Robust, affordable photonic crystal sensors for point-of-care disease diagnostics

RAPID

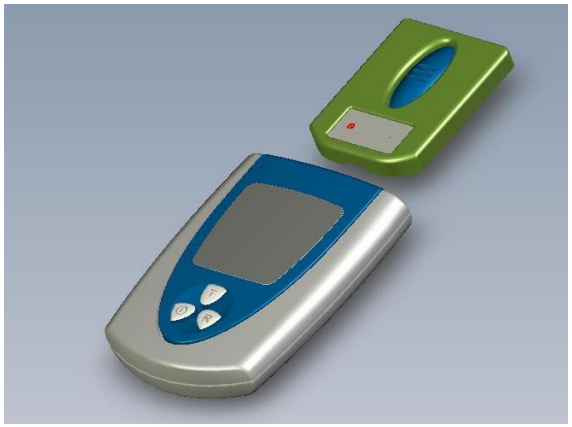
Project No 258238

Consortium

Tyndall National Institute

Lund University

Manchester 1824



UCD Dublin

AnOther
NIL partner

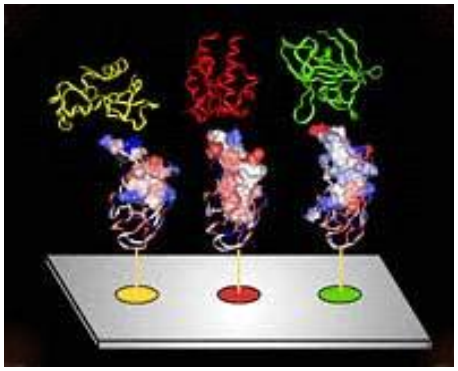
sierrasensors
Biosensor Technologies

Project Goals

- The overall goal of RAPID is to design and develop an integrated **multichannel 2D photonic crystal based disposable biosensor,** for point-of-care disease diagnostics applications.
- Photonic crystal core sensing element will be fabricated in gallium phosphide (GaP) semiconductor material.
- Enable rapid monitoring of antibody–antigen binding events (typical assay times <5 min)
- High sensitivity (~ 1 x 10^{-5} refractive index units, RIU, at 850 nm).
- Enable detection limits of 100 fM for our pancreatic biomarkers (5 pg/ml)
- LOD for state of the art assay (ELISA) is commonly in the pg/ml to ng/ml range
- Sensor disposable to cost ~€10 per test

Challenge

(a)



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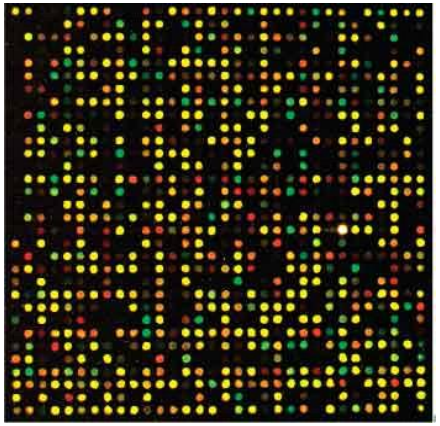
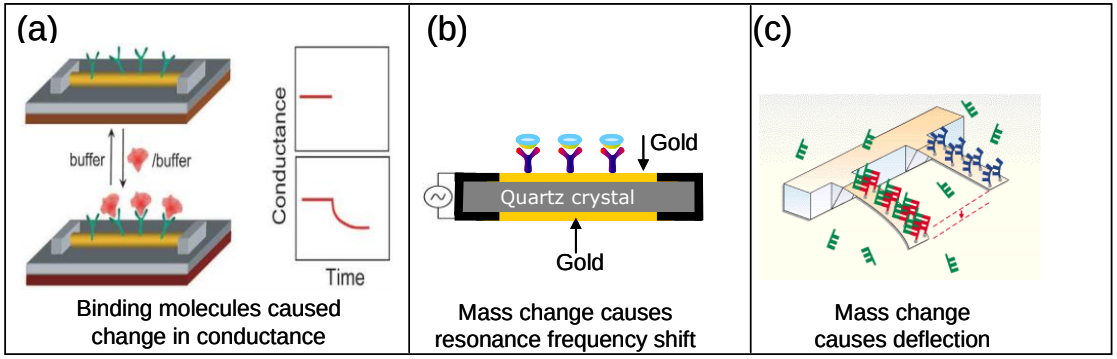
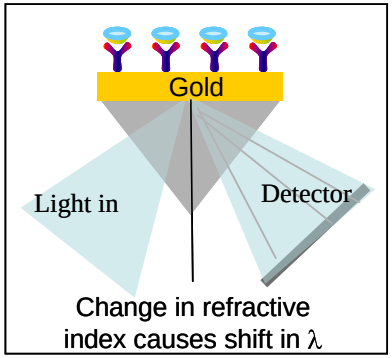
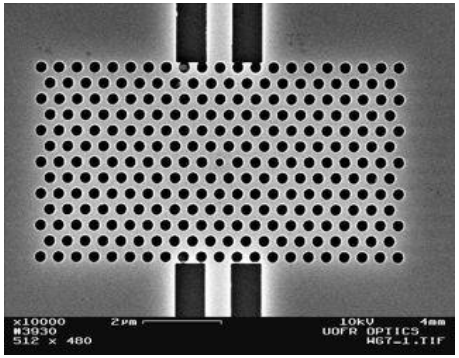


