Optimization of GaInAs MQW for NEAR INFRARED VERTICAL-EXTERNAL-CAVITY SURFACE-EMITTING LASERS

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Several types of lasers, such as, solid-state, semiconductor, gas, excimer, and dye lasers, have been developed. Today lasers are used in many fields, particularly in optical fiber communication, optical digital recording, material processing, biology and medicine, spectroscopy, imaging, entertainment, and many others. Due to exceptional material properties and/or investigation conditions various application require unique set of laser parameters - emission wavelength, its tunability, beam quality, operation temperature, optical output power, as well as convenient method of laser excitation, power consumption, high-speed modulation and device size is very important.

Vertical-external-cavity surface-emitting lasers (VECSEL) also called optically pumped semiconductor lasers (OPSL) or semiconductor disk laser (SDL) belong to relatively new laser family that combines many of the desirable properties. VECSELs were developed to overcome key problems typical to conventional semiconductor lasers. In comparison to both types of electrically pumped Vertical-cavity surface-emitting lasers (VCSELs), which emit circular fundamental transverse mode beam but exhibit low power and edge emitting lasers (Fabry-Perot and DFB) that can reach high output power but an asymmetric beam with strong angular divergence, VECSELS are capable to generate high optical power with circular beam quality.

VECSEL structure is demonstrated in Fig.1. To obtain lasing it is necessary to design the Bragg mirror, gain region and surface barrier layer (window) depending on the target wavelength of the laser. The gain region is usually composed from quantum well structure calculated to match the laser optical standing wave antinodes as shown in Fig.1 (black curve).

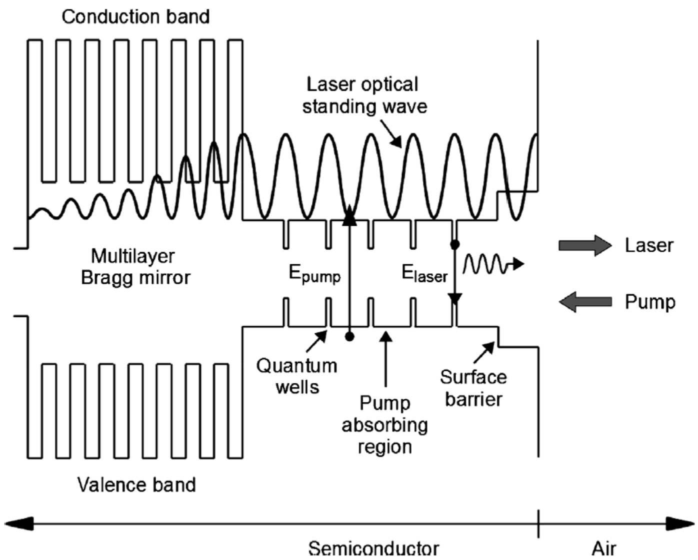

Fig. 1. Energy levels across the VECSEL structure [1].

In this work the modelling of design of VECSEL emitting at wavelength of 976nm was performed. Multiple InGaAs/GaAs quantum wells (MQWs) and AlAs/GaAs Distributed Bragg reflector (DBR) were used for VECSEL architecture. The separate layers and VECSEL structures were grown using solid-source MBE system (Veeco GENxplor R&D) equipped with standard cells for metallic Al, Ga and unique As design source generating pure arsenic dimers flux. The semi-insulating GaAs substrate oriented in (001) crystalline plane was selected for deposition of laser structures. To optimize the growth conditions In content in the well was changed from 10 to 15 %, the width of QW and barriers varied from 5 to 10 nm and from 10 to 15 nm, respectively. Quantum well number was set from 5 to 10. The reflectance of DBR was modelled for 25-30 GaAs and AlAs periods to obtain higher than 97% at central DBR wavelength of 976 nm.

All grown layers and VECSEL structures were characterized by Atomic Force Microscopy, Reflectance and Photoluminescence measurements.

1. Mark Kuznetsov, VECSEL Semiconductor Lasers: A Path to High-Power, Quality Beam and UV to IR Wavelength by Design, Semiconductor Disk Lasers. Physics and Technology. Edited by Oleg G. Okhotnikov, 2010, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim