



## **Abstract Report: Mass Produced Optical Diagnostic Labcards Based on Micro and Nano SU8 Layers, OPTOLABCARD**

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Our envisioned diagnostic device will use small raw samples. It will consist of a portable base unit and a disposable Lab on a Card (OptolabCard). The future card platform will contain a chip made by equipment that combines lamination & photolithography of dry films. Sample preparation is being undertaken within the card. The reagents are kept in the LabCard allowing non-expert personnel to use the device. Currently, the developed process based on SU-8 devices has fulfilled the expectation and this process will allow us to fabricate very thin devices, and therefore, truly labcards. Two patents have been filed to protect this fabrication knowledge. The successful fabrication process together with preliminary biological miniaturisation good results allow us to feel confident to tackle the rest of the project.

### **INTRODUCTION**

In the late 90's, the development of chemical and biological sensors played a significant role in improvements of public health, by providing new applications with high sensitivity. **Nevertheless, the commercialisation of such devices has continued to lag behind "research", mainly because this advantage can not currently be offered at low cost.** The following table lists some of the most remarkable approaches:

Manufacturer	Technique	Time	Automa
NEOGEN	Strip	1 day	NO
Merid. Diaq.	Strip	1 day	NO
BioMerieux Vitek	Immunoassay	2 day	YES
Orqanon Teknika	Immunomaq.	1 day	YES
Dynal Inc	Immunomaq.	1-3 days	NO
Vicam	Immunomaq.	1-3 days	NO
Applied Biosys	Q-PCR	5 hours	YES
Molecular Biosys	PCR	5 hours	YES

List of the available devices in the market ordered by size and time response

It can be seen that neither of them can perform the analytical assay in a quick, simple way within a Lab on a Chip. Up to date, the majority of the existing microsystems have been designed as microscale devices coupled to a macroscale infrastructure. A lack of automation is an outstanding concern due to the cross sensitivity to labour hand since preparative hand steps are needed.

### **OUR VISION**

Our vision of a true Lab on a Card (LabCard) consists of a hand held base unit and a disposable LabCard that will carry out a biology assay automatically, from sample preparation, to detection (i.e. Quantitative

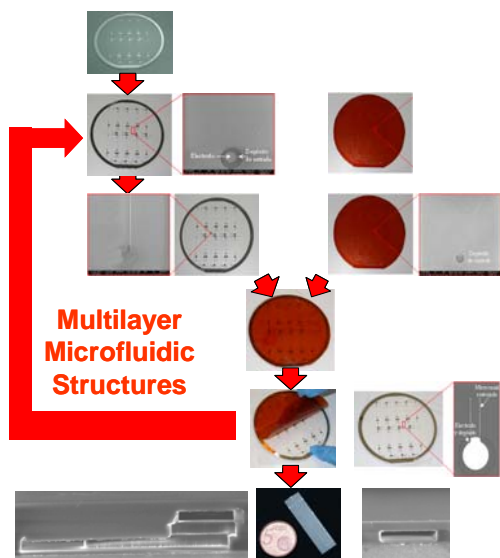
Polymerase Chain Reaction qPCR). **The chip, made out of polymer films, contains all the disposable components (reagents, valves, pumps, beads) and it is packaged in a Card, whereas the base unit has all the complex electronics and optics. This approach will avoid any cross contamination between measurements and it will allow us to drastically simplify the chip components (valves, pumps, reservoirs, sensors, heaters, etc) since they will need to be used just once.**

### **CHALLENGES TO BE FACED**

Through the first year of the project, many **challenges** are being faced to obtain a commercially viable LabCard: (i) High throughput fabrication process, (ii) few materials involved, (iii) authentic sample preparation, (iv) simple fluidic control, (v) high sensitivity, (vi) small amount of measured sample, (vii) reagents stored within the card, (viii) manipulation of biomolecules (enzymes, DNA, or antibodies) as components of our LabCard, and (ix) thin fluidic devices able to be packaged within a Card. Basically, our strategy resides on making things as simple as possible through the combination of the bio-info-cogno-nano fields. This strategy is essential to make the LabCard word meaningful.

