PhotonHub Experience Centre

Course xx

Silicon and Silicon Nitride Photonic Integrated Circuits

Course Provider

ePIXfab – the European Silicon Photonics Alliance
and its members
Hosted from Ghent University, Belgium

Course Overview

Silicon photonics (SiPh) is a key photonic integration technology. The evolution pace of silicon photonics technology is tremendous. Industries developing SiPh-based solutions have to continuously train their workforce to equip them with latest trends and developments.

This 3-day training course provides industry, especially those involved in PIC-based product development, with the basic technical skills in ideating, designing, fabricating and testing SiPh PICs. The course covers various forms of SiPh such as thin SOI, thick SOI, LPCVD SiN, PECVD SiN, and Ge- on-Si along with the deployment of these technologies into application domains such as communications, medical, sensors, quantum, environmental, computing, etc.

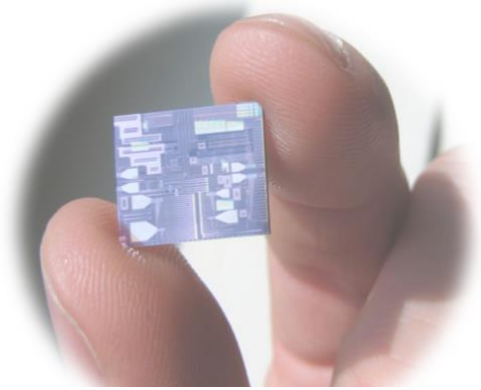
The training will be organized by ePIXfab (hosted by UGent) with the support of its members that are partners in PhotonHub Europe project. The support provided by ePIXfab members will make the course cohesive and inclusive to all forms and brands of SiPh technologies – that is the biggest value proposition of the proposed course and makes it unique in the European landscape.

The training will provide a hands-on training with respect to:

- determining the right SiPh technology platform & design environment for a given application
- designing a SiPh chip and associated key fabrication steps
- developing test-beds and testing of SiPh PICs for various applications.

Target Audience

It is desirable but not essential that course attendees have a basic understanding of photonics. The course is ideally suited to those planning to internalize basic skills necessary for innovative PIC-based product development.

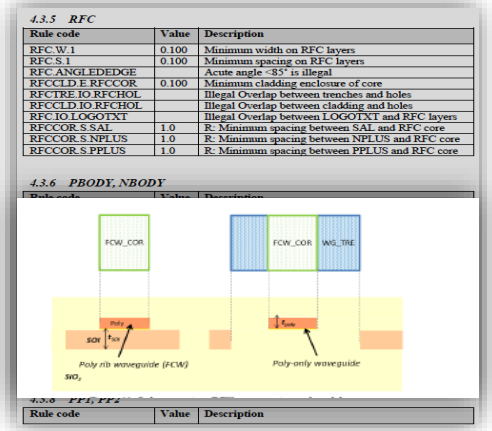


Expected Outcomes

1) Mastery in choosing the appropriate technology platform for a use case
2) Mastery in adopting the right design framework for a use case
3) Hands-on skills with respect to the SiPh design process
4) Understanding of challenges associated with the fabrication of SiPh chips
5) Experience in different testing schemes and fiber-chip-fiber coupling schemes
6) Experience in on-chip opto-electronic testing, including high speed testing

Course Equipment & Infrastructure

Design Software
(Device, Circuit, Layout, System)



