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Structural and Optical Characteristics of Nanoscale Semiconductor Lasers for Telecommunication and Biomedical Applications: A Review

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Abstract. This paper presents the structural and optical characteristics of nanoscale semiconductor lasers for telecommunication and biomedical applications. Improved fabrication techniques, new materials and nano-scale heterostructures have led to improvement in the device performance. The material selection and their bandgap have an important role in the heterostructure to generate a lasing wavelength for particular applications. The bandgap modification can be done by the use of alloy semiconductor, quantum well structure, and strain layer epitaxy without changing the material itself. Semiconductor multilayers on the substrate are generally grown by using the metal-organic vapor phase epitaxy (MOVPE) and molecular beam epitaxy (MBE) process. Many researchers have provided different designs of heterostructures for the lasers. Generally, lasers are manufactured by using different semiconductor layers grown on GaAs, InP or GaSb substrate at the nanoscale. But controlling the thickness of the layer grown on the substrate at the nanoscale is the major problem in the fabrication. In a study, it has been found that for the proper functioning of semiconductor lasers it is beneficial to have light conduction and valence band masses. By using band structure engineering theory of quantum confinement and incorporation of strain on the active layer, this problem can be resolved. Red lasers are currently used in biomedical applications for treatment of superficial skin diseases like psoriasis, vitiligo etc. The manufacturing of red laser was earlier done by using nitrides material but they are harmful to skin and are expensive as well. An alternative for designing of red laser is manufacturing red lasers by using phosphides. The red laser is manufactured by using GaInP and AlGaInP ternary and quaternary compounds are widely used in the biomedical industry currently. This paper is the outcomes of the papers presented by many researchers in the field of optoelectronics.

Keywords: Double heterostructure, Laser, Quantum well, Optoelectronics.

1. Introduction

Nowadays in the world of science optoelectronic devices like LASER diodes, photodetectors, optical waveguides, directional couplers, and LED's are playing the major role in communication industries [1, 2]. The optoelectronics deals with the systems that detect and control the light and it is considered as a sub-field of photonics. Optoelectronic devices can be designed to be used for the shortwave infrared region, mid-wave infrared regions and near-infrared regions. The regions are selected on the basis of the wavelength at which the device is operating for an application [3]. Currently, for the treatment of tumor, cancer and superficial skin diseases, researchers are more concerned about the use of laser in telecommunication and biomedical applications in photo-dynamic therapy (PDT). A laser is a light