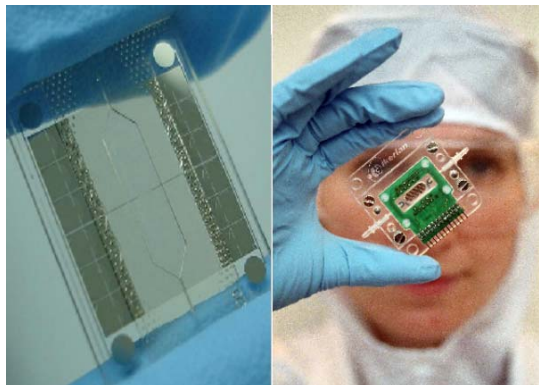
### **FIRST YEAR RESEARCH RESULTS**

This section summarises our advances to fabricate a LabCard where sample preparation and detection take place. We have developed an approach that consists of using just one fabrication procedure to produce all Labcard components.



Fabrication process of SU-8 multilayer stack<sup>1</sup>.

This procedure is based on the negative photoresist SU-8 to build fluidic control components, optical waveguides, electrodes, microfluidic channels and microreactors.

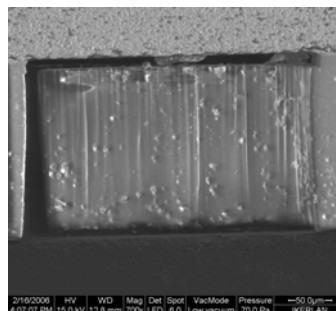


Picture of the SU-8 PCR chip.

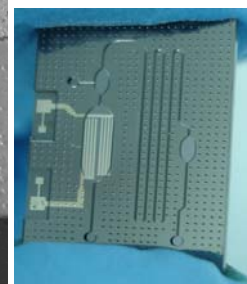
Packaging capsule.

As for the packaging, the replacement of these devices within the capsule is simplified since there is no need of drilling to leave the inlets of the microchannels in contact with the outside world. A plastic capsule and O-ring per reservoir are enough to introduce liquid into channels.

<sup>1</sup> M.Agirregabiria, F.J.Blanco, J.Berganzo, M.T.Arroyo, A.Fullaondo, K.Mayora and J.M.Ruano López. Fabrication of SU-8 multilayer microstructures based on successive CMOS compatible adhesive bonding and releasing steps. Lab on a chip, Vol. 5, No. 5, pp. 545-552



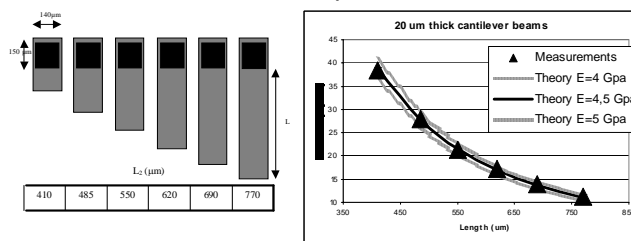
Embedded Cantilever



Electrolysis pump

Using this technology, we are getting preliminary fluidic control results. A cantilever check valve is being developed with an extremely low footprint (high density integration). An electrolysis pump is being characterised for fluidic pumping.

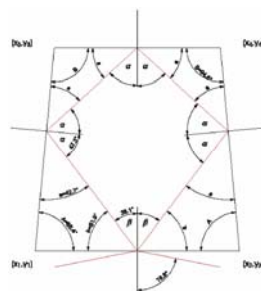
In order to obtain the Young's modulus of the SU-8, measurements of the resonance frequency from different length of cantilever beams made of SU-8 were performed.



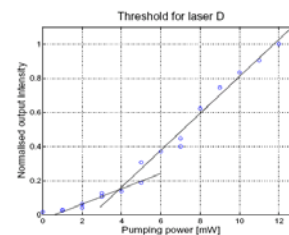
Design of six different cantilever beams

Resonance frequency measured and E modulus.

The singlemode laser has been reproduced and the spectrum has been characterized. We have found that lasers with gain lengths between 1000 micrometers and 4050 micrometers produces wavelengths in the interval 567 nm - 571 nm and that the output intensity was reduced compared with multimode lasers of the same size.

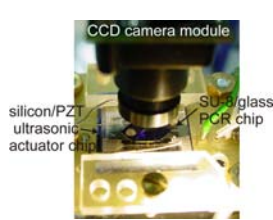


The trapezoid design of the lasers

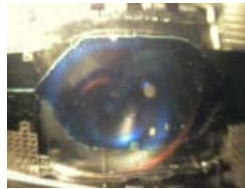


The normalised intensity of the dye laser

The mixer has been fabricated and tested. Complete mixing of two water-based fluids in the demonstrator of PCR chip has been obtained in 10 sec for 6 kHz vibration