4.3.5 RFC

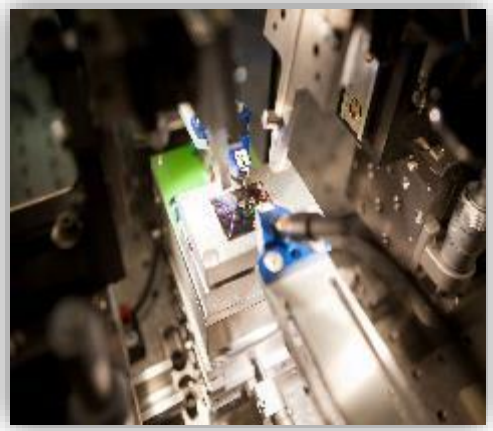
Rule code	Value	Description
RFC.W.1	0.100	Minimum width on RFC layers
RFC.S.1	0.100	Minimum spacing on RFC layers
RFC.ANGLEDEDGE		Acute angle <85° is illegal
RFCCLD.E.RFCCOR	0.100	Minimum cladding enclosure of core
RFCTRE.IO.RFCHOL		Illegal Overlap between trenches and holes
RFCCLD.IO.RFCHOL		Illegal Overlap between cladding and holes
RFC.IO.LOGOTXT		Illegal Overlap between LOGOTXT and RFC layers
RFCCOR.S.SAL	1.0	R: Minimum spacing between SAL and RFC core
RFCCOR.S.NPLUS	1.0	R: Minimum spacing between NPLUS and RFC core
RFCCOR.S.PPLUS	1.0	R: Minimum spacing between PPLUS and RFC core

4.3.6 PBODY, NBODY

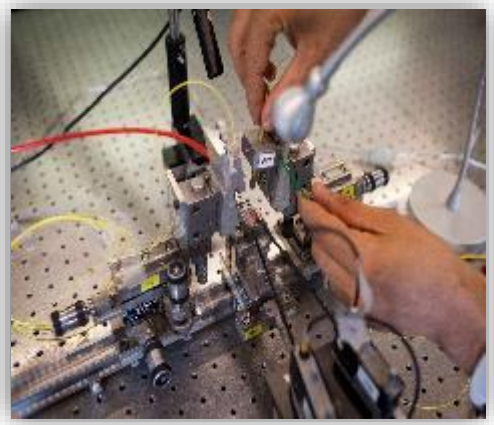
Rule code	Value	Description

Fab-like PDKs

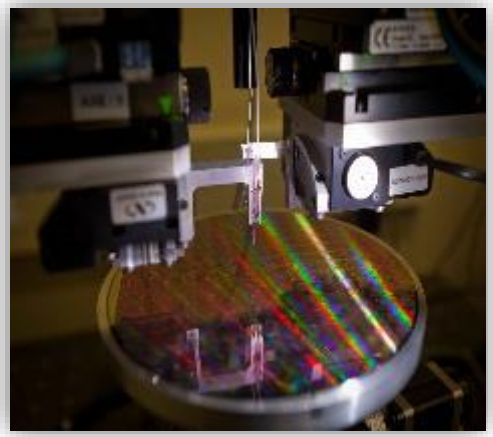
Cleanroom processes



High-speed test beds



Vertical and horizontal coupling setups



Wafer-level automated testing setups

Course Schedule

Day	Time	Training Activity
DAY 1	09:00 – 12:30	Learn about silicon photonics platforms in relation to application areas (tutorials and hands-on demos)
	13:30 – 17:00	Learn to select a design environment and application-specific design choices (hands-on)
	19:00 – 20:30	Learn about light source co-integration (tutorials)
DAY 2	09:00 – 12:30	Learn to design a chip by incorporating application-specific constraints (hands-on)
	13:30 – 17:00	Learn how a chip is made (demos + hands-on)
	19:00 – 20:30	Estimate the cost of manufacturing a silicon photonics product (Guided exercise)
DAY 3	09:00 – 12:30	Learn to couple light into a chip from a fiber for different application wavelengths (demos + hands-on)
	13:30 – 17:00	Learn to test an unpackaged silicon/silicon nitride PICs for various application areas (demos + hands-on)
	17:30 – 18:30	Digital meetup and Q&A with fab experts (online)

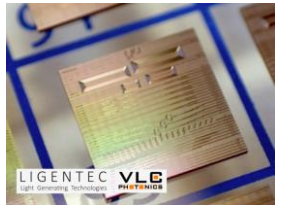
Course Details (Day 1)

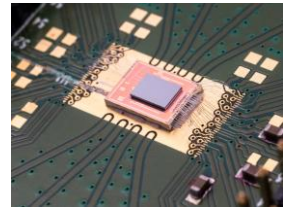
Day 1a. Learn about silicon photonics platforms in relation to application areas (lectures + demos)

