Demonstration of a Semiconductor Double Microring Resonator Coupled Laser

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Abstract: A single mode GaInAsP-InP double microring resonator coupled laser is demonstrated for the first time. The laser has an output power of 0.12 mW with a sidemode supression ratio of 30 dB.

Summary: A double ring resonator coupled laser (DR-RCL) with integrated semiconductor optical amplifiers on the basis of GaInAsP / InP has been fabricated and tested. A detailed theoretical analysis of ring resonator coupled lasers can be found in [1]. The design, fabrication and layer sequence of the SOA and the passive waveguides are described in [2]. A photograph of the DR-RCL is shown in Fig. 1.

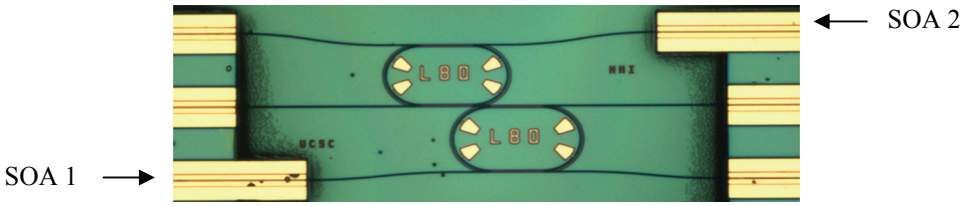

Fig. 1. Photograph of a double ring resonator coupled laser.

The ring resonators have a slightly different radius to increase the free spectral range (FSR) and to achieve a single mode operation. The radii of the rings are 100 µm and 108 µm, which leads to a FSR of about 15 nm. The resonance wavelength of the rings can be tuned by the integrated platinum resistors on top of the passive waveguides in the ring resonators. The coupling between the bus waveguides and the ring resonators is realized by a codirectional coupler with a length of 500 µm and a coupling gap of 1 µm. The achieved splitting ratio is 3 dB. The laser cavity consists of SOA 1, SOA 2 (Fig. 1) and the two ring resonators. The remaining SOAs are used as absorbers. The end facets of the chip are as cleaved and have not been coated, which could be improved to increase the performance in the future. The output of the DR-RCL is collected using a tapered fiber at SOA 2. The spectrum is shown in Fig. 2a when the driving currents for SOA 1 and SOA 2 are 80 mA and 100 mA respectively. A sidemode supression ratio of 30 dB is obtained. The linewidth of the lasing wavelength is limited by the bandwidth of the optical spectrum analyzer (0.06 nm in the inset of Fig. 2a). The output power varies with the currents supplied to SOA 1 and SOA 2(Fig. 2b). The threshold of the DR-RCL is about 30 mA when SOA 1 is biased above 40 mA.

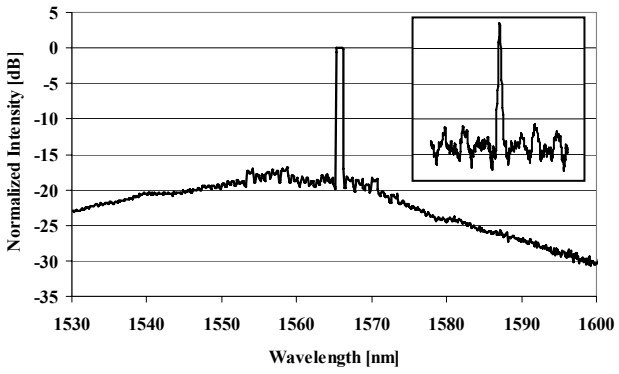

Fig. 2a. Spectrum of the DR-RCL

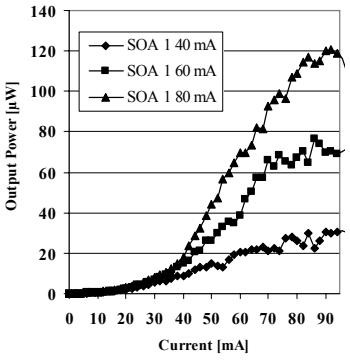

Fig. 2b. PI curve changing the current at SOA 2

In conclusion, we have demonstrated for the first time a single mode double ring resonator coupled laser comprising two passive ring resonators, SOAs in the bus waveguides and 3 dB codirectional couplers.

[1] Z. Bian, B. Liu, A. Shakouri, "InP-Based Passive Ring-Resonator-Coupled Lasers," *IEEE J. Quantum Electron.*, 39, 859-865 (2003).
[2] D. G. Rabus, M. Hamacher, U. Troppenz, and H. Heidrich, "Optical Filters based on Ring Resonators with Integrated Semiconductor Optical Amplifiers in GaInAsP/InP," *IEEE J. Select. Topics Quantum Electron.*, 6, 1405-1411 (2002).