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1981

Development of a dynamic-single-mode indium-gallium-arsenide-phosphide/indium- phosphide DFB laser (NTT and Kokusai Denshin Denwa Co., Ltd.)

~ Discrete Semiconductor/Others ~

It was found that the minimum loss wavelength of optical fibers was around 1.55μm, and optical transmission of long span (over 50 km) was pursued at high speed exceeding 1 Gb/s in the 1.55μm band. The Fabry-Perot type laser used at that time became multimode oscillation when high-speed modulation was applied, and it could not satisfy the above requirement. The development of a dynamic single longitudinal mode laser which maintained single longitudinal mode oscillation at high speed modulation became active globally.

The methods studied at that time were as follows: (1) Distributed feedback type (DFB) laser, (2) Distributed Bragg Reflector type (DBR) laser, (3) Composite resonator laser, (4) External diffraction grating laser, (5) injection seeding type laser, and (6) short resonator laser. In Europe and the United States, (1), (4), (5) were actively studied without putting hands on the laser chips, but in Japan which preceded in device fabrication technology, the development of monolithic lasers in (1), (2) was promoted. In 1981, Utaka et al. of KDD and Matsuoka et al. of NTT succeeded in room temperature continuous wave oscillation of distributed reflection (DBR) type laser, and Abe et al. of Tokyo Institute of Technology succeeded in the same for distributed feedback (DFB) type, and this put the monolithic type in the global mainstream. DFB type was adopted as a light source for time division multiplexing (TDM: Time Division Multiplexing) light transmission from the viewpoint of operational stability, contributing to the full-scale operation of the NTT F-1.6G system, which started operation in 1987. On the other hand, the DBR type evolved into a wavelength tunable light source for Wavelength Division Multiplexing (WDM) transmission, which came to be widely deployed since 2000.

It was found that waveform transmission distortion occurred in the dynamic single mode laser caused by a small wavelength change called chirping at the time of high-speed modulation of 1.6 Gb/s or more, and the chirping control became a big issue. In 1988, Kobayashi et al of NEC succeeded in the significant reduction of chirping by DFB-MQW laser which deployed MQW (Multiple Quantum Well) structure, and further a strained multiple quantum well structure in active layer as shown in Fig.2.
As a more essential solution, Kawamura et al. of NTT developed an MI-DFB (Modulator-Integrated DFB) laser which integrated an external modulator in a chip as shown in Fig.3 in 1986, and it was adopted for the NTT FA-10G system which started service in 1996.

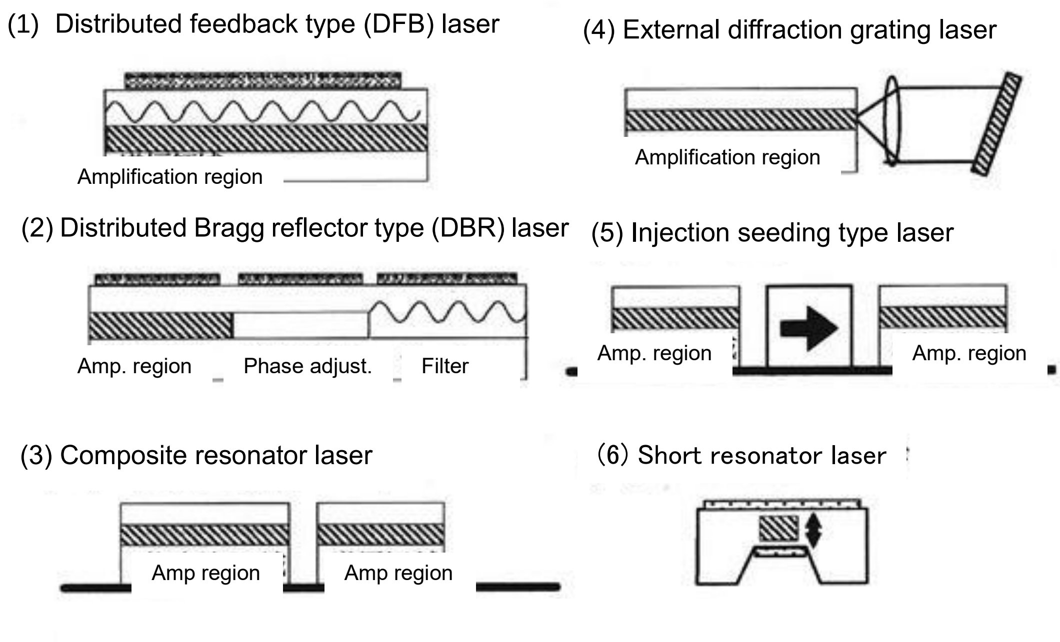

Fig.1: Dynamic single longitudinal mode lasers studied [1]

