White Paper

Picosecond／Nanosecond／CW 1024-1120 nm, 1180 nm DFB Laser

QD Laser, Inc.

1. Introduction

Fiber lasers and solid-state / fiber hybrid lasers using a rare earth doped fiber or crystal are expected to be widely used in various industrial applications such as semiconductor inspection equipment, micromachining, LiDAR, etc., due to their compactness and robustness. We have developed and produced 1000 nm band wavelength semiconductor DFB (Distributed FeedBack) lasers, which can be used for seed light sources of these lasers, by utilizing crystal growth technology, grating formation technology, and semiconductor laser chip design technology (Fig. 1). This article introduces the features of our DFB lasers.

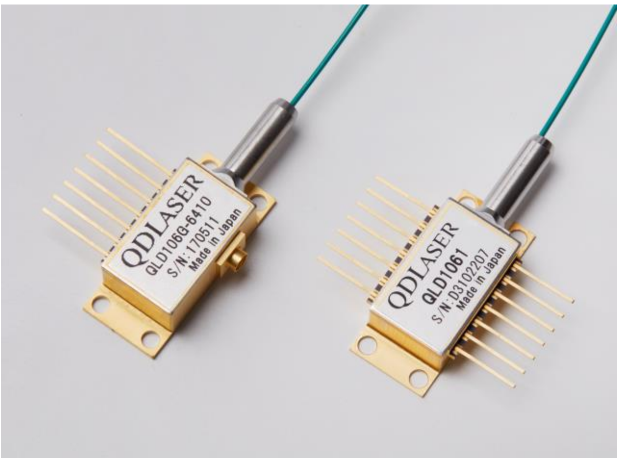

Fig. 1. DFB laser (Butterfly package)

2. Feature of DFB laser

A DFB laser consists of an active layer (light emitting layer), a grating and a waveguide formed on a semiconductor substrate. The active layer generates light with a wide spectrum. However, only a specific wavelength is resonated and amplified by a grating with strong wavelength selectivity and is emitted to the outside as laser light. A laser of any wavelength can be fabricated by an appropriate combination of the emission wavelength of the active layer and the period of the grating.

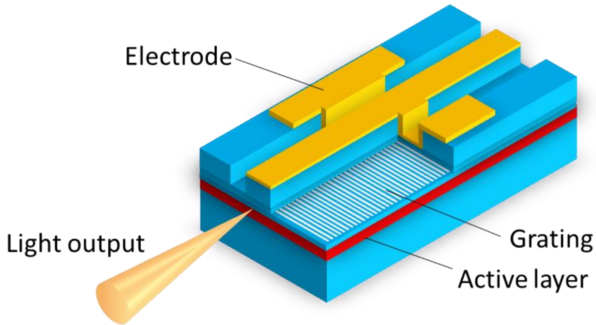

Fig. 2. Schematic of DFB laser chip

When a current applied to the DFB laser is modulated, an optical output power changes accordingly. Since the modulation band is determined by the RC time constant, nanosecond pulse generation and GHz-class direct modulation are possible without using an external modulator. It is also possible to generate a picosecond pulse under a gain switching operation by injecting a shorter electrical pulse. The gain switching operation is an operation that utilizes a strong short optical pulse oscillation phenomenon that occurs immediately after the semiconductor laser reaches the lasing threshold, and a semiconductor laser capable of high-speed modulation can generate a particularly short pulse.

Our 1000 nm band DFB lasers have the following features.

[1] Extensive wavelength lineup of 1024-1120 nm and 1180 nm (wavelength accuracy +/- 1 nm).

[2] Supports a wide range of applications from 15 picosecond pulse to nanosecond pulses and CW

[3] Single-peak gain switching pulse shape without secondary peak

[4] Various pulse condition settings

[5] Plug and play with a pulse and CW driver

[6] Custom support

The features of each are explained below.

[1] Extensive wavelength lineup of 1024-1120 nm and 1180 nm

InGaAs, which is obtained by adding indium to GaAs that emits light in the 850 nm band, is used for the active layer that emits light in the 1000 nm band. The larger the indium composition, the longer the wavelength of light emitted. However, the crystal strain on the GaAs substrate becomes greater, so high crystal growth technology is required to obtain an active layer with suppressing generation of crystal defects. We have realized a highly reliable active layer even at wavelengths exceeding 1100 nm by the MBE method in which crystals grow in an ultra-high vacuum reactor.

