POSITIVE NEWSLETTER 2: NEW PHOTONIC BIOSENSORS FOR THE FAST AND SAFE DETERMINATION OF SENSITIZATION TO MULTIPLE FOOD ALLERGENS

Six European research centres and two industry partners have joined in a new European research consortium called POSITIVE. The goal of POSITIVE is to develop new rapid and multi-assay diagnostics for determining sensitization to food allergens. The European Union supports the consortium during a three-year period with 2.9 MEuro through its Seventh Framework Programme.

Food allergies can provoke clinical reactions whose most severe is anaphylaxis, with respiratory and/or cardiovascular problems that might result in death. They are common in 1-2% of adults and up to 8% of children, corresponding to a serious public health problem that affects over **15 million people in Europe** from infants to the elderly and its prevalence is increasing.

POSITIVE will develop a diagnostic platform that can quickly and safely identify the sensitization of a patient to multiple food allergens so as to be able to proscribe a suitable diet and lifestyle. Ideally it will be a rapid system with little hands-on time, so as to be used at point of care (PoC) in an intensive care unit by paramedics.

The consortium will develop a state-of-the-art diagnostics Lab-on-a-Chip platform via an integrated microfluidic sample preparation technique capable of serum preparation from whole blood of volumes, <100µl. The detection will be based on ultrasensitive photonic biosensors that are integrated into the lab-on-chip device. A final prototype consisting of a packaged biochip and reader will be used on clinical samples in order to determine sensitization to allergens such as that for hen's eggs, cow's milk, peanuts, wheat, tree nuts, fish, sesame, and shrimp ingestion.

More information about POSITIVE and its partners can be found on the POSITIVE website http://www.fp7positive.eu or in the attached project flyer.

ABOUT THE POSITIVE CONSORTIUM:

Positive project manager and main contact person:

Dr. Daniel Hill, UVEG – Universitat de Valencia (http://www.uv.es/umdo)

Other partners:

Royal Institute of Technology - Microsystem Technology Lab (http://www.ee.kth.se/mst)

Centre Suisse d'Electronique et de Microtechnique (http://www.csem.ch)

Farfield Group Ltd (http://www.farfield-scientific.com/)

Charite Universitaetsmedizin Berlin (http://www.charite.de)

Phylogene SA (http://www.phylogene.com)

Università degli Studi Di Trento (http://science.unitn.it/~semicon/)

Consiglio Nazionale Delle Ricerche (http://www.icrm.cnr.it)

Highlights of technology developed in first 12 months:

The project is proceeding according to plan with all deliverables and milestones having been reached timely, these report on the following developed technology –

- We have defined the specifications of the final product, sample and sample treatment and project prototype. We have studied and written what could be the risks and defined specifications of some alternative solutions
- Construction and testing of temperature control unit and integration with fluidic cell enclosure from CSEM and software modification.
- Development of off-stoichiometry thiolene based sensor chip encapsulation
- Development of process for low temperature "click" wafer bonding of off-stoichiometry thiol-ene (OSTE) polymers to silicon
- Module developed for blood filtering
- Various microfluidic flow cells have been developed for device cartridges
- Development of models for birefringence in porous silicon membranes etched from (100) and (110) silicon for polarimeter and interferometer schemes
- Identification of depolarization causes in porous silicon membranes
- Bulk refractive index experiments have successfully been performed for porous silicon membranes

Partner feature:

Nanoscience Laboratory

Nanoscience Lab (NL) is a well-established research group with a strong focus on Silicon Photonics. The head of the lab, Prof. L. Pavesi, has provided a strong contribution to the development of the Si Photonics field, obtaining remarkable results in demonstrating the use of Si nanostructures in active photonic devices. The group is internationally renowned and actively collaborates in different research projects all centered in the core field of Silicon Photonics. NL has a number of activities focused in integrated photonics for ICT applications (integrated optical network, optical switching and routing) and optical sensing. Moreover NL has mastered the PS etching mechanism to experimentally demonstrate important phenomena such as optical analog of Bloch oscillations and Anderson light localization in extremely complex 1D photonic crystals composed of up to hundreds of layers. From its strong involvement in integrated photonic research, NL posseses advanced capabilities for modeling photonic structures modeling (in house developed codes, FDTD and PWE engines) and a dedicated cluster facility. NL has also demonstrated the use of advanced PS structures in sensing applications and fabricates highly sensitivity, multi-parametric gas sensors. More recently the group acquired a substantial background in PS surface functionalization and optimized different strategies to effectively stabilize PS surfaces.

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Participants

Dr. Paolo Bettotti works as researcher at NL and has developed an electrochemical etching procedure to obtain high aspect ratio macroporous silicon from p-type substrates. His research interests are shared between integrated photonics for ICT and optical sensing application. The two fields share the common background of the integrated optical structures. He possesses an in depth knowledge of porous silicon (PS) fabrication that spans both nano and macroporous structures. Concerning PS he has focused his work on material applications: worked on PS functionalization techniques with rare earth and solgel material, demonstrated the use of PS as high sensitivity gas sensors and as a positronium source. He also possesses expertise about photonic structure modeling and material characterization with spectroscopic and microscopic (optical, electronical and scanning probe) techniques.

Porous Silicon membrane development feature:

In Positive the group provides its strong knowledge on the fabrication of complex porous silicon (PS) multilayers. Porous silicon (PS) membranes with different pore size and porosities have been fabricated on both p- and n-type substrates and particular attention given to microfluidics requirements. Different substrates have been investigated to optimize the porous structures so as to respect both optical and fluidics membranes properties. Porous free standing membranes are essential to achieve the ultimate goals in POSITIVE. They are fabricated from specifically chosen substrates and then distributed amongst the other project partners for their processing and/or analysis. A method to control the partial membrane detachment from the bulk supporting silicon substrate has been developed to permit the transport of the delicate membranes to other partners for their mounting on suitable supports. In order to achieve a stable device operation it has been necessary to reduce the high surface energy possessed by PS. Various passivation methods to stabilize PS surface have been developed: thermal treatment (to create a thin oxide layer over PS surface), and chemical reactions (such as silanization and hydrocarbonization) have been considered. All of these methods have demonstrated their usefulness in avoiding uncontrolled surface oxidation and a stable PS surface state and optical properties.

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