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Development of a 650nm band aluminum-gallium-indium-phosphide based laser for DVD players (Matsushita, Toshiba, Sharp, and Sony)

~ Discrete Semiconductor/Others ~

CD with a GaAlAs laser light source of wavelength 780nm was commercialized in 1982 and spread in the market, and in the 1990s, development of a digital video disk (DVD) to store digital video images on a CD size optical disk was demanded. In order to increase the memory capacity from 0.65GB of CD to 4.7GB of DVD, 650 nm was adopted as the wavelength of the light source.

Among compound semiconductors, InGaAlP with the oscillation wavelength of 650nm was available as a crystal that could be epitaxially grown on a GaAs substrate (lattice match) for which the largest diameter crystal could be obtained. And each company promoted laser development by this material. Although quaternary material had many problems in crystal growth, NEC, Sony and Toshiba introduced InGaAlP/InGaP double hetero (DH) structure in 1985 by the development of vapor phase epitaxial growth (VPE) and metalorganic (MO) CVD, and they succeeded in continuous room temperature oscillation ahead of the world. In 1986, a transverse mode control structure required for optical disc applications was also realized.

In order to increase the power of the laser, a multiple quantum well (MQW) structure, a multiple quantum barrier (MQB) structure, etc. were introduced, and high temperature oscillation and high reliability were realized. Matsushita Electronics devised a structure with a highly doped saturable absorber layer (HDSA: Highly Doped Saturable Absorbing) in the p-type cladding layer as shown in the Figure, and it developed a low noise self-oscillation type laser.
DVD players equipped with these lasers were released in 1996 and began full-fledged spread around 2003.

After that, recording type (DVD-R, DVD-RW) was developed for DVD, and the lasers with light output of 20~30mW were developed for this. As the recording speed further increased to 2 × speed and 4 × speed, high power lasers were developed. Sony and Mitsubishi Electric commercialized a laser with the output of 220mW in 2003, which corresponded to 16 x speed, and Mitsubishi Electric delivered a laser output of 350mW capable of 16x speed recording to a 2 layers DVD+R disc.

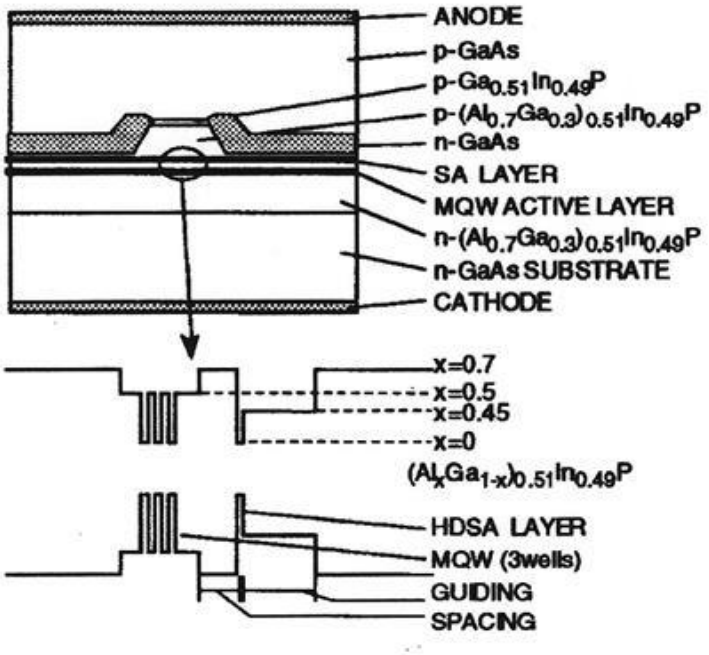

Fig. 2. Schematic cross section and band diagram of the transverse-mode stabilized AlGaInP visible laser diodes.

Cross-sectional schematic diagram and band diagram of self-oscillation type red semiconductor laser with saturable absorber layer [4]

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