Manufacturing and optimization of a microfluidic device LEGO portable for optical detection-Photonic lab on a chip

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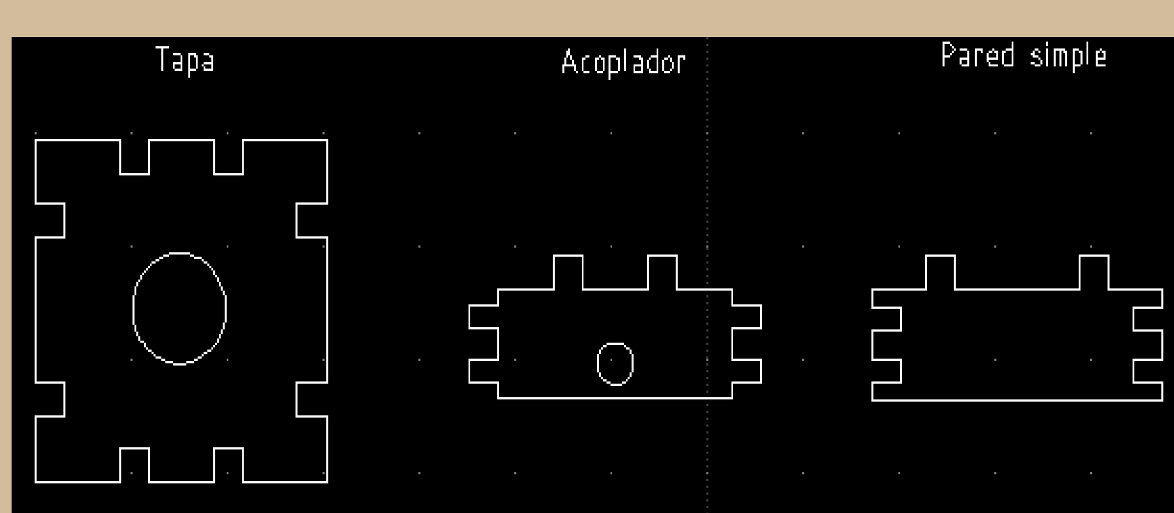
INTRODUCTION

LEGO® building blocks have been patterned with laser so as to obtain photonic elements which can easily be combined into a photonic lab on a chip (PhLoC). As opposite to the monolithic integration, the building block architecture enable to modify only specific regions of the PhLoC. In addition, it allows to replace damaged parts without a complete breakdown of the system.
In this context, different laser writing speeds and conditions have been tested so as to achieve lightguides of 500 um in width and 500 um in depth on transparent LEGO® building blocks. Once the optimal writing conditions were achieved, they were used to implement absorbance-based filters using transparent but colored building blocks. Here, it has been obtained stopbands higher than 30 dBs for blue transparent building blocks, which is the maximum dynamic range of the Maya Spectrometer (Ocean Optics) used. Finally, an experimental set-up was implemented by using a building block as a cuvette, and measurements in absorbance and fluorescence were pursued by placing lightguides either at 180° or at 90° from the input lightguide. Measurements in absorbance showed a limit of Detection (LoD) of 0'0171 ppm using Fluorescein as target analyte. When measuring fluorescence, two different compounds were tested: Fluorescein (LoD of 5.22 ppm) and Norfloxacine (22.82 ppm).
The results presented herein allows confirming the possibility of defining PhLoC building blocks for absorbance and fluorescence measurements.

Figure 1. Channels on a LEGO piece

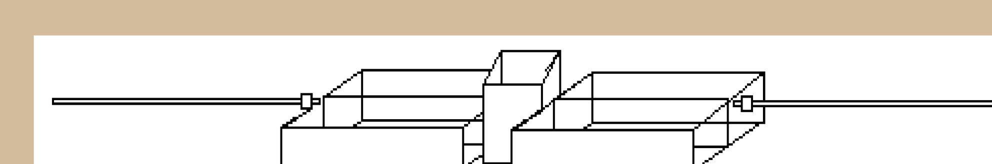
Support fabrication

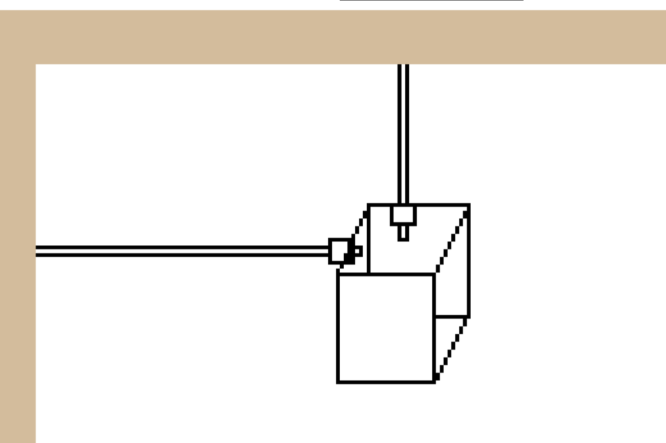


Power	Speed	Resolution	Frecuency	Times
80%	20%	600 dpi	5000 Hz	1

$$P_T = -10 \cdot \log\left(\frac{I \cdot T_{I,ref}}{I_{ref} T_I}\right)$$

$$A = -log\left(\frac{I}{I_{ref}}\right)$$





	Integration time (ms)	Number meassures	Peak width
Fluorescence	100 - 4000	15	2