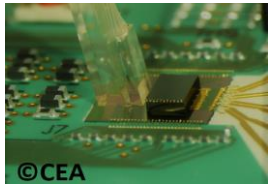
- See and manipulate SiPh chips from at least four platforms (thin and thick SOI, SiN,…)
- Match different forms of silicon photonics with application areas
- Study basic waveguide cross-sections under electron microscope
- Meet the laser co-integration experts

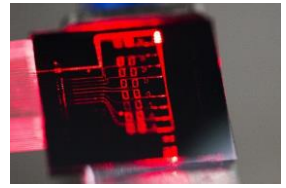
Partners Involved: CNIT, imec, LETI, LIGENTEC, LioniX International, VTT, University of Southampton, Universitat Politècnica de València, Karlsruhe Institute of Technology, TNO, Tyndall National Institute

Training Duration: 3.5 Hours







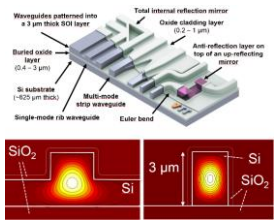


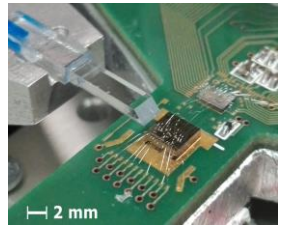
Day 1b. Learn to select a design environment and application-specific design choices (hands-on)

- Learn the design process flow and specific consideration for a given application
- Overview of design landscape (Device, Circuit, Layout, System)
- Hands-on exposure to at least two design environments

Software used: Luceda, SYNOPSYS

Training Duration: 3.5 Hours





Day 1c. Learn about light source co-integration (tutorials)

- Meet the laser co-integration expert(s)

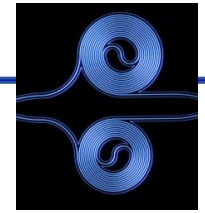
Partners Involved: CNIT, imec, LETI, LIGENTEC, LioniX International, VTT, University of Southampton, Universitat Politècnica de València, Karlsruhe Institute of Technology, TNO, Tyndall National Institute

Training Duration: 1.5 Hours

Locations: iGent Tower, Technologiepark-Zwijnaarde, 9052 Ghent +

UGent Cleanroom, Technologiepark-Zwijnaarde

European Photonics Innovation Academy



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Course Details (Day 2)

09:00

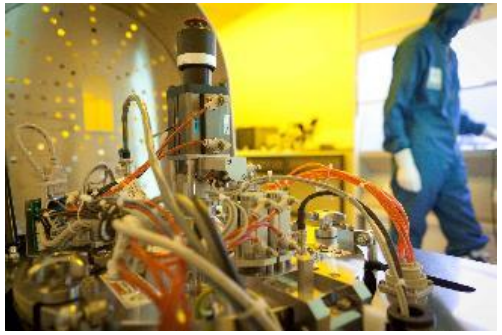
17:00

Day 2a. Learn to designing a chip by incorporating application-specific constraints (hands-on)

- Hands-on design of a simple circuit in a design environment of your choosing
- Incorporating application-specific practices into PIC design

Software used: Luceda, Synopsys

Location: Training Duration: 3.5 Hours



Day 2b. Learn how a chip is made (Demos + hands-on)

- Execute one or two key process steps in PIC-fabrication yourself

Techniques: Lithography, Etching

Training Duration: 3.5 Hours

Day 2c. Learn to estimate the cost of manufacturing a silicon photonics product (Guided exercise)

- Shortlist a technology platform for an application
- Understand the most important cost parameters for a technology flavor

Techniques: Literature survey, handouts, intuition

Location: Technologiepark-Zwijnaarde

Training Duration: 1.5 Hours

Locations: iGent Tower, Technologiepark-Zwijnaarde, 9052 Ghent +

UGent Cleanroom, Technologiepark-Zwijnaarde

Course Details (Day 3)

