❖ Abstract

The present thesis covers the optimization of post-growth processing and various fabrication techniques for high-power laser diodes (HPLDs). This process includes laser diode processing, facet coating and packaging. Each of these processes play a significant role in determining the overall performance of the laser diode and need to be optimized very carefully, as various laser diode characteristic parameters viz. electrical, optical, spectral, and device life-time, depends on it. Present thesis includes the development and optimization of these processes for HPLDs to improve its performance and hence its reliability. The thesis also consists of optimization of various laser diode characterization techniques to characterize laser diode at different stages of optimization. The fabrication and automation of these characterization facilities are also discussed in the thesis.

The double quantum well (DQW) InGaAs/GaAs laser diode epitaxially grown at SCLS, RRCAT, Indore (M.P.), was processed to develop mesa-stripe geometry structure. Processing steps viz. photolithography, lift-off processes, mechanical lapping and polishing, insulation and metal contact layer deposition, has been optimized to fabricate edge-emitting laser diode bars and are very important to achieve high-power operation.

Design, simulation and optimization of anti-reflection and high-reflection coating of dielectric thin films on front and rear facets of laser diode, respectively are discussed here. The facet coating is designed for 808 nm and 980 nm HPLDs and the effects of facet-coating on the device characteristics have been studied. The optimized facet coating has also been tested for laser-induced-damage threshold (LIDT) measurements and proved to be a suitable facet coating for HPLDs. Various experimental setups have been developed and automated to characterize various laser diodes.

Finally, the packaging processes for high-power laser diode, consisting of die-bonding and wire-bonding, were optimized using different solder materials viz. indium and gold-tin preform, and the process is further carried out on a 650 nm and 980 nm HPLDs using indigenously developed setup. A complete package has been successfully tested under pulse and continuous wave (CW) operation. The improved device performance has been demonstrated successfully after applying various optimized post-

growth process to HPLDs, and the device life-time has been estimated under accelerated aging conditions, 80 °C, as well as at room temperature.

Subsequently, the developed semi-package, non hermetic, 980 nm laser diode was used for the characterization of electronic transitions of InAsP/InP quantum well in photoluminescence (PL) spectroscopy.

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