Our DFB laser is realized by the technology to form a diffraction grating inside the semiconductor and the regrowth technology to embed it, which we have cultivated in the development of lasers for optical communication where the performance criteria is strict. The DFB laser oscillates at a single frequency and with a narrow linewidth of 10 MHz or less (typical value) due to the strong wavelength selectivity of the diffraction grating. In addition, it is possible to provide wavelength accuracy of +/- 1 nm by precise control of the diffraction grating period. It covers a wide wavelength range of over 100 nm, including 1030 nm, 1053 nm, 1064 nm, and 1080 nm, which are typical wavelengths of fiber lasers. Using this DFB laser as a seed light source, various applications are possible such as second harmonic generation (green), third harmonic generation (ultraviolet) and high output power light source by wavelength multiplexing.

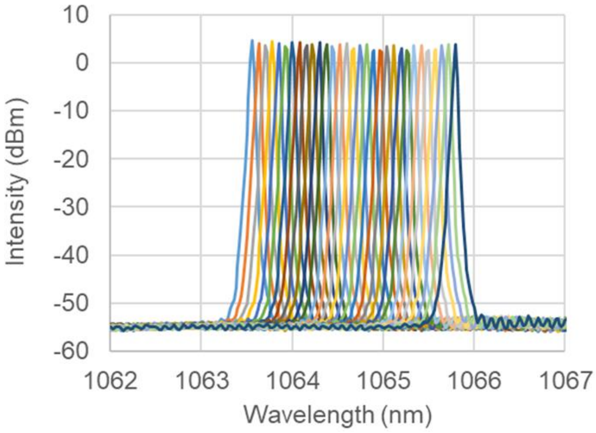

Fig. 3. Optical spectra

[2] Supports a wide range of applications from 15 picosecond pulse to nanosecond pulses and CW

We have developed DFB lasers to meet the needs of various pulsewidths. The 15 picosecond pulse is the world's fastest gain-switched semiconductor laser product and is suitable for seed light sources such as lasers for non-thermal processing, semiconductor inspection equipment, and supercontinuum light generation (Fig. 4).

The 50 picosecond pulse is suitable for seed light sources of lasers for micromachining such as semiconductors, organic LEDs and flexible printed substrates, and lasers for inspection in semiconductor manufacturing processes.

Nanosecond pulses are suitable for seed light sources of lasers for micromachining such as glass, solar cells, printed circuit boards, silicon and ceramics, and lasers for LiDAR (Fig. 5).

CW laser can be used for seed light of fiber lasers, sensing, and high power lasers by wavelength division multiplexing.

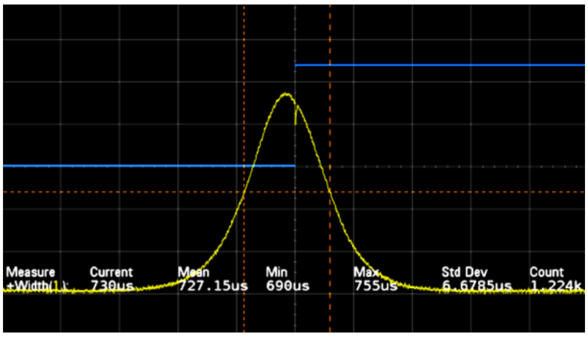

Fig. 4. 15 ps pulse waveform

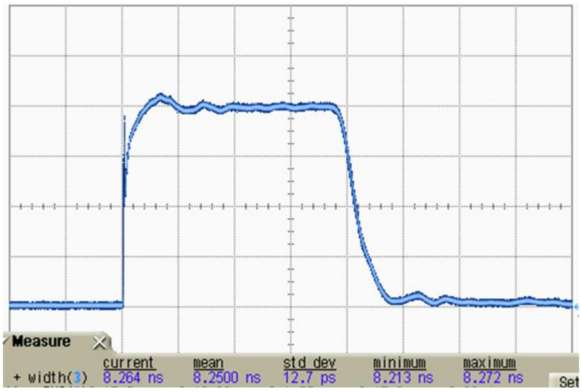

Fig. 5. Nanosecond pulse waveform

[3] Single-peak gain switching pulse shape without secondary peak

Since DFB lasers are used for seed light in fiber lasers and solid-state / fiber hybrid lasers, tailing or secondary peak in the seed light pulse affects the pulse quality of the fiber laser. If the pulse of the laser for micromachining contains tailing or secondary peak, a sharp cutting shape cannot be obtained due to residual heat in the object. In case of LiDAR, the signal-to-noise ratio deteriorates, leading to a decrease in detection sensitivity. As shown in Fig. 6, our gain switching pulse has a single peak without tailing or secondary peak, so an excellent pulse shape can be obtained even after amplification.

