SMART PHOTONICS
Independent InP Foundry

YOUR DESIGN
OUR SERVICE
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APPLICATION NOTE

ADVANCED ACTIVE PHOTONIC CIRCUIT DESIGN

Using a Process Design Kit

SMART Photonics offers a generic process for manufacturing InP based photonic integrated circuits. This process allows for fast prototyping and low cost development without compromising performance and functionality. Custom designed photonic integrated circuits can be developed using the SMART Photonics Process Design Kit (PDK). This PDK consists of an extensive building block library and design rules. No in-depth knowledge of the technology is required for the user.

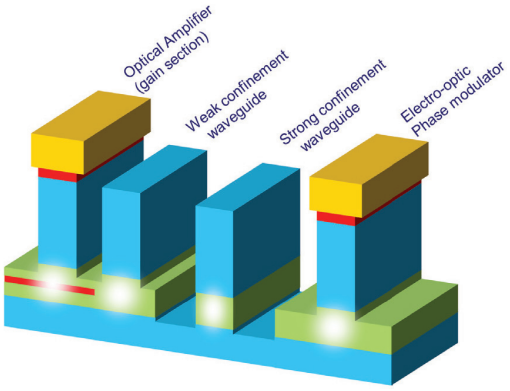

Figure 1. Schematic representation of the building blocks.

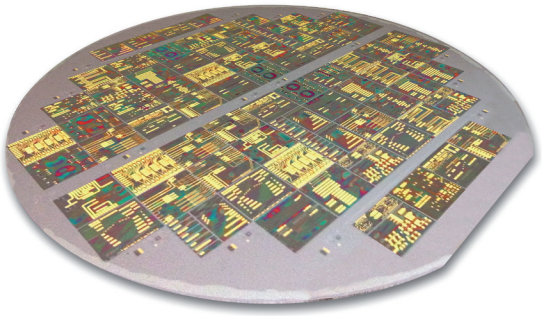

Figure 2. A photograph of a Multi Project Wafer with a number of different user designs.

Building blocks

The building blocks currently available operate in the entire C-band (1530–1565 nm). Most building blocks are parametric. The designer only needs to create the design by connecting the building blocks (with the desired parameters). This design can be used to run simulations to achieve the circuit's objectives.

Figure 1 displays a schematic representation of the technology. The table on the right gives an overview of the available building blocks.

A number of software packages is available communicate with the SMART Photonics PDK (contact us for more details) for both mask design and circuit simulation.

BUILDING BLOCKS
Waveguides (weakly guiding)
Waveguides (strongly guiding)
Waveguide transition elements
waveguide crossings
Electrical isolation sections
Curved waveguides, S-bends
EO phase modulators
Pin-Photo-diodes
Optical amplifiers

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Cost effective prototypes and production ramp-up

A significant cost reduction in the development phase is achieved by making use of Multi Project Wafer (Figure 2) runs where multiple users share the same wafer. The standardization of the process allows for easy up-scaling to volume production.

Design flow

Complex designs can be created using the building blocks provided in the PDK. An example of acomplex circuit designed by ikhef is provided as a reference. A typical design flow is shown in Figures 3-5 and described as follows:

- Translate the application specifications into an optical circuit and make a selection of the required building blocks.
- Implement your circuit in the circuit simulator and evaluate the results against the requirements.
- Verify that the circuit has no design rule violations using the automatic design rule checks (DRCs).
- Export automatically to GDS file, ready for manufacturing.

Design example

Schematic circuit and building block selection

As an example of a complex circuit, a reflective modulator is demonstrated. The schematic of the chip is shown in (Figure 3). The required building blocks are identified:

- Straight and curved waveguides
- AWG multiplexer
- Photodiode (detector)
- Reflective Modulator
  (Mach Zehnder Interferometer):
  - MMI coupler
  - phase modulator
- Optical amplifier (SOA)

Simulation and parameterization

The PDK is used in combination with simulation software to obtain the correct parameters for the required building blocks. The reflective modulator can be designed using readily available MMI couplers, phase modulators and bends. The length of the phase modulator can be chosen to match the required phase change. The SOA gain [cm-1] is obtained from the PDK and this is used to optimize the performance for this circuit.

Some of the elements need additional design effort, but even a complex device such as an AWG can be easily designed using the available parameterized AWG modules.

Design check and export

Once the circuit is designed it is converted to a mask design in GDS format as shown in (Figure 4). The software checks for DRC errors, according to design rules implemented in the PDK, ensuring a manufacturable design. The circuit is fabricated (Figure 5) and sent to the user.

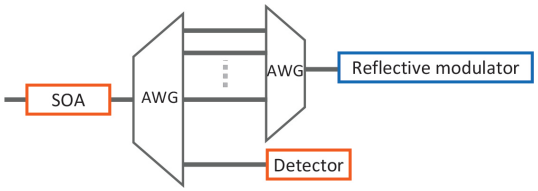

Figure 3. Schematic of the reflective modulator.

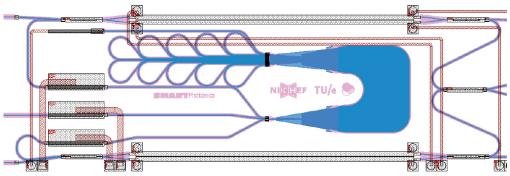

Figure 4. The mask design in GDS format.

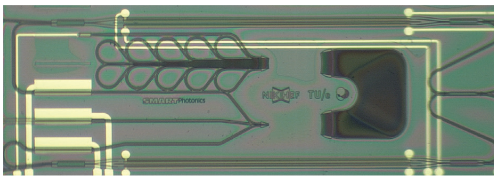

Figure 5. The manufactured chip of the reflective modulator.

More information: The design of the reflective modulator is performed at Nikhef, Amsterdam by Deepak Gajanana: deepakg@nikhef.nl. The device is fabricated in the generic integration process at SMART Photonics: luc.augustin@smartphotonics.nl. This work is supported by IOP Photonic Devices, FOM-Nikhef and NWO.