Modeling and design issues in high speed and high power 1.3μm InP/ GaInAsP laser diodes

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Introduction

This presentation outlines the work undertaken for the design and optimization of directly modulated FP and DFB lasers for un-cooled operation at 2.5 and 10 Gigabits. Uncooled environment requires the device to work over temperature range of -40 to 85°C (possible 95°C)

The Model

To model the predicted device performance a complex two-dimensional simulation package LASTIP was used. This package solves the drift-diffusion equations self-consistently with the Poisson's equation and photon generation rate-equations. The model includes a detailed gain-recombination module for the MQW active region.

The talk will cover 2 main area:

1). We will discuss ways of obtaining high temperature operation by minimizing the thermally activated leakage currents. We will comment on the contributions of heterobarrier leakage from active region and diffusion across blocking layers.

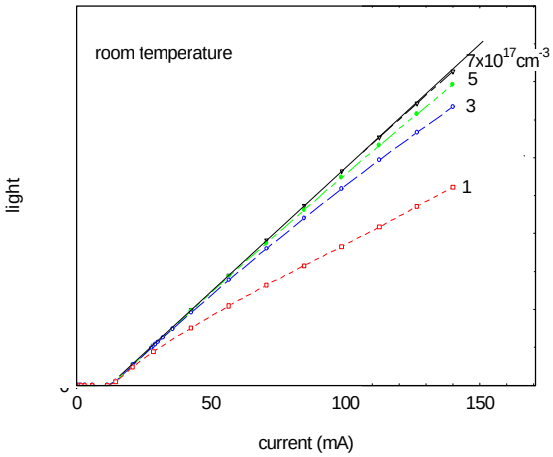

Figure 1: Light current characteristics for various P doping concentrations. The calculation assumes facet reflectivity of R=0.3 and an internal scattering loss α_i=10cm^{-1}

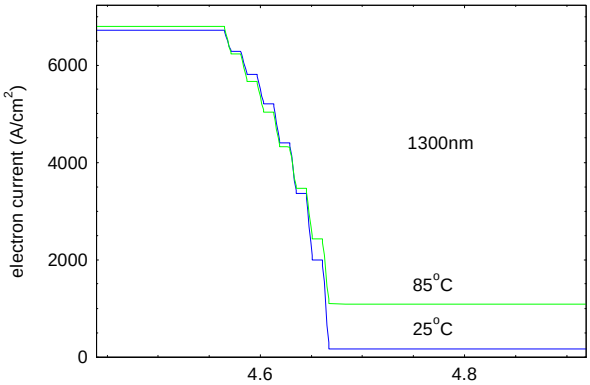

Figure 2- The electron current density in the structure. (LHS is the n side and RHS is p-side)

2) How to optimize for high-speed operation.

We have assessed the effects of:-

i) carrier transport (drift and diffusion) in InGaAsP MQW active regions
ii) capture and emission effects from and into the MQWs.
iii) carrier non-uniformity effects on the average differential gain of the active region (see Figure 3-4)

iv) chip blocking capacitance and resistance. We have used Lastip to calculate the depletion and diffusion capacitance associated with various blocking layer configurations.

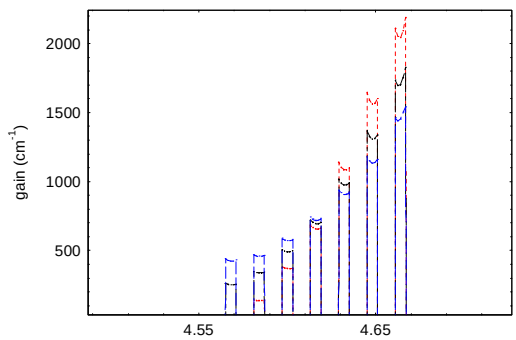

Figure 3: The gain distribution across the active region for various InGaAsP mobility values in the active region.

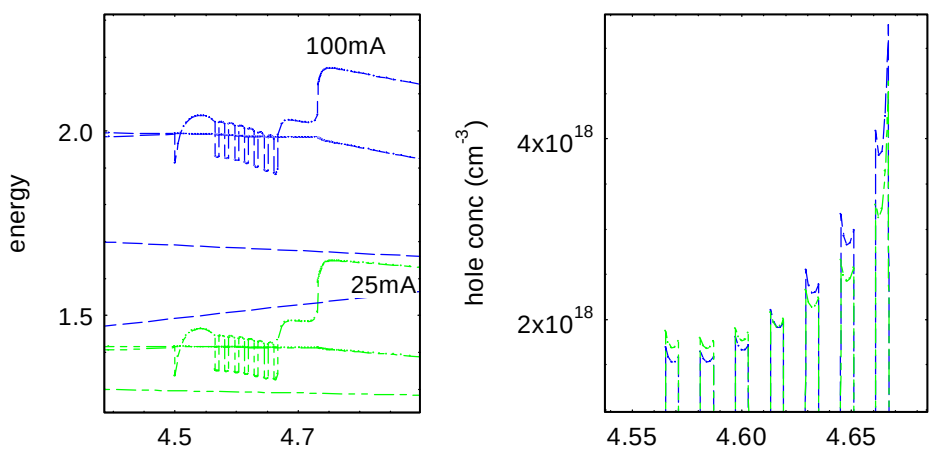

Figure 4: The band-profile and carrier distribution for an injection current of I =25mA and 100mA.