SMART Photonics

ENABLING THE FUTURE

October, 2018
INTRODUCTION TO SMART PHOTONICS
SMART PHOTONICS

- Founded in 2012
  - Pure Play InP Foundry
  - Started with 3 FTE using the NanoLab@TU/e

  
  

  Philips
  OppoElectronics Center

  JDS Uniphase

  Cedova

  Philips Research - Photonics Lab

  Generic Integration Technology by TU/e

  SMART Photonics

- Today
  - R&D at NanoLab@TU/e
  - Production at SMART@HTC
  - Staff of >50 FTE
    - >35 very experienced engineers
  - Serving >30 customers
OFFERING

- Manufacturer of photonic components on InP
  - Discrete components (lasers, receivers, amplifiers)
  - Photonic Integrated Circuits (PICs)

- Uniqueness
  - A proven business model “Pure Play Foundry”
    - To meet cost requirements (€/bit and €/mm²)
  - A unique technology for integrating photonic components
    - To meet technology requirements (Gb/s, J/bit and more functionality/mm²)
    - More functionality in one chip and Improved performance
## CAPABILITIES

<table>
<thead>
<tr>
<th><strong>Epitaxy</strong></th>
<th>2 (3) Multi-wafer MOVPE reactors for base wafer growth, regrowth and overgrowth</th>
</tr>
</thead>
</table>
| **Lithography** | High throughput, high resolution (<100 nm) - **ArF scanner**  
0.6 μm projection litho – **I-Line stepper**  
High resolution (<100 nm) – **E-beam**  
0.6 μm contact litho – contact aligner |
| **Etching** | Cassette-based wet etching  
ICP for single and multi-wafer etching  
RIE dedicated tools for photoresist, dielectric and polymer etching |
| **Dielectrics** | PECVD for SiO$_x$ and SiN$_x$ |
| **Metallization** | E-beam evaporation  
Sputtering  
Plating |
| **Back-end** | Grinding and polishing  
Scribe and break  
Optical coatings |
SMART INTEGRATION ON INP
RESULT OF 20 YEARS DEVELOPMENT AT TU-EINDHOVEN

- Founding father
  - Professor Meint Smit
  - €300M invested

- Monolithic integration of all photonic functionalities

Passive waveguides  Phase modulators  gratings (development)  Amplifiers/ laser gain section
GENERIC INTEGRATION PHILOSOPHY

Electronic integration
3 basic elements

Photonic integration
3 basic elements

- PWD
- PHM
- SOA

Waveguide
Phase
Amplitude
SAME BUILDING BLOCK PRINCIPLE AS LEGO
MPW SERVICES

- World’s first commercial run July 2013
- Complex designs
- Over 250 designs fabricated Ytd
- Multiple applications a.o. communication and sensing
- > 50% Industry
LOW THRESHOLD ACCESS

- Access via MPW shuttles
  - Low cost access (multiple users/wafer)
  - Regularly (quarterly) MPW runs
  - Fixed leadtime (4 months)
- Design kit (PDK) available
  - PDK for mask design implemented
  - Extended design manual
  - Functional building block descriptions
  - Design support
  - Training for new designers
CUSTOMER APPLICATIONS

▪ Tele- and Data communications
  ▪ Long Haul
  ▪ Access
  ▪ DC

▪ Sensing
  ▪ Internet of Things (IoT)
  ▪ Health (POC)
  ▪ Automotive (LIDAR)
  ▪ Aviation and Space (Safety, Communication, Analysis)
  ▪ Machining (Accuracy, measuring, safety)
PICS IN THE INTERNET

Fiber-optic links

Photonic Integrated Circuits
PICS FOR TELE-DATA COMMUNICATIONS

>100 Gb/s transmitter on single chip, fabricated in our powerful MPW platform

Wavelength tuning

20 Gb/s per channel

3 x MZM modulator

6 x 22 nm tunable laser

3 x MZM modulator

W. Yao, COBRA
PICS FOR SENSING

- Disruptive solutions in ao. Sensing
  - Health and medical
  - Automotive
  - Aviation
  - Aerospace
  - Machinery
PICS IN NON-TELECOM APPLICATIONS

- Compact Frequency-comb generators for metrology
- Readout units for fibre strain sensors
- Skin Analysis
- Optical Coherence Tomography
EXAMPLE 1: FBG INTERROGATOR

Distributed temperature and strain measurement with embedded fibers + PIC readouts

Wider possibilities for structural health monitoring
EXAMPLE 2: GAS SENSING

- 36 mm(!) cavity
- Optical spectrum: distinct peaks spaced 2.5GHz.
- Electrical spectrum: mode-locking to a frequency of 2.5 GHz

Design and analysis by COBRA: Saeed Tahvili and Sylwester Latkowski
INDUSTRIALISATION AND RAMP-UP PROGRAM
ROAD TOWARDS VOLUME PRODUCTION

2012
Start-up

2015
Start Production at HTC

2017
Expanding toolbase

2018-2019
Expanding HTC cleanroom and toolbase

2018-2020
New factory

Getting started at 2”-wafers

Capacity 500 3”-Wafers / Year

Capacity increase >4000 3”-wafers / Year

Capacity increase >20000 4” (6”)-wafers / Year
PHASE 2

- **New Fab**
  - Increase process flow to 100% on own equipment
  - Increase Capacity to >20K wfrs/yr
- **Fab specifics**
  - Footprint 5700m²
  - Production 2000m²
  - Wafer size 4” (6” capable)
  - Capacity >20K wfrs/yr
  - Feature size <100nm (ArF)
  - Operational July 2020