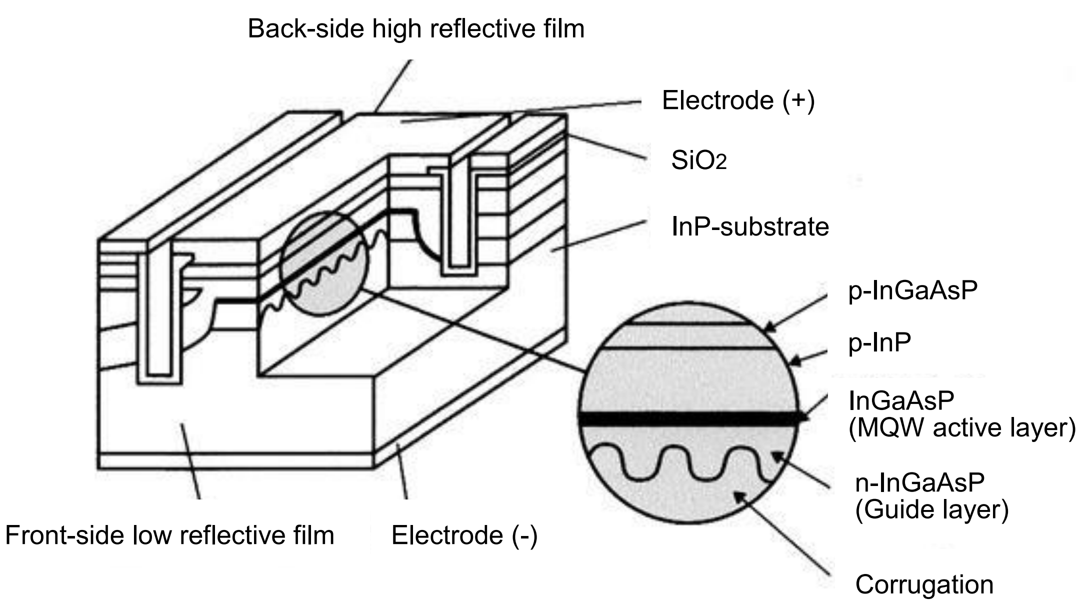

Fig.2: Structural schematic of distributed feedback multiple quantum well

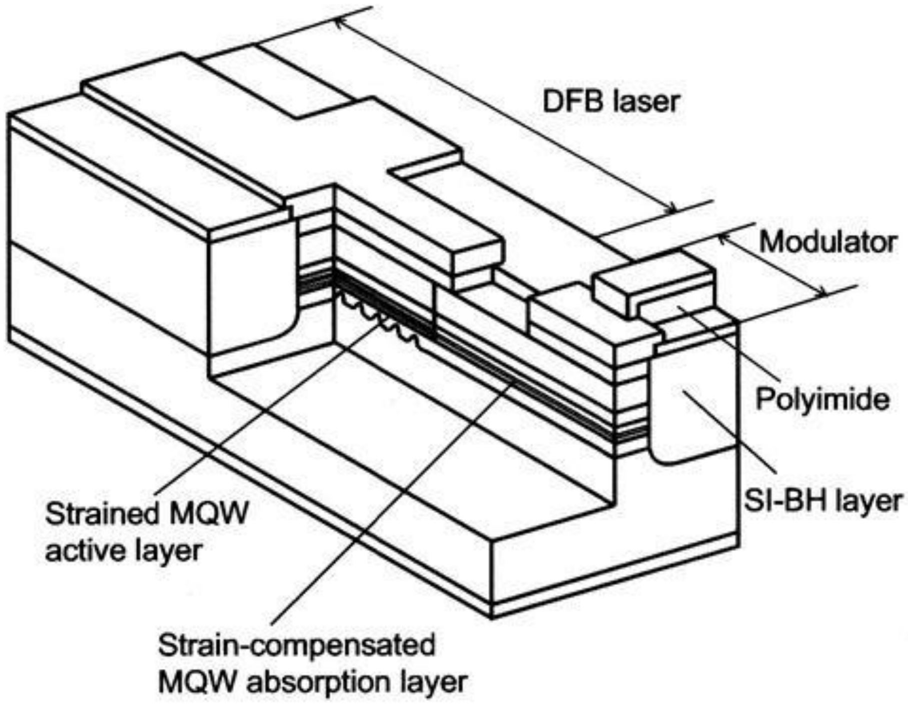

Fig.3: Structure of modulator-integrated distributed feedback laser (1)

Reference:

(1)Kiyohide Wakao, Haruhisa Soda, Yuji Kotaki, “Fujitsu Sci. Tech. J., Vol. 35, No. 1, pp. 100-106, (July 1999)
http://www.fujitsu.com/downloads/MAG/vol35-1/paper12.pdf

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