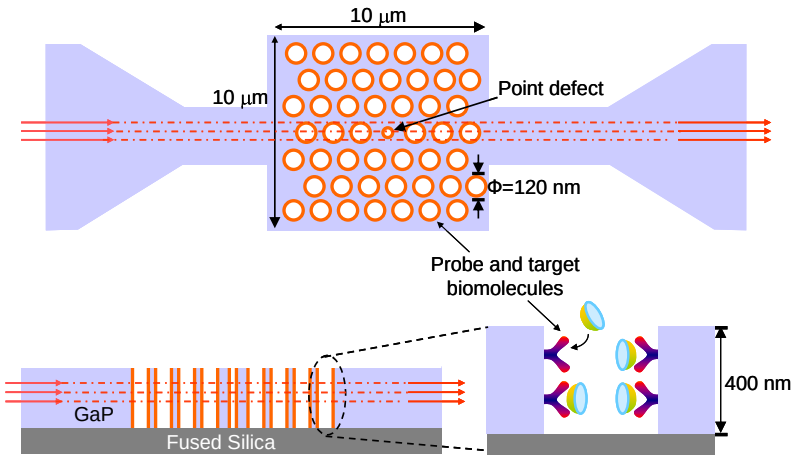


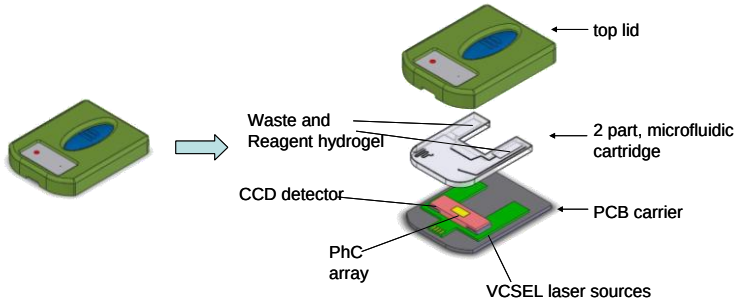




Challenge: The need to develop practical and effective technologies that can quantitatively detect specific disease biomarker proteins with high specificity, selectivity and sensitivity in complex media, in a rapid and label free manner for point-of-care disease diagnostics, is essential.

Rapid Approach





NIL ➔ Integrated **multichannel 2D photonic crystal based disposable biosensor** based on GaP

Sensitivity enhancement will arise from high confinement of the light (n_{GaP} = 3.1 V's n_{Bio} = 1.45)

Modeling to ensure full pore wetting

1D VCSEL array will be used as the light source

Light out-coupled to low cost Si CCD detector array

Probe source: Human recombinant single chain variable fragment, scFv, microarray adapted.

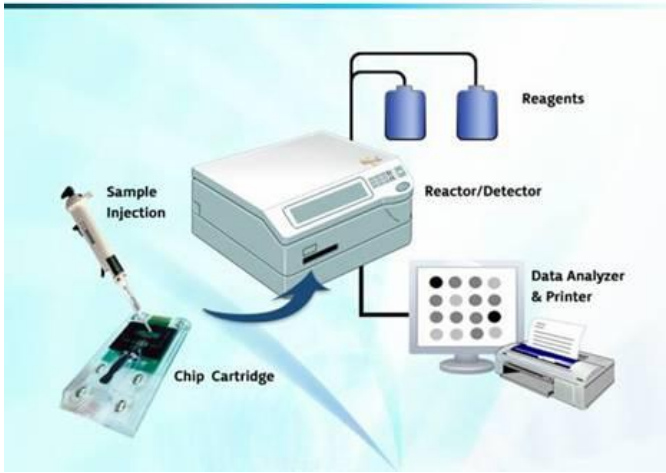
Selective patterning using novel attachment chemistries.

