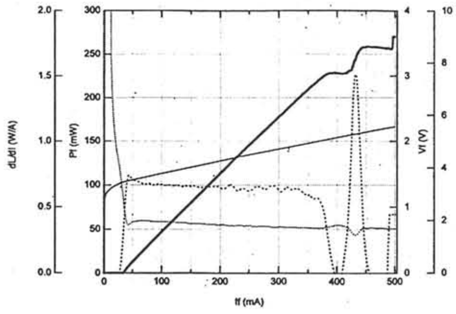


Fig. 5 Coupled power characteristics of 980nm lasers.

In conclusion, state-of-the-art both 980nm/1480nm lasers and their modules are reviewed. Both high power, high reliable pump laser modules are commercially available. Higher output power can be realized in lasers with either novel material or lower dimensional quantum size effects like quantum dot structure.

Acknowledgment
The author would like to thank Dr. K. Ohkubo, Dr. Y. Suzuki, Dr. T. Kamiya, J. Kikawa and M. Shibata for their encouragement. The author would like to acknowledge all members of the pump laser team at Furukawa.

References

[1] H.Meier et al., ECOC'94, Firenze, p.947 (1994)
[2] J. S. Major et al., Electron. Lett., 27, p.540 (1991)
[3] A. Kasukawa , OFC/IOOC'99, Paper TuC1 (1999)
[4] A. Kasukawa et al., IEEE Photon. Technol. Lett., 1, p.4 (1994)
[5] T. Kimura et al., Paper ThD12, OAA'99
[6] S. Koyanagi et al., OAA'98, p. 35 (1998)
[7] Y. Irie et al., OFC/IOOC'99, Paper WM15 (1999)