Universität Stuttgart
Institut für Halbleitertechnik

Qualification work

Master thesis

Fabrication and Characterization of MQW SiGeSn/GeSn Lasers with SiN Stressor

Motivation

The goal of Si photonics is to build a photonic integrated circuit (PIC) on a Si. One key element of such a PIC is a monolithically integrated laser on a Si substrate. A very promising approach for such a laser is the use of the binary alloy semiconductor GeSn. Mixing Ge and α-Sn leads to a decrease of the Γ- and L-valley. Since the Γ-valley decreases faster than the L-valley, a direct bandgap semiconductor can be achieved for Sn concentrations above 6%. Increasing the Sn content leads also to an increase of the average lattice constant and thus to a compressive strained GeSn layer when grown on Si or Ge. This leads to a reduction in the directness of the material. To overcome the compressive strain the layer can be partially underetched, see figure 1.

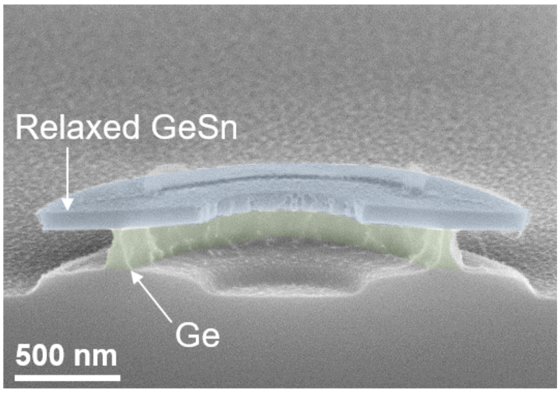

Figure 1: Cross-section of an underetched GeSn layer standing on a Ge pedestal.

Additionally, adding Si to GeSn enables a decoupling of the bandgap and the lattice constant. This allows building heterostructures to confine charge carriers spatially in the optical-active region.

Furthermore, by reducing the thickness of the active layers to the nanometer-scale, charge carriers are energetically confined on discrete energy levels resulting in a reduction of the lasing threshold.

Scope of the work

The scope of this work is to fabricate and characterize underetched SiGeSn/GeSn heterodidodes and multi-quantumwell diodes. The fabrication takes place in our institute cleanroom. A major part of this work is to plan and run a fabrication process for underetched microring-resonators. After the fabrication, an electrical and electro-optical analysis should be done. The key goal of this work is to investigate the influence of the n-contacting layer, the multi-quantumwell structure, and to achieve lasing at low thresholds.

Prior knowledge

Prior knowledge in the field of semiconductor engineering and photonics, as well as in the field of semiconductor technology is necessary. Basic knowledge on performing measurements is beneficial.

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