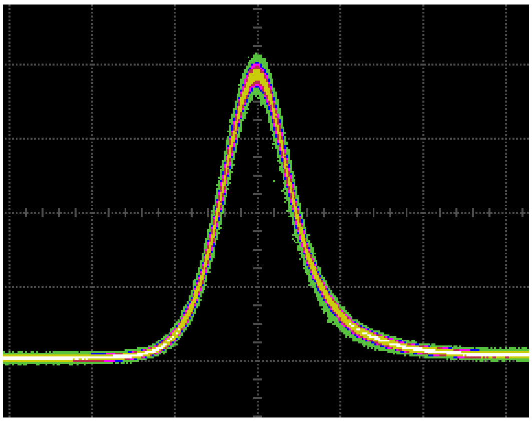

Fig. 6. Pulse waveform under gain switching operation

[4] Various pulse condition settings

Since the DFB laser can be directly modulated by the applied current and responds at high speed, it can cover from single shot to high repetition frequency on the order of MHz, and can operate even in burst mode. Also, it is possible to change the pulsewidth and pulse peak power for each pulse in nanosecond range.

[5] Pulse and CW driver

We have driver boards suitable for 15 picosecond pulse, 50 picosecond pulse, nanosecond pulse, and CW. DC bias current, pulse current, pulsewidth, repetition frequency, and LD temperature (all butterfly packages have a built-in Peltier module) can be controlled with a dedicated software, so you can use it immediately after purchase. In addition, by combining an external clock and programming, more flexible pulse drive conditions can be set, and it can be integrated into an equipment.

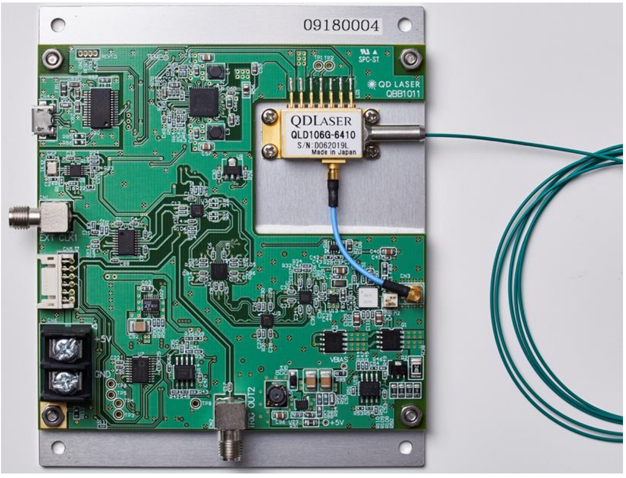

Fig. 7. Laser driver

[6] Custom support

Tables 1 and 2 show the main product lineup of DFB lasers and laser drivers. Due to the wide range of applications for DFB lasers, each customer has each requirement. Therefore, we have responded to numerous requests to support the creation of our customers' unique products. The followings are examples:

・Tighten a wavelength accuracy

・Use customer's driver board for shipping inspection to improve manufacturing yield at customer's site

・ Perform shipping test under specific driving conditions

・ Change the pin layout of a butterfly package

・ Provide a chip-on-carrier or TO-CAN package instead of a butterfly package

・ Remove an isolator from a butterfly package

・ Set a pass/fail criteria for spectrum width under pulsed operation

・Change a fiber type

・Need a 30 ps pulse instead of 50 ps

・Develop a dedicated laser.

Please feel free to contact us as we will respond flexibly to requests even if it is not listed here.

Table 1. Product lineup of DFB laser

Product series	QLD106G	QLD1x61	QLD106P	QLD106D	QLA1x6x
Pulse width	15 ps	50 ps, 1 to 20 ns	50 ps, 1 to 20 ns	1 to 20 ns (option: 50 ns)	50 ps, 1 to 20 ns
Wavelength	1030 nm 1064 nm	1024 to 1120 nm 1180 nm	1030 nm 1053 nm 1064 nm	1064 nm	1064 nm 1122 nm 1188 nm
Peak power (ps gain switching operation)	>50 mW	>100 mW	>100 mW	n/a	>300 mW
Peak power (ns pulsed operation)	n/a	>100 mW (1 to 5 ns) >300 to 400 mW (5 to 20 ns)	>300 mW >400 mW	>400 mW	>300 mW
Output power (CW operation)	n/a	>30 mW	>30 mW	>40 mW	>100 mW

Table 2. Product lineup of laser driver

Product series	QCED	QC2D	QC9D	QBB1005	QCBA
Pulse width	15 to 20 ps	50 ps to 9 ns	10 to 125 ns	CW	50 ps to 9 ns
Pulse repetition rate	12 kHz to 200 MHz	12 kHz to 250 MHz	3 kHz to 1 MHz	n/a	12 kHz to 5 MHz
Max. current	100 mA	200 mA	2 A	500 mA 2 A	DFB: 200 mA SOA: 2 A

3. Summary

We introduced the 1000 nm band DFB laser of QD Laser, inc. The product lineup with a wide variety of wavelengths and pulsewidths contributes to the creation of customers' unique products as it is suitable for seed light sources for various purposes such as lasers for micromachining, LiDAR, and inspection.