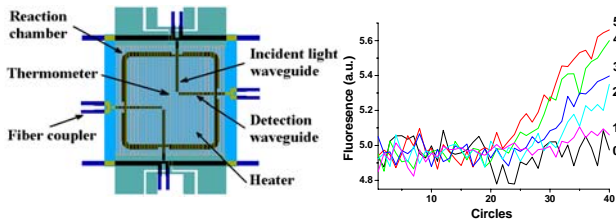


Picture of the Mixing stand-up



True picture of the mixed liquid in a chamber

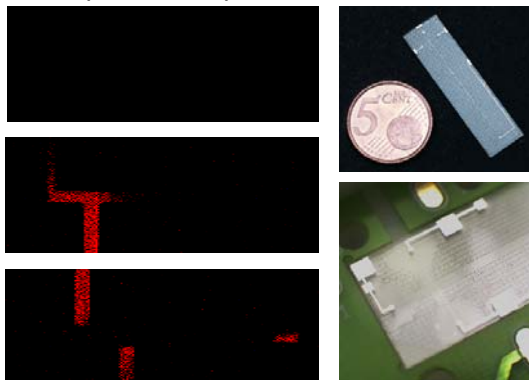
Regarding the waveguides, this task has achieved remarkable results. A better result than expected since to our knowledge, this is the first time real-time PCR monitoring using integrated optical elements in a lab-on-a-chip system was demonstrated.<sup>2</sup>



Schematics of the chip structure

Real-time PCR on chip to amplify Campylobacter

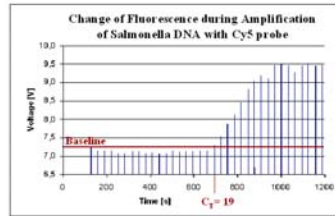
The potential of the developed fabrication technology is also being demonstrated by the integration of a SU-8 Capillary Gel Electrophoresis of proteins.



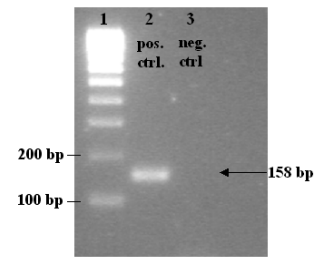
Results of a SU-8 Capillary Electrophoresis chip

Another type of chip

This SU-8 technology transferred to a reel-to-reel process could be superior in cost, integration and ease of fabrication compared to glass, silicon and embossed bonding polymer devices. Our packaging technology allows easy handling and replacement of used LabCard.

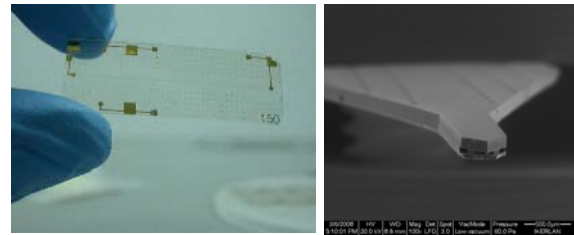


Real time PCR *Salmonella spp.* PCR on chip



Gel electrophoresis

As future work, we are developing a thin fabrication technology to manufacture complex microfluidic SU-8 only devices of 200  $\mu$ m thickness. These devices could be easily packaged within a Card (see figure below).



New devices made of SU-8 only and 200 microns thick. To sum up, this fabrication technology allows research laboratories to produce devices within two days, offering an excellent tool for LabCard prototyping. Moreover, our 100% fabrication yield corroborates that this technique is feasible for mass production by lamination guarantying low cost and high reproducibility.

By using this process another Bio-Micro applications are being undertaken with fruitful results.<sup>3</sup>

**CONCLUSION**

The planned tasks are being developed according to the schedule. The successful fabrication process together with preliminary biological miniaturisation good results allow us to feel confident to tackle the rest of the project.

Apart from the technological achievements, the project has got public coverage by TV news, radios and newspapers. Besides, 8 conferences papers and 2 journals have been accepted. Two patents have been filled. Finally, a PhD student from Ikerlan will work at MIC during 2007.

<sup>2</sup> Z. Wang, A. Sekulovic, J. P. Kutter, D. D. Bang and A. Wolff. Real-time PCR detection *Campylobacter jejuni* on a microchip with integrated thermal system and polymer waveguides. *Electrophoresis*, Accepted.

<sup>3</sup> M. Agirregabiria, F. J. Blanco, J. Berganzo, A. Fullaondo, A. M. Zubiaga, K. Mayora and J. M. Ruano-López, Sodium dodecyl sulfate-capillary gel electrophoresis of proteins in microchannels made of SU-8 films, *Electrophoresis*, Vol 27, Issue 18, pages 3627-3634.