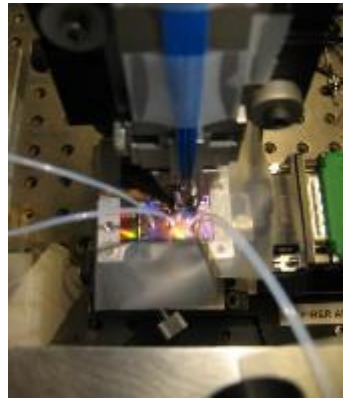
Day 3a. Learn to couple light into a chip from a fiber for different application wavelengths (demos + hands-on)

- Execute and optimize coupling of light in and out of a chip, both horizontally and vertically for different application wavelengths
- Measure coupling efficiency + data analysis

Facilities used: vertical test bed, horizontal test bed, fiber arrays

Partners Involved: CNIT, imec, LETI, LIGENTEC, LioniX International, VTT, University of Southampton, Universitat Politècnica de València, Karlsruhe Institute of Technology, TNO, Tyndall National Institute

Training Duration: 3.5 Hours



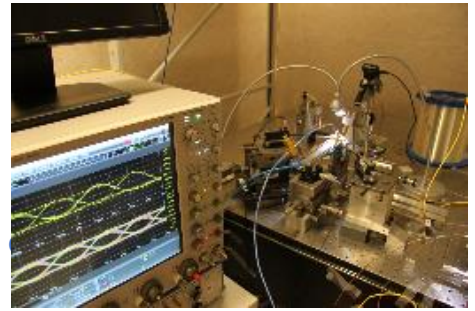
Day 3b. Learn to test an unpackaged silicon/silicon nitride PICs for various application areas (demos + hands-on)

- Test a PIC with optical and high speed electrical probing
- Use spectral measurements to identify spurious reflections on chip

Facilities used: High-speed test bed, Optical VNA, fiber arrays

Partner involved: CNIT, imec, LETI, LIGENTEC, LioniX International, VTT, University of Southampton

Training Duration: 3.5 Hours



Day 3c. Digital meetup and Q&A with ePIXfab fab members (online + on-demand)

- Online one-on-one conversation with trainees and the representatives of various fabs

Partners Involved: CNIT, imec, LETI, LIGENTEC, LioniX International, VTT, University of Southampton, Universitat Politècnica de València, Karlsruhe Institute of Technology, TNO, Tyndall National Institute

Training Duration: 1 Hour

Location: iGent Tower, Technologiepark-Zwijnaarde, 9052 Ghent

Course Trainers

Course Directors: Prof. Roel Baets, Prof. Wim Bogaerts

Course Manager: Dr. Abdul Rahim

Tutorials: Selected speakers from PhotonHub , Experts from UGent- ePIXfab

Chip Fabrication: UGent Cleanroom staff

Chip Coupling: ePIXfab + UGent Manpower + Application engineers from PhotonHub partners

Chip Testing: ePIXfab + UGent Manpower + Application engineers from PhotonHub partners

Course Material (technical hand-outs)

https://einstein.epixfab.eu

- Electronic access to
  - Course handouts/slides
  - Video recordings of tutorials
  - Design examples
  - Python notebooks
  - Video recordings of lab demos

Course Location, Schedule & Cost

- Course Location: Ghent, Belgium
- Course Schedule (exact dates to be confirmed)
- Number of people (Groups of 10 people per course)
- Course Cost (500 Euros per person, includes lunch catering, handouts, etc.)

Further Information

- abdul.rahim@epixfab.eu
- https://epixfab.eu
- www.photonhub.eu/euphotonicsacademy

UGent
Cleanroom

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At the heart
of Europe

Keywords

Silicon photonics, SOI, Silicon Nitride, High Index Contrast, CMOS, Laser, Modulators, Detectors, Component design, Circuit simulation, System emulation, Design layout, Design Rules, Manufacturing, Pilot Line, Ecosystem, Open-access, Fabless, Fab-lite, Communications, Medical, Sensors, Quantum, Environmental, Computing