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Mass produced optical diagnostic labcards based on micro and nano SU8 layers

OPTOLABCARD Contract No. 016727

COORDINATOR

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PROJECT DESCRIPTION

The emergence of new pathogens or variations has recently created severe threats to human health (E.coli O157:H7, SARS, the avian-flu disease). The gravity of the problem resides on the fact that their impact and spreading is growing dramatically due to the ongoing increase in worldwide human mobility in combination with trade in livestock, and food products. However, detecting the source of infection through conventional analytical methods requires complicated and time-consuming protocols.

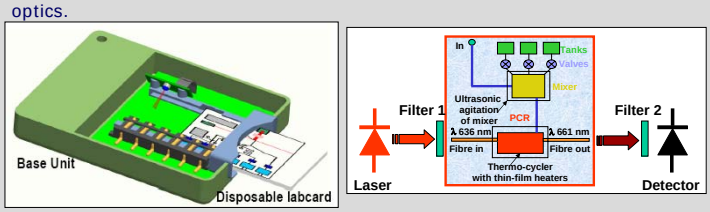
The main objective of the project is to improve the health conditions in Europe reducing the incidence of infectious diseases through the development of a quick and automatic diagnostic device (Lab on a Card) that develops and integrates technology advances in optoelectronics, microfluidics and microbiology.
The range of applications of **OPTOLABCARD** is limitless (infectious diseases, flu, tuberculosis, hepatitis, AIDS, cancer, etc). and it will be validated on Salmonellosis and Campylobacter detection. The scenario where this diagnostic device is used covers hospitals, food factories and private homes. Its impact will be enormous, reducing the incidence of infectious illnesses, and providing EU governments with a certificated tool to quickly monitor and survey the sources of pathogen contamination.

OUR ROLE IN THE PROJECT

ITE is responsible for development of optical/mixing platform and its packaging. The applications of GaN lasers and LED diodes and its on-chip integration problems as the effective coupling of the light sources with the cells and waveguides will be studied. Next, a simple and easy method of integrating system with a light source for fluorescence excitation and a detector for fluorescence detection will be defined.

RESULTS

The project aims at the development of a quick and low-cost diagnostic device (Lab on a Card) that develops/integrates technology advances in optoelectronics, microfluidic and microbiology, capable of detecting, in-situ, DNA pathogens in 15 minutes. The device consists of a hand held base unit and a cartridge or labcard that will carry out a Real Time polymerase chain reaction automatically, from sample preparation to an optical detection. The labcard, made of a photoresist called SU-8, contains all the disposable components, whereas the base unit includes all the standard electronics and optics.



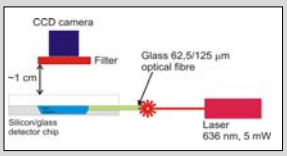
Concept of OPTOLABCARD hand held base unit and a labcard (left) and scheme of the card (right) integrating microfluidical, optoelectronical and microbiological devices

Detection of optical signals generated during DNA real-time chain polymerase reaction inside microreactor of optocard is one of the key problems to be solved "from green field". Of course one can use huge and expensive instrumentation used commonly in genetics science, but, according to basic technical assumption of the **OPTOLABCARD** project, data generated by the card chip, made of glass and SU8, should be collected by a kind of desk-top, portable and cheap "docking station", a kind of small, computerized read-out instrument for mass use. This is a new and difficult task to optimise costs, quality and portability of such instrument.

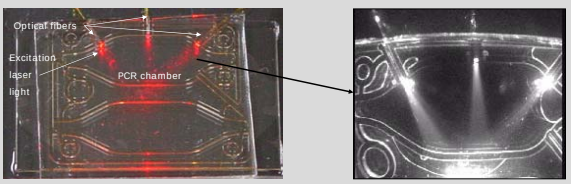
These results concern the first stage of development of optical detection for **OPTOLABCARD** project meeting the mentioned above expectation. The goal of research is to evaluate configuration of detecting set-up, which should be: cheap as possible (~200-300 EUR), sensitive enough to detect **ng/ml** of DNA in liquid sample, working with extremely low quantity of sample volume (<µl) and co-working with card.

The additional but attractive feature of the detecting set-up should be the use of commonly available components and construction allowing wider application in bio- and life-science.

In order to evaluate signal levels, which can be expected in the optocard, several detection units, simulating expected geometrical relation and metrological environment of the true microinstrument, have been constructed and tested. The detection unit consists of a microengineered silicon/glass or glass/SU8 chips with a set of light-guiders, light source and miniaturized spectrometer or CCD camera modules. Each unit can be used without optical filters, or, if needed, with optical filters localized preferably directly onto top surface of the chip. The tests have been carried out with TO-PRO 3 fluorophore samples with and without addition of DNA, as well as with samples delivered by GAIKER containing real Salmonellosis DNA labelled by Cy-5 fluorophore. Among many obtained results, it seems that the application of sensitive but commercially available and cheap CCD camera module is the most promising and reliable solution.



Measurement set-up of the detection unit with CCD camera/filter module: scheme (left) and real picture (right) of the stand



Top views of PCR chip made of glass and SU8, developed by MIC (Technical University of Denmark), on the testing stand (left) and real picture of the sample, containing 250 ng/ml of salmon sperm DNA labelled by TO-PRO 3 fluorochrome, irradiated simultaneously by three optical fibres, the picture captured by CCD camera equipped with 650 nm long-pass filter (adjusted to emission wavelength of TO-PRO 3 fluorochrome)

The research has clearly indicated that commercial components can be successfully applied in optical read-out system of labcard but the configuration of measurement set-up, kind of optical components (mainly filters) and construction of labcard meeting are feed-backed. The lowest detection limit of DNA labelled by TO-PRO 3 fluorochrome, in the system with CCD camera and long-pass filter, is about **2 ng/ml** of DNA, which is enough from the point of view of **OPTOLABCARD** project requirements. The research will be continued.

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