InP-Based Photonics Integration

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Abstract. *Monolithic integration on InP has reached complexity levels extending to over 200 discrete functions on a single substrate, including optical signal amplification, and demonstration of multi channel devices capable of aggregate data rates in excess of 1Tb/s. In this presentation we will review the progress in this field.*

Introduction

Monolithic photonic integration has a very long history dating back to the late 1960's, and it is interesting to note that the first proposal for a photonic integrated circuit (PIC) predates the first demonstration of a CW semiconductor laser [1]. Historically InP has been the substrate of choice for monolithic integration with light emitting and passive optical components. Although a lot of progress was made in the last thirty years and integrated components with two to four elements were being manufactured, it was not until four years ago that the first large scale (with component counts higher than 50) PIC (LSPIC) was successfully deployed in long haul telecommunication networks carrying commercial traffic [2].

LSPIC's have been shown to be highly manufacturable and reliable to meet the stringent requirements of carrier grade equipment. At this point, 100Gbit/s (10channels x 10Gbit/s) version of the Infinera PIC, in field deployment carrying live traffic, has passed the 50 million hour mark of operation without any failures.

Scaling of Photonic Integrated Devices

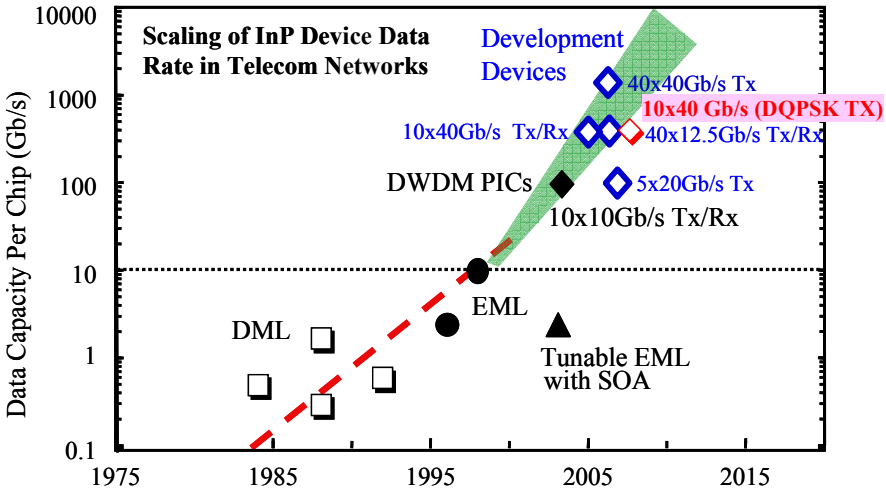

Fig. 1 Scaling of InP device data rate in Telecom transmission networks

Fig. 1 shows the historical data rate scaling in photonic integrated circuits [2,3,4] deployed in commercial transport networks (the devices under development at Infinera are shown in blue for comparison). From mid 1990's to until the introduction of the 100Gbit/s LSPIC four years ago, the data rate for an optical integrated device was largely flat at 10Gbit/s. We have since then demonstrated 40 channel transmitters with per channel data rates up to 40Gbit/s with the NRZ modulation format. The total aggregate data rate from such an integrated device is in excess of 1Tb/s. More recently we have developed 10 channel, 40Gbit/s per channel, DQPSK PIC's [4] which enables us to deploy transport systems with higher spectral efficiency in the fiber. The DQPSK PIC's have integrated Mach Zehnder (MZ) modulators whilst the current generation PIC's have integrated electro absorption modulators (EAM).

We have also demonstrated high functional count devices (transmitters and receivers with up to 40 channels) integrated with semiconductor optical amplifiers (SOA) [5,6]. The requirement for polarization independent, multi channel operation makes integrating the SOA's in a receiver PIC especially challenging. We have demonstrated (see Fig. 2) 10 channel, receiver PIC's with wide optical bandwidth SOA with median gain in excess of 22dB, and worst case polarization dependent gain (PDG) of less 0.8dB in manufacturing [5]. The intrinsic noise figure of the SOA (not including fiber coupling) is a little under 4dB.

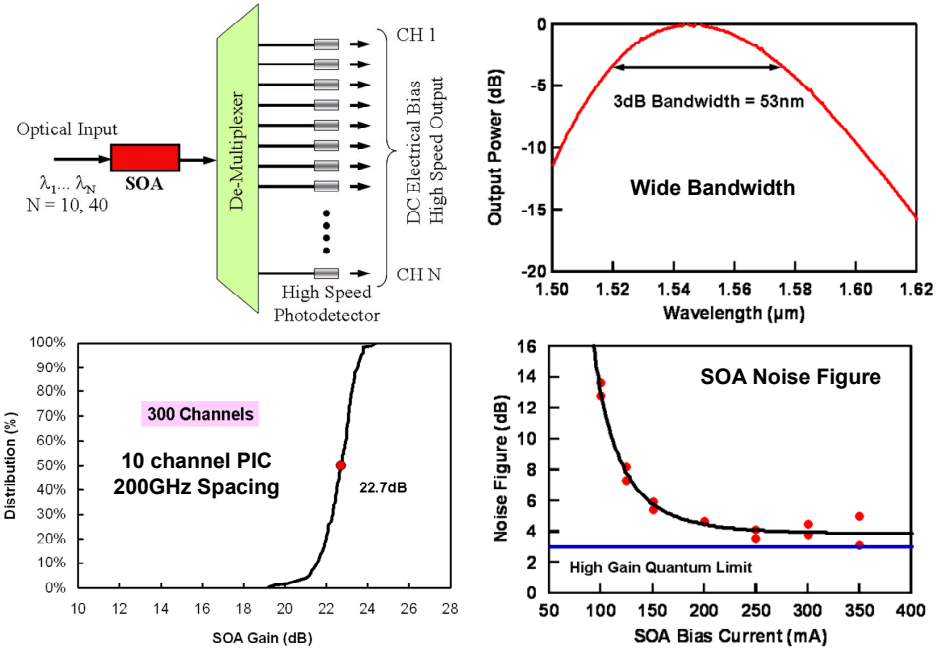

Fig. 2 Characteristics of SOA integrated multi channel receiver PIC.

In the talk we will review these results and give a historical perspective on the progress in the field if InP based photonic integration.

Acknowledgment

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References

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