grown on both the passive and active regions, with a highly p-doped ternary InGaAs contact layer on top. Local planarisation with polyimide is used that also provides passivation of the active waveguide. A Ti-Pt-Au metallisation scheme is applied, which was selected because it provides low-resistance ohmic contacts to both the p-doped InGaAs and the n-doped InP layers.

Shallowly etched active waveguides are fabricated in the active layer regions. The analysis of sub-threshold spectra of extended cavity lasers shows that reflections of transitions from the passive to the active (amplifying) areas in shallow waveguides at the butt-joint interface can be kept at -50 dB or less [20]. This is particularly relevant for this label-swapper subsystem since feedback above -50 dB can seriously affect the behavior of the laser system.

5. Discussion and conclusion

A photonic chip, of application in SAC label swapping, and produced monolithically in InP technology, has been presented in this paper. Compared to previous demonstrations using discrete component assembly, the device footprint is greatly reduced and the operation speed for label processing is increased by more than two orders of magnitude. Scalability in wavelength is possible by using larger port count AWGs. Combination with other building blocks to perform complimentary functions, for instance to spectrally separate the payload and intermediate swapping wavelengths, is possible by means of the generic integration technology described.

One important aspect for the label swapper is the on/off device response. As mentioned before, this is related to the rate at which packets occur, i.e., the label rate in SAC label swapping. The advantage of SAC label swapping is the label is decoupled from the payload in the wavelength domain, hence they may have significantly different rates. For instance, a payload length of 64 bytes, (minimum length for an Ethernet frame [21]), at a payload rate of 160 Gbps [12], translates to a packet rate (equivalent to label rate in SAC label swapping) of less than 320 Mpbs. The results in this paper show complete operation at 155 Mbps as well as the possibility for operation at 622 Mbps. The limitation in this current design is mainly due to the SOAs carrier recovery. The SOAs are based on a Multi-Quantum Well structure (MQW, see ’Methods’), and other researchers have shown that Quantum-Dot (QD) SOAs can perform at least 6 times faster than MQW ones [22].

Other important issue is the optical power balance, which is to be improved, as on chip power at the input/output. This figure can be improved (less input power required to switch, more output power) for instance by means of spot size converters, for a more efficient light in/out coupling (0.5 dB at [23]), and/or by including an additional integrated SOA as booster amplifier for the output signal.

Finally, besides the particular and relevant application of the device demonstrated in this paper, the concept and functionality can serve other purposes. In general, the device can be operated as logical NAND or NOR gate through wavelength conversion, but at very modest rate (hundreds of Mbps) compared to other photonic integrated converters based on SOA-MZI, that can be found in the literature elsewhere.

Acknowledgments

The activities have been carried out in the framework of the Joint Research Activity (JRA) ’Active-phased Arrayed Devices’ (WP 44) of the European Commission FP6 Network of Excellence ePIXnet (European Network of Excellence on Photonic Integrated Components and Circuits), Project Reference: 004525, http://www.epixnet.org/. This work has been partially funded through the Spanish Plan Nacional de I+D+i 2008-2011 project TEC2008-06145/TEC. It has also been partially supported by the Canadian Institute for Photonic Innovations. Devices are presently being fabricated through the InP Photonic Integration Platform JePPIX (coordinator D J Robbins), at the COBRA fab, http://www.jeppix.eu/

#147210 - $15.00 USD Received 9 May 2011; revised 14 Jun 2011; accepted 14 Jun 2011; published 28 Jun 2011