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Citation for published version (APA):

Document status and date:
Published: 28/06/2016

Please check the document version of this publication:
- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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Download date: 11. Jun. 2020
Integrated butt-coupled membrane laser for Indium Phosphide on Silicon platform

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Abstract – In this work we present the design and technology development for an integrated butt-coupled membrane laser in the IMOS (Indium Phosphide Membrane On Silicon) platform [1]. Laser is expected to have a small footprint (less than 50 \(\mu\)m\(^2\)), 1 mA threshold current and a direct modulation frequency of 10 GHz.

Keywords – Laser; PIC; IMOS; integration; butt-coupling; membrane; photonic crystal.

I. INTRODUCTION

Photonic integration on membranes can be used to combine electronic and optical functionality. InP membranes on Si is an advantageous solution, since it can include lasers, detectors and waveguide devices. An efficient laser is required for this platform [2]. Active-passive regrowth provides an optimized choice of laser materials and an easy coupling to waveguides. This paper reports the development of such an integrated laser.

II. LASER DESIGN

Fig. 1a shows the schematic of the laser. It consists of an SOA structure with a cavity realized through mirrors in the waveguides. Electrical and optical confinement is provided by a double heterostructure with InGaAs as an active layer as shown in the cross-section in Fig. 1b.

![Fig. 1. (a)Schematic of the butt-coupled laser; (b) cross-section of a SOA.](image)

To calculate laser parameters we perform gain calculations using the Poisson equation and Fermi’s golden rule. Fig. 2. shows the calculated gain spectrum of the designed active layerstack with different injection current densities.

![Fig. 2. Calculated gain spectrum of the SOA.](image)

III. INTEGRATION TECHNOLOGY DEVELOPMENT

Keeping the cavity loss below 100 cm\(^{-1}\) we can achieve threshold current density below 13 kA/cm\(^2\). Choosing an appropriate geometry, according to calculations we can reduce the threshold current down to 1 mA in our platform. This gives above 10 GHz modulation frequency and up to 15 % wall-plug efficiency. FDTD results show that reflectivity of the surface DBR mirror is expected to reach up to 90 % and of a photonic crystal mirror up to 99 %.

IV. CONCLUSION

An Integrated butt-coupled membrane laser is being developed for the IMOS platform. The laser is expected to operate above 10 GHz modulation frequency, have a 1 mA threshold current and has less than 50 \(\mu\)m\(^2\) footprint. Realization in the IMOS platform is currently ongoing.

REFERENCES


This work is supported by Zwaartekracht research grant.