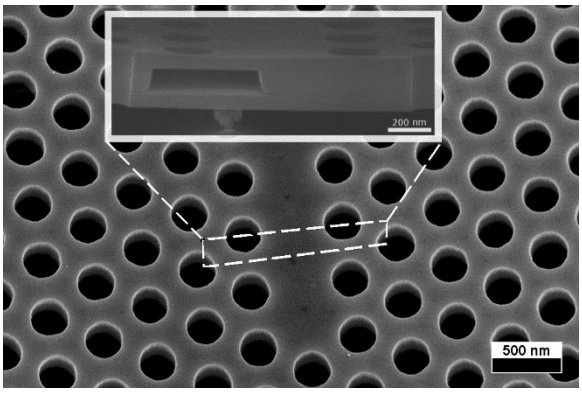
DTU Fotonik
Institut for Fotonik

MSc Project (30 ECTS)

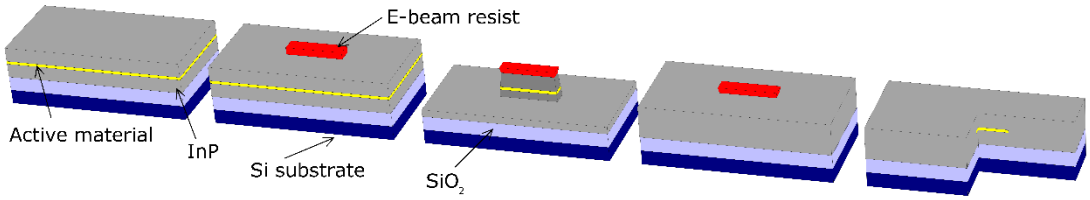
Fabrication and Experimental Characterization of Photonic Crystal Lasers with Buried Heterostructure

Description

The development of novel ultra-small and highly efficient laser devices is driven by the expectation that optical interconnect systems are to become the solution to the problem of power consumption and limited bandwidth capacity of the integrated circuits [1]. The photonic crystal (PhC) membrane lasers are currently one of the most compact and efficient on-chip light sources. Separation of active and passive materials by means of the buried gain region inside the cavity pushes the efficiency and performance of these semiconductor lasers to record heights [2].



SEM image of the buried heterostructure line-defect photonic crystal cavity laser (inset shows device structure in cross-section).



Schematic diagram illustrating the fabrication process of the buried heterostructure (dimensions of layers not to scale).

Goals of the project

The aim of this project is to tailor and optimize the fabrication process and design of the BH PhC semiconductor lasers in order to achieve high-performance and efficiency operation. Three major parts constitute the fabrication process of the laser device: epitaxial growth and direct wafer bonding, the formation of the buried heterostructure region and regrowth, aligned transfer of photonic crystal pattern and membranization. After the completion, the experimental characterization is carried out inside the in-house optical lab, and the fabrication process is re-iterated based on the acquired information.

Skills/knowledge acquired

This project is a part of the NATEC Center of Excellence and provides you with the opportunity of gaining hands-on and in-depth knowledge of the state-of-the-art semiconductor device fabrication inside the Danchip cleanroom facilities, principles of the photonic crystal devices, and the experimental device characterization.

Recommended background

34034 - Applied photonics / 34055 - Fabrication of Nanophotonic Devices / 34127 - Experimental Optics and Photonics / 34051 – Nanophotonics / 33250 - Semiconductor Technology

Please contact us if you are interested and we can tailor the project based on your interests and qualifications.

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References:

[1] D. Miller, "Device requirements for optical interconnects to silicon chips", Proc. IEEE 97, 1166 (2009).

[2] S. Matsuo, A. Shinya, T. Kakitsuka, K. Nozaki, T. Segawa, T. Sato, Y. Kawaguchi, and M. Notomi, "High-speed ultracompact buried heterostructure photonic-crystal laser with 13 fJ of energy consumed per bit transmitted", Nat. Photon **4**, 648 (2010).