Silicon Photonics for Sensing Applications

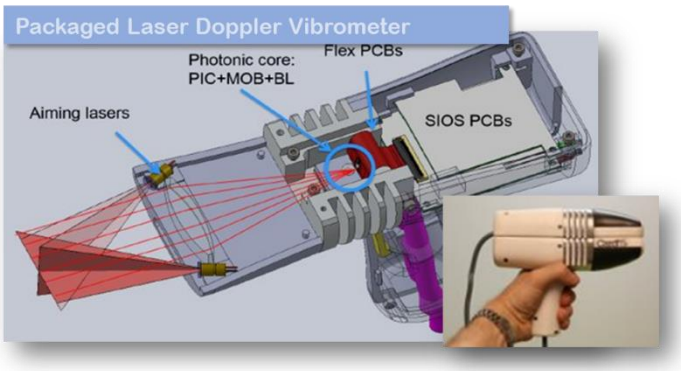
The attendees of this demo center will increase their understanding on how Silicon Photonics can be used to develop sensing solutions for a broad range of applications.

The basics of the underlying sensing principles will be introduced, together with the advantages that integrated photonics offers as opposed to competing technologies.
Product development will be presented, from the market needs to chip design, manufacturing and packaging into a working prototype.
Though the concrete presented demo examples, attendees will learn how photonics technology can enable not only the realization of novel analytic techniques but also the mass deployment of existing ones through cost-effectiveness and compactness.

IMEC Orientation, Course Introduction & Tutorial (Silicon Photonics, Optical Sensing)

- Silicon Photonics (Tutorial)
- Optical Sensing Mechanisms (Tutorial)
- Supply chain (review presentaiton)

Demo 1: Silicon photonics vibration sensing



Laser Doppler Vibrometry (LDV) is a technique to measure remote vibrations using the Doppler effect for light reflected from the target. Conventional LDV systems are built using discrete optics, which make it difficult or expensive to build multi-beam LDV systems. With silicon photonics, we can easily implement multiple LDV systems in a compact photonic IC. We will demonstrate a silicon-photonics based multi-beam LDV system packaged in a handheld system.

The demonstrator will be a portable multi-beam LDV system. We will first introduce the working principle and applications. In a first demonstration, the trainees will use the LDV to remotely

record a human voice in a noisy environment. The measured sound will be replayed and compared with that acquired from a microphone. Secondly, a carotid pulse will be measured to demonstrate the medical application of LDV.

Demo 2: Disposable sensing chips for in-situ environmental and biomedical testing.

Environmental and bio-medical markets aim to mass-deploy cost-effective, easy-to-use, highly sensitive sensors to be use at the 'point-of-testing' in contraposition to existent centralized lab equipment requiring expert operators. Photonic systems consisting of compact read-out units and disposable sensing chips are a versatile and efficient approach to fulfil those needs. We present two examples based on refractive index sensing and Mid-IR spectroscopy respectively.

The demonstrator will consist of two sensing systems developed for detection of IgG antibodies and in-line oil-in-water monitoring respectively. Both demonstrators are explained and contextualized in terms of maturity and versatility. The highly tolerant interfacing enabling manual chip exchange and sensing capabilities will be demonstrated with hands-on operation.

Demo 3: Fiber Bragg Grating Readout Unit

Fiber Bragg Grating (FBG) sensors are widely used in applications requiring multi-point strain or temperature sensing, e.g. in structural health monitoring of bridges, dams and buildings. Also, increasing the efficiency of wind turbines and monitoring chemical processes are important applications. They can operate in harsh environments and are immune to electromagnetic radiation.

But, while the sensors themselves are relatively cheap, traditional FBG interrogators are too expensive for many applications. This demo, with support of spinoff-company Sentea, will show how an ultracompact silicon photonics-based spectrometer can overcome this limitation.

In the demonstrator a packaged readout-unit (based on silicon photonics chip) will be used. Attendees will measure the strain of FBG-sensors in some demo-setups (suspended between optical stages, embedded in composite material under stress…) both using the compact readout-unit and a 50kEuro laboratory type spectrometer and compare the results. Also a dynamic measurement (vibration) will be carried out and linked with demo 1 (vibration sensing using LDV).

- **Closure: Discussion on supply chain, clean-room tour (optional)**

TRAINING CONTACT PERSONS:

Nuria Teigell Beneitez: **Nuria.TeigellBeneitez@UGent.be**

Dries Van Thourhout: **dries.vanthourhout@imec.be**