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2002

Release of a 10-Gbps surface-emitting semiconductor laser (Fuji Xerox Co., Ltd.)

~ Discrete Semiconductor/Others ~

Surface emitting laser (VCSEL: Vertical-Cavity Surface Emitting Laser) was invented by Iga of Tokyo Institute of Technology in 1988, and it was the first semiconductor laser invented in Japan to achieve continuous operation at room temperature for the first time in the world.
An ordinary laser is an edge emission type laser which emits laser light from an end of the cavity formed horizontally in a semiconductor chip with cleaved chip edges as reflecting mirrors. On the other hand, the VCSEL has a resonator in the direction perpendicular to the semiconductor substrate surface and emits laser light from the semiconductor surface. Since the volume of the active layer is small, it has an advantage that is not in the edge emitting type, such that it is possible to realize a small current, high speed driving, and a two-dimensional laser array can be easily realized.

The cross-sectional structure of a typical VCSEL is shown in the Figure.
An n-type buffer layer, an n-type $Al_{0.3}Ga_{0.7}As/Al_{0.9}Ga_{0.1}As$ DBR (Distributed Bragg Reflector) layer (Si doped) of 40.5 cycles, a triple quantum well $Al_{0.12}Ga_{0.88}As/Al_{0.3}Ga_{0.7}As$ active layer, p-type AlAs layer (Zn doped), 24 period p-type $Al_{0.3}Ga_{0.7}As/Al_{0.9}Ga_{0.1}As$ DBR layer (Zn doped), p-type GaAs contact layer (Zn Dope) are sequentially laminated by MOCVD method. The mesa structure is formed by dry etching until the n-type $Al_{0.3}Ga_{0.7}As/Al_{0.9}Ga_{0.1}As$ DBR layer is exposed. A reactive ion etching method was utilized using a chlorine-based gas. The oxide aperture shown in green is formed by steam oxidizing the p-type AlAs layer from the side surface of the mesa.
The VCSEL was delayed in practical use due to the requirement of a very complicated and precise crystal growth technique as described above, but after the use of AlAs lateral oxidation technology for the current confining means of VCSEL in 1994, the performance of VCSEL dramatically improved and it became possible to secure a product life of more than 10,000 hours. In 1996, as Honeywell entered the market, it began to be adopted full-scale in high-speed LAN in the United States from 1999.

Fuji Xerox developed a technology for steam oxidizing AlAs while observing the oxidation state in situ, called OPTALO (Optical Probing Technique for AlAs Lateral Oxidation), in order to accurately form the oxidation aperture diameter, and it developed a surface emitting semiconductor laser with the world's top level performance with oscillation wave length of 850nm, maximum optical output of 4mW and modulation speed of over 10 G bps. The company also commercialized an 8 × 4 single mode VCSEL array for laser printers.

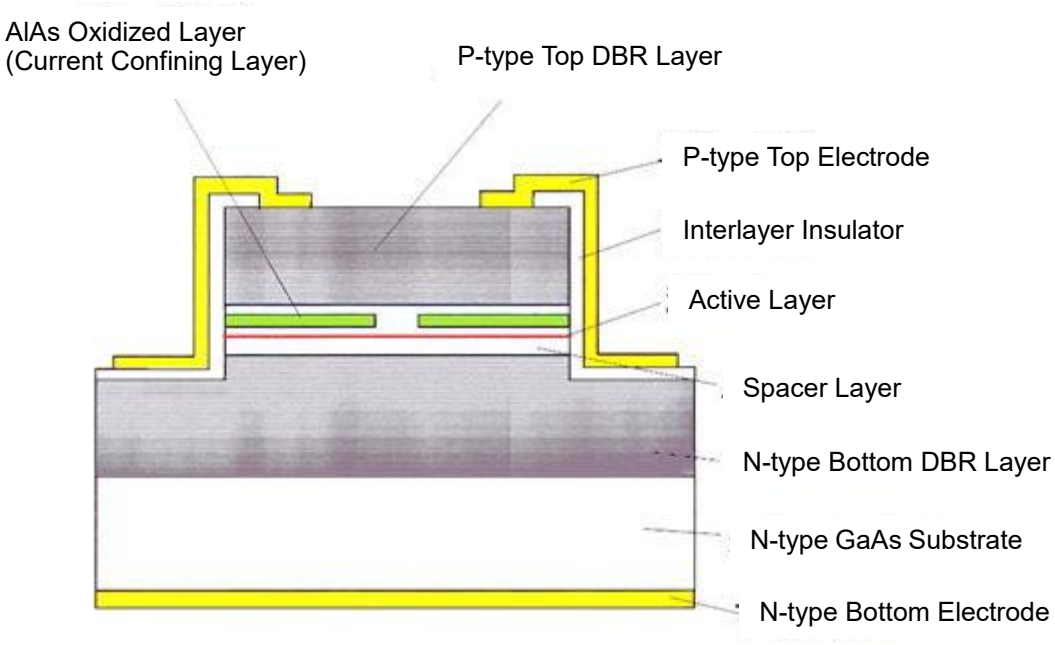

Fig.2 Schematic cross-sectional structure of a typical oxide-confined VCSEL and AlAs oxide layer.

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