SILICON INTEGRATED LASER SOURCES WITH INDEPENDENT WAVELENGHT TUNING

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Successful integration of multiple laser sources in a single photonic chip is demonstrated for a four channel laser array and a polarization agnostic source where the output wavelength of each source is tuned independently via micro-heaters.

Keywords: RSOA integration, remote laser source

Photonic Integrated Circuits (PICs) are the key for the realization of high performance, low footprint, energy and cost sustainable subsystems needed to implement ubiquitous next generation mobile networks [1]. Increasing the level of integration of PICS reduces the cost of volume production in terms of materials and packaging and small size localized elements facilitate power saving. In this work we demonstrate hybrid integration of multiple laser sources on a single Silicon Photonic (SiPh) chip, with independent thermal controls for wavelength tuning. Using this technology, an array of four integrated tuneable laser sources with independent controls and a polarization agnostic power source are demonstrated.

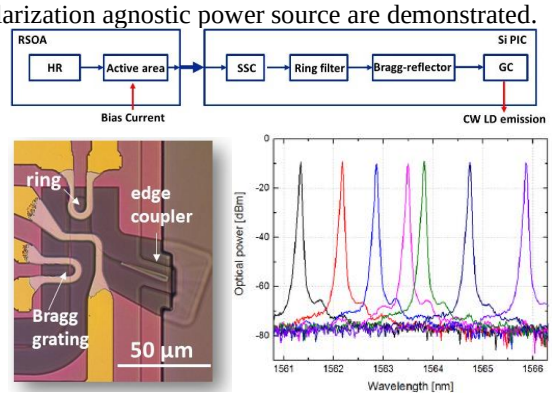

Fig. 1: *Laser source comprising RSOA, external cavity and heaters (top,left) External cavity laser tunability (right).*

An important issue in SiPh PICs is efficient integration of III-V sources on board of the chip [2,3,4]. Here we show how a tuneable laser source can be realized via hybrid integration of a InP RSOA chip on a SiPh, PIC. The PIC contains the trench for placement of the RSOAs and the external cavity, comprised of a spot size converter -SSC-, to adapt the mode of the RSOA to that of the SOI waveguide, a ring resonator filter for wavelength selection, and a Bragg grating as a reflecting element, top of Fig, 1. The photonic chips were fabricated at the InPhoTec front end facility. The RSOAs are placed flip-chip in the trench, designed to provide alignment of the output of the SOA to the cavity SSC. Electric contacts are fabricated on the trench floor to provide the bias current to the flipped RSOAs, positioned in the trench using the electric pads as fiducials. The emission wavelength of the laser is thermally controlled via micro-heaters located on the ring filter and Bragg reflector. Heaters and solder pads are deposited in the same process: the design of the mask includes both the features on the wafer surface and those on the trench floor. The SSC achieves good coupling to the RSOA mode thanks to a Si_3N_4 double tapered structure on top of the silicon waveguide. More details on design, fabrication and complex hybrid integration process will be given at the Conference. A first demonstrator PIC features integration of four RSOA chips, with the technique just described (Fig. 2, left). Coupling to the external single mode fibres is via an array of grating couplers. The measured tunability of a fabricated source is shown in Fig. 1 (right): a range of 4.5 nm is obtained with 85mW of power applied on the heaters. The side mode suppression is very good, ~ 50 dB. Output power was -4.5 dBm at RSOA bias around 140 mA. The cavity free spectral range is 2.2 THz.

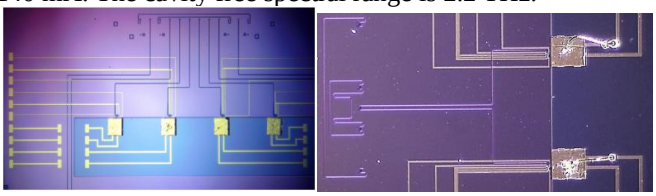

Fig. 2 *Photonic Chip with 4 laser sources (left).Polarization agnostic source (right*

A second demonstrator PIC features a polarization agnostic laser source (Fig. 2 right), following the scheme in [5]. Two laser channels integrated on a PIC with the technique described above are combined via a dual polarization grating coupler so that, in the output fibre, the polarization of the first source is orthogonal to the polarization of the second source. PICs were designed and fabricated by the Authors. The fine tuning of the two sources is controlled thermally, acting on the heaters on top of the ring filter and the Bragg grating in the laser cavity. Electronic circuitry on PCB for programmable PIC control was developed for both demonstrators.

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