InGaAsSb/GaSb lasers and photodetectors integrated on a Silicon-On-Insulator waveguide circuit for spectroscopic applications

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Spectroscopy is one of the most efficient techniques for the analysis of solid, liquid or gaseous samples, especially in the shortwave infrared region where water absorption is low. While conventional, bulky systems with expensive sources and detectors offer high-accuracy measurement results, compact and low-power systems are very attractive for many applications including portable gas sensors and implantable medical devices.

Silicon-On-Insulator (SOI) provides a platform for the realization of compact optical waveguide circuits with mass production capability by exploiting existing CMOS fabrication technologies. This results in low-cost integrated optical circuits. On the other hand, GaSb excels as an active component platform in the shortwave infrared wavelength range. It provides very efficient and room temperature operation lasers and detectors, making it ideal for spectroscopy [1]. Combining SOI and GaSb opto-electronic components would thus yield a compact, efficient spectroscopic detection system.

In this paper, we report integrated GaSb-based photodetectors on SOI and integrated Fabry-Perot (FP) lasers. The epitaxial layers are transferred onto the Si waveguide circuit by a die-to-wafer bonding process using Benzocyclobutene (BCB) as the bonding agent. 2 coupling mechanisms from the SOI waveguide circuit to the integrated photodetector are studied: evanescent coupling and grating-assisted coupling. High responsivity (>1A/W) of the evanescent photodiode and 0.4 A/W for grating-assisted coupling at 2.2µm is achieved. The dark current is ~4µA at -1V. SEM image of both designs are shown in Fig.1.

We also demonstrate thin-film GaSb-based FP lasers integrated on a carrier substrate. The device operates at 2.02 µm wavelength in continuous wave at room temperature. A threshold current of ~49.7 mA is achieved. This yields a current density of ~828A/cm^2. The integrated laser operates up to 35 ^{o}C. Figure 2 represent the LIV characteristic of the laser and its spectrum is shown in the inset.

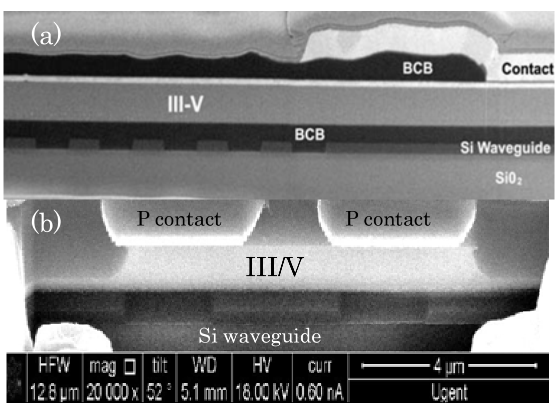

Fig.1 SEM image of the realized components a)grating-assisted coupling, b) evanescent coupling

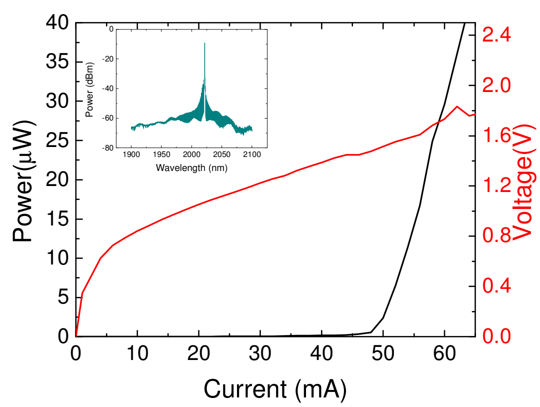

Fig.2 LIV and spectrum of the realized laser

[1] D. Barat, J. Angellier, A. Vicet, Y. Rouillard, L. Le Grateit, S. Guilet, A. Martinez, A. Ramdane, *Appl. Phys. B* **90**, 201 (2008).

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