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Tutorial

Multi-function Integrated InP-Based Photonic Circuits

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Abstract

Although InP-based photonic ICs (PICs) have been researched for many years, widespread acceptance of the viability of such technologies has not occurred until recently. A few relatively new commercial existence proofs have now proven that multiple functions can be successfully performed on a single InP chip with advantages in cost, size, performance, and power dissipation. As a result of these, as well as some market realities and an ever growing body of research existence proofs, the development of viable PIC products now seems to be a key goal of many component suppliers. This tutorial will review current integration approaches and results, with some slight emphasis on our UCSB work.

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The recent commercial success of viable multi-funtion InP-based Photonic ICs (PICs)[1,2] has altered the perception of many in the field that such components would continue to be products for the future, products that could not compete with hybrid approaches that could optimally incorporate known-good-die to give superior performance and reliability. Now there would appear to be fairly wide-spread acceptance of some monolithic integration technologies for at least some applications. Reductions in size and weight have not been too surprising, but improvements in cost, power dissipation, reliability, and even performance are the real reasons for these successes. The buzz seems to be that many component vendors are now trying to develop such PICs for a variety of applications.

At the core of most PICs is a basic active-passive waveguide integration technique, and this largely determines the viability of the resulting integration platform. Much of the basic work occurred more than a decade ago[3-5], and this led to a few successes, such as the integration of an electro-absorption modulator (EAM) with a DFB laser (the so-called EML), but until recently there have not been many PICs in production, certainly not 'multi-functional' ones.

In this tutorial a number of integration platforms will be reviewed and discussed[4-6]. Commercial examples as well as some newer proof-of-principle multi-functional PICs will be introduced to evaluate the viability of some of these integration approaches. The pro and cons of each approach will be identified. Some discussion of alternative hybrid integration approaches will also be given.

Figure 1 is an example of a single-chip, widely-tunable, data-format-transparent all-photonic transceiver that incorporates an SOA-PIN receiver with an SGDBR-EAM transmitter[7]. In the example given, the stages are internally connected to provide seemless wavelength conversion with only DC biases applied to the chip. Overall chip gain with some degree of regeneration has been demonstrated with this kind of configuration [8].

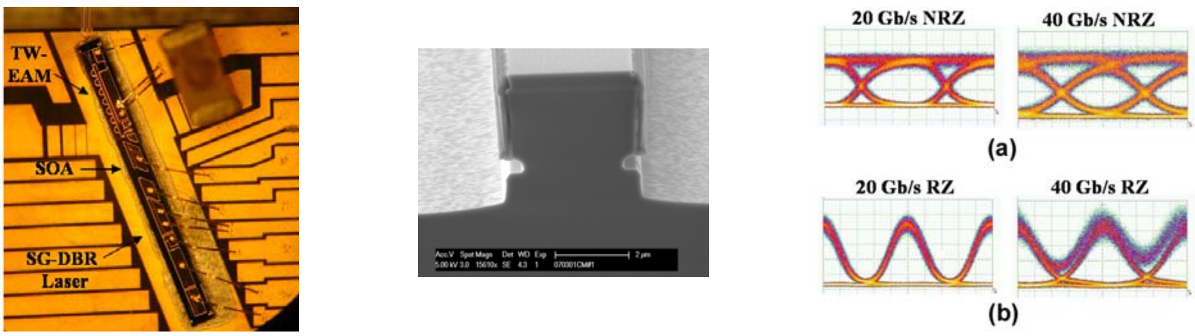

Figure 1. (Left): 5-40Gb/s NRZ or RZ wavelength converter tunable over 40 nm about 1550 nm. (Center): Cross section of a periodically-loaded, traveling-wave EAM with an undercut waveguide. (Right): Converted outputs at 20 and 40 Gb/s for (a) NRZ or (b) RZ.

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