Sample delivery using microfluidics

Genetic algorithms on multivariate analysis to reduce false positives and negatives

➔ Detection based on a shift in resonant transmission λ with changing refractive index

Innovations



RAPID will **develop GaP as the guiding layer** and fabricate PhCs that are 10 x 10 mm in dimension. **GaP is transparent in the 650 – 1000 nm spectral range,** respectively permitting the integration of low cost lasers and detectors, such as vertical cavity surface emitting lasers (VCSELs 850 nm emission) with a tuning range of >5 nm and charge coupled detectors (CCD chips) in the biosensor platform.

Gratings will be developed and **fabricated simultaneously with the PhC** in the wave guiding layer to **facilitate in and out coupling of light**.

The sensing platform developed in RAPID will operate at 850 nm, a region which is free of overtone absorption resonance in bio-media and low in biological autofluorescence that would otherwise decrease signal to noise and thus increase sensitivity of the sensor platform.

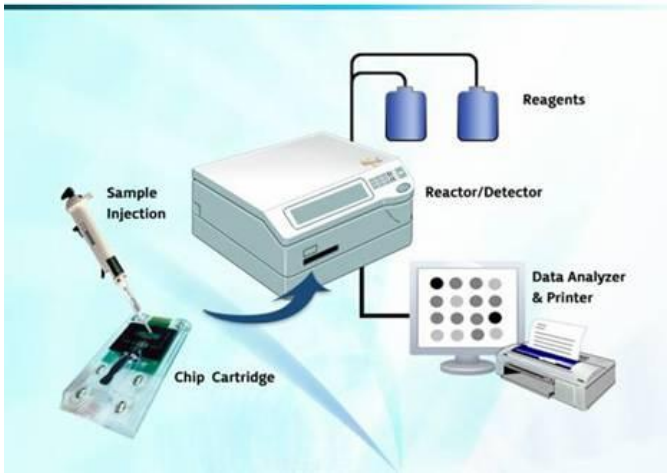
A human recombinant single chain variable fragment, scFv, antibodies for **four pancreatic caner biomarkers** will be employed as biological probe.

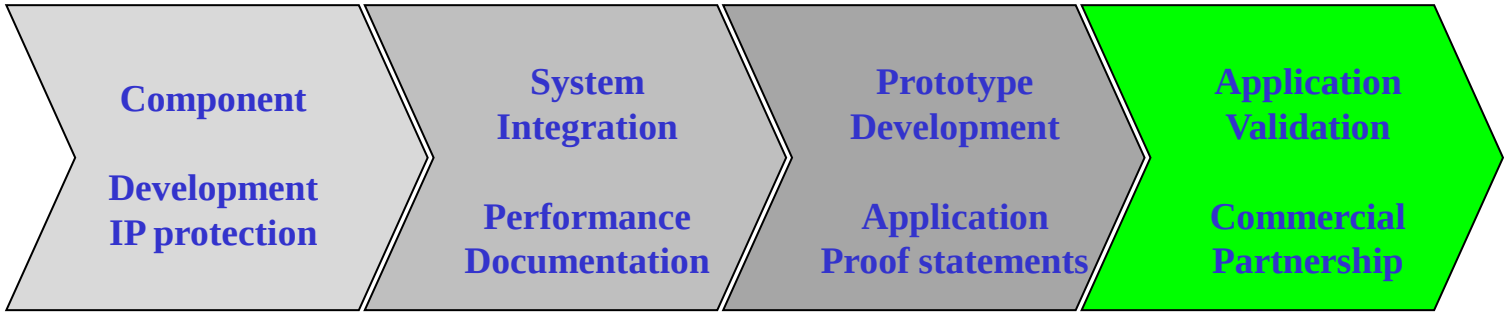
Low Cost ~ €10 per test

Exploitation

Development of a disposable photonic crystal based biosensor and desk top reader for label free point-of-care disease diagnostics with sensitivity **equivalent to the most sensitive established laboratory, ELISA,** based techniques.

Simplicity “pipette and click”





- Develop and validate a pre-commercial point-of-care diagnostic system
  - Pancreatic cancer
- Partner with established diagnostic company
  - Certification and commercialization
  - Ortho, Roche, Qiagen, R-Biopharm