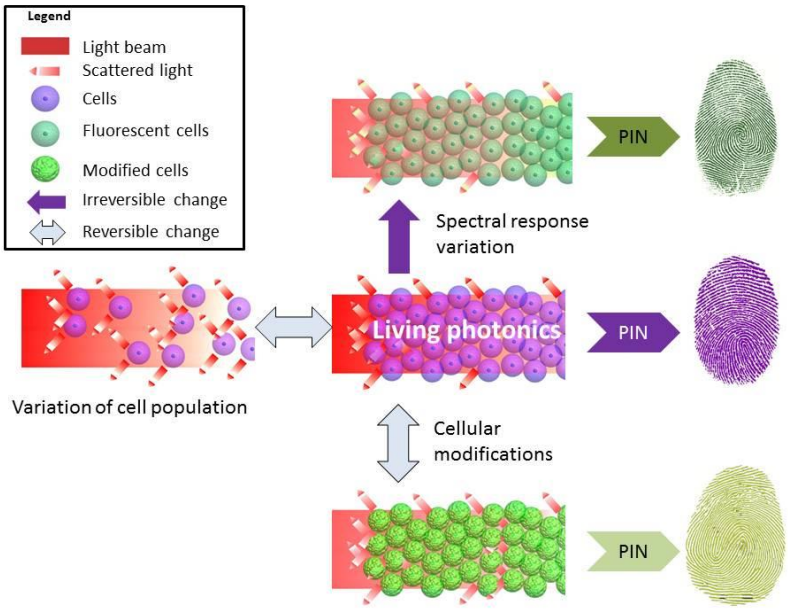
Living Photonics: Monitoring light propagation through cells (LiPhos)

The LiPhos project will develop biophotonic diagnosis tools (BDTs) in which cells are, for the very first time, used for defining the core of the waveguide, giving rise to the "Living Photonics" concept. Measurement protocols will consist of the determination of the Photonic Fingerprint (PIN) of the biological system under study and will be applied to the diagnosis of cardiovascular disease (CVD).

Background / Motivation

Photonics has emerged as a unique, extremely powerful technology for contactless real-time analysis in the life sciences and medicine. This is a reflection of the fact that using light as an interrogation mechanism in life sciences has major advantages, such as high sensitivity, non-destructive measurement, minimally or even non-invasive analysis and low limits of detection (LoD).

Biophotonics is powerful and mature enough to provide the next generation of diagnosis and prognosis tools. Nevertheless, the combination of technologies such as microfluidics and photonics will be required to enable the real time measurement of relevant analytes in very small sample volumes.



Objectives

The main objective is the integration of new biophotonic functionalities and development of breakthrough diagnosis tools based on the living photonics concept and following a user-driven application-specific approach. In addition, the PIN of the cell culture (which will include information regarding cell population, spectral response and morphology) will be studied to obtain an unprecedented level of detailed information for the diagnosis of CVD. Finally, pre-clinical validation of the cell-based photonic systems for diagnosing CVD will be carried out.

Project Description

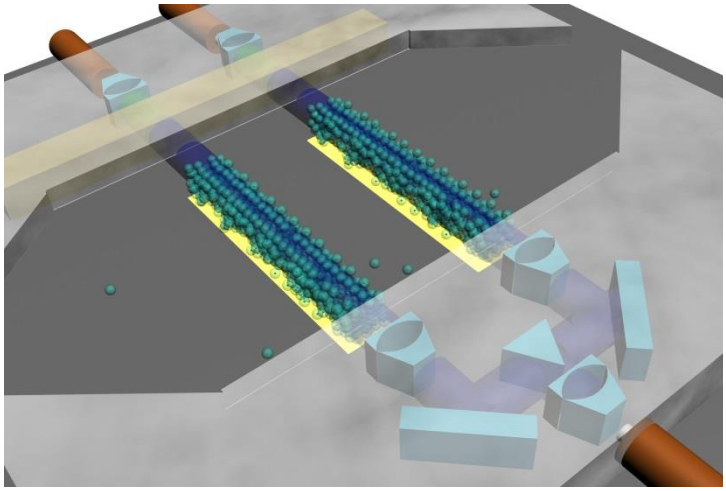
LiPhos is focused on the development of innovative biophotonic diagnostic tools using cells as the constituent material. In this context, cells play a two-fold role: i) they form a biomaterial with higher refractive index than the surrounding media, thus defining the waveguide; and ii) they are interrogated by the light coupled into them, and act as reporter elements to exhibit a unique spectral response. The advantage of this configuration is a highly-efficient cell-light interaction, making it possible to diagnose diseases by measuring the photonic fingerprint (PIN). This key parameter, newly introduced in LiPhos, is the spectral response of the living photonics and includes the different inherent or acquired bands (scattering, absorbance and/or fluorescence) directly related to the cell culture or tissue under study. This is highly specific, since healthy and non-healthy cell cultures or tissue will yield different PINs when used as waveguides. This ground-breaking method will give rise to a powerful analytical tool, which could be applied to study and diagnose a disease at the cell culture or tissue level.

The ultimate aim of the LiPhos project is the diagnosis of CVD. This target will be addressed by first obtaining and comparing the PINs of adherent cell layers cultured under controlled conditions, and representing diseased or healthy states. At a later stage, the LiPhos concept will undergo pre-clinical validation as a diagnostic tool for CVD, using arterial segments obtained from patients with known endothelial dysfunction.

LiPhos provides an innovative and potentially game-changing opportunity to reduce both the social and financial impact of CVD, as well as huge market possibilities to the companies involved.

Expected Results & Impacts

LiPhos presents a breakthrough photonic technology based on the use of high density cell cultures to confine and guide the light, thus acting as an active, living waveguide. Hence, LiPhos is NOT a merger of existing technologies. Rather, it presents an innovative approach in photonics for life sciences, in which the different roles of the biosensor (transducer, reporter elements) are combined in a photonic system to develop a new generation of BDT. The BDT consists of a living photonic system together with auxiliary semiconductor/polymer integrated optic/micro-optic structures.



The expected project impacts, societal & economic benefits can be summarised as follows:

- High performance and functionality: the cell-based photonic systems will provide a revolutionary tool for acquiring real time key information, which could be applied to investigating biochemical and metabolic processes at the heart of various physiological and pathological conditions.
- Novelty and potentiality: no other research groups or companies across the world have yet started developing this new generation of photonic systems and thus this approach is currently world-leading with a clear potential for patents and spin-offs.
- Multidisciplinarity, component size and cost reduction: the synergistic combination of key research fields (photonics, microfluidics and cell biology) in a highly multidisciplinary approach will provide for the very first time an extremely compact, photonic lab-on-a-chip system suitable for performing real time multiparametric screening of cell cultures and hence obtaining their PIN.
- Socio-economic impact: CVDs are the main cause of death within the EU, being responsible for around 48% of the deaths every year and with overall estimated costs to the economy of €192 billion a year [European Cardiovascular Disease Statistics, 2008 edition]. Hence LiPhos can make a major economic and societal impact, putting Europe at the forefront of this new technology.

Regular updates on results will be published through conferences, journal publications and through the LiPhos website.

At A Glance

Project co-ordinator:
CSIC-CNM, Spain

Contact person:
Dr Andreu Llobera
Tel. + 34 93 594 7700
Fax. + 34 93 580 1496
E-mail: andreu.llobera@imb-cnm.csic.es

Project Website:
www.liphos.eu

Timetable: from 11/2012 to 10/2015

Total cost: € 4,175,431

EC funding: € 3,200,000

Instrument: STREP Project

Grant Agreement No.: 317916

PROJECT PARTNERS

Agencia Estatal Consejo Superior de Investigaciones Científicas – Centro Nacional de Microelectrónica (CSIC-CNM) – Spain

Rijksuniversiteit Groningen (RUG) – The Netherlands

Aarhus Universitet (AU) – Denmark

Dublin City University (DCU) – Ireland

Fundación Centro Nacional de Investigaciones Cardiovasculares Carlos III (CNIC) – Spain

iXscient Ltd – UK

Cellix Ltd – Ireland

Lionix BV – The Netherlands