

JePPIX : the platform for InP-based photonics

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JePPIX: the platform for InP-based photonics

Xaveer Leijtens

COBRA Research Institute, Eindhoven University of Technology, the Netherlands

Email: X.J.M.Leijtens@TUE.nl

Abstract—JePPIX is the European platform that offers access to Indium Phosphide based technology for proof of concept, prototyping and large volume manufacturing. This is enabled by using a generic integration technology.

I. INTRODUCTION

The joint European platform for InP-based components and circuits, JePPIX, is a technology platform for the development and promotion of Photonic Integrated Circuits (PICs) in Indium Phosphide. JePPIX aims at a generic integration technology in which a variety of photonic integrated circuits can be designed and fabricated using the same process. This concept is well known in electronics; in photonics it is new and can lead to huge cost reductions by realizing photonic ICs for a broad variety of applications using a small set of basic building blocks that are integrated in a generic foundry process.

JePPIX is one of the three photonic integration platforms that were started from ePIXnet, the EU FP6 Network of Excellence, besides ePIXfab (silicon photonics) and TriPlex (dielectric waveguides).

II. GENERIC INTEGRATION TECHNOLOGY

One of the main challenges for photonic integration is to develop a technology that supports a small set of building blocks with good performance, with which a broad class of functionalities can be realized. At COBRA we use a technology that offers active-passive butt-joint integration: three-step epitaxy by MOVPE, self-aligned $\text{CH}_4\text{-H}_2$ RIE process for etching, planarization and metallization. This process integrates the following building blocks:

- 1) Passive waveguide devices (PHMs), including the most widely used components such as waveguide bends, multi-mode interference couplers, arrayed waveguide grating demultiplexers (AWGs), and tapers. Shallow and deep-etched PWDs are available, figure 1 and 2, for low and high contrast, respectively.

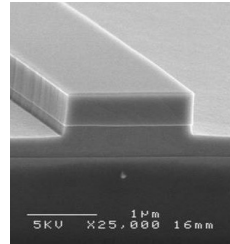


Figure 1. Shallow etched waveguide.

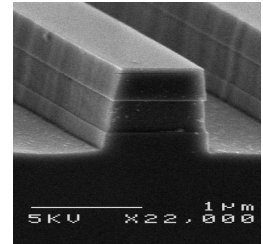


Figure 2. Deep etched waveguide.

- 2) Phase modulators (PHMs) to control the phase of the optical signals. When used in an interferometric configuration, such as a Mach-Zehnder interferometer, phase modulators provide a means for signal intensity modulation or space switching as well.
- 3) Semiconductor optical amplifiers (SOAs), figure 3. The importance of the SOA for photonics is similar to that of the transistor for electronics: it provides amplification but it also supports a broad class of non-linear signal operations, like wavelength conversion, 2R and 3R signal regeneration, optical time-domain demultiplexing, clock extraction and other digital signal operations. When operating the SOAs in reverse bias, they can be used as high-speed photo-detectors.

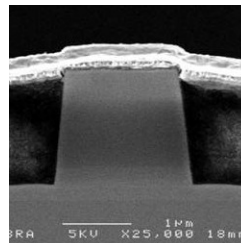


Figure 3. Shallow etched SOA or photo-detector.

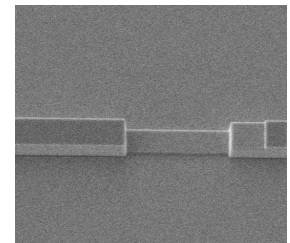


Figure 4. Isolation section, where top layer is locally removed (angled top-view).

- 4) Isolation sections, figure 4. These are regions where the highly conductive p^+ -layer is locally removed to provide electrical isolation between different SOAs and/or phase modulators.

At the moment JePPIX is offering small-scale access to the COBRA generic integration process of TU Eindhoven.

III. ACCESS TO MULTI-PROJECT WAFER RUNS

Having a technology that makes use of standard building blocks will greatly reduce the costs of photonic ICs, because the development cost of that technology will be shared by all users of that technology. For smaller-scale projects, those costs can be even further reduced, by making use of multi-project wafer runs. In this approach, different users share cells on the same wafer, and thereby they share the cost of that run, typically proportional to the total chip area that they use.

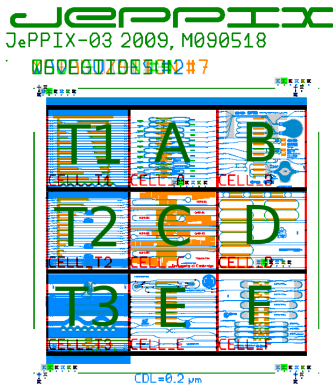


Figure 5. View of the cell layout of a JePPIX MPW-run at COBRA, consisting of test cells (T1–T3) and multi-project user cells (A–F).

COBRA offers access to multi-project runs to external users, who are first trained in the design of photonic ICs in a two-week course at the COBRA institute in Eindhoven. The runs then consist of processing active-passive 2-inch epiwafers, split into 9 cells (typically $4 \times 4 \text{ mm}^2$), see figure 5; three of which are reserved for test structures (T1–T3, to qualify the processing) and 6 cells host the designed PICs of the users (A–F). Each user can make an independent design, even without the need to know anything about the neighboring cell. This is achieved by using pre-defined positions and dimensions of the input and output waveguides, see figure 6. These waveguides may be placed on a $25 \mu\text{m}$ pitch, either straight or angled, where the 7° angle greatly reduces the reflections from the cleaved chip-facet.

A number of novel devices made from these basic building block in a JePPIX multi-project wafer run at COBRA have been demonstrated, including a mode-locked

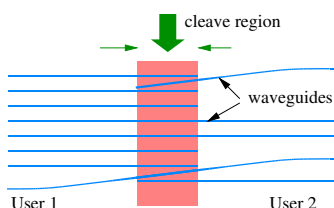


Figure 6. Standardized waveguide locations at cell boundary.

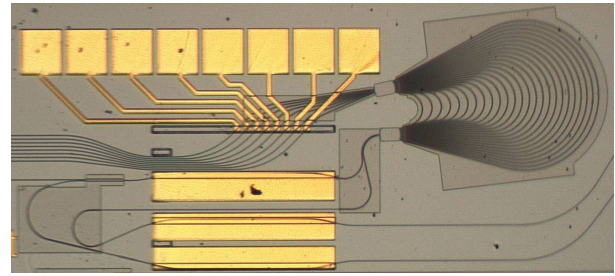


Figure 7. Discretely tunable laser with ns switching time.

ringlaser [1], which uses a combination of the SOA, isolation and PWD building blocks; a pulse-compressor [2], using combinations of PHM and PWD building blocks; a fast tunable laser [3], integrating SOAs with PWD building blocks. Figure 7 shows a photograph of that tunable laser. Clearly visible are the gold contact pads for the current injection of the SOAs (three bottom contacts), eight contact pads on the top, which connect to short SOA-sections that act as optical gates which select the wavelength, and an AWG acting as wavelength filter is visible on the right side of the picture.

IV. OUTLOOK

COBRA offers small scale access to its process for gaining experience with the generic foundry process. In the EuroPIC project, <http://europic.org>, transfer of this model to industrial fabs is presently being investigated. Two EuroPIC partners, Oclaro Technology in the UK and the Fraunhofer Heinrich Hertz Institute in Germany, whose processes are conceptually similar to the process of COBRA, are presently preparing their processes for experimental generic foundry runs. When the EuroPIC project is successful, COBRA will move its activity to development of improved or novel features for later integration in the industrial foundry processes.

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