Interferometric Imager with Subnanometer-resolution

Imaging surfaces with nano-scale topology is essential for the field of nanosciences, in particular for material analysis and medical applications. To-date such imaging devices are often very expensive, bulky and mostly for laboratory usage. This project is about developing and verifying a prototype of such an imaging device (based on CMOS) for **material analysis** (e.g. detection of defects in transparent glass) and point-of-care (PoC) applications (such as early state detection of blood infections (SEPSIS) and other diseases). The detection mechanism is based on a **lens-free interferometric** method allowing the detection of **height-differences down a few Å** over a **large field-of-view of ~1cm^2**.

For **material analysis** an appropriate algorithm will allow the precise 3-dimensional detection of particulates, defects or surface deformation. This is in particular essential for transparent substrates for flexible electronics. For **PoC** it allows the real-time reading of millions of biomarkers at once. The small size (handheld) and low-cost (based on consumer electronics) of the device will allow PoC in remote and poor areas for end-consumer applications.

The goal of this master-/ or project-thesis is to develop a compact/hand-held version of this device and/or to test it on materials with defects or PoC samples. The project could include the following parts:

- Development of low-cost and handheld imaging device
  (including improvement of optical setup)
- Development and implementation of a holographic tomography software
- Use machine learning techniques to improve analysing of samples / micro-arrays
- Evaluate 3D samples for detection of material defects
- Evaluating Point-of-care (PoC) applications with protein-protein interaction on micro-arrays
  (could be done in collaboration with other institutions or local hospitals)
- Using quantum sources and single-photon detectors to increase sensitivity and develop first practical quantum device for imaging (part of EU project)

The student would learn to build an optical interferometer (including the fields of optics, programing, electronics), design a Point-of-Care / Internet-of-Things prototype, design & verify computational holography including machine learning, exploit and perform biomedical measurements and develop practical quantum imaging device. The exact project can be adapted to the interest of the student and his availability.

The work will be carried at ICFO, ands its state-of-the-art laboratories (located close to Barcelona) under the supervision and support of ICFO engineers, technicians and PhD students. Do not hesitate to contact us for more information or a lab-tour.

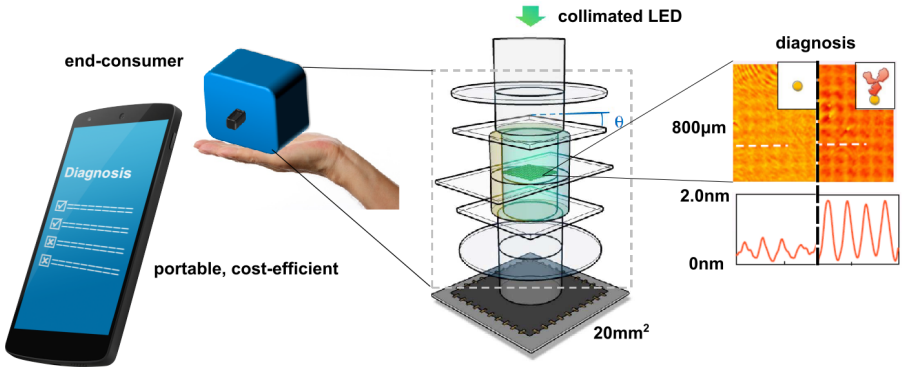

Figure 1: Scheme of the Interferometric Imaging System (middle). A nanometric resolution image (right) can be taken over the whole sensor area. This allows the rapid analysis of biomarker arrays, for the detection of diseases.

Project start and timeframe

Project start to be discussed, minimum 4 months

ICFO – The Institute of Photonic Sciences is a non-profit research organization performing applied research in collaboration with several companies of the region. The Optoelectronics group at ICFO, led by Prof. Valerio Pruneri, aims at bridging the academic and industrial worlds by pursuing fundamental ideas with great potential for revolutionizing future photonic products. Valerio Pruneri himself is a highly recognized scientist in the field (>250 publications, >40 patents) with a wide and collaborative network of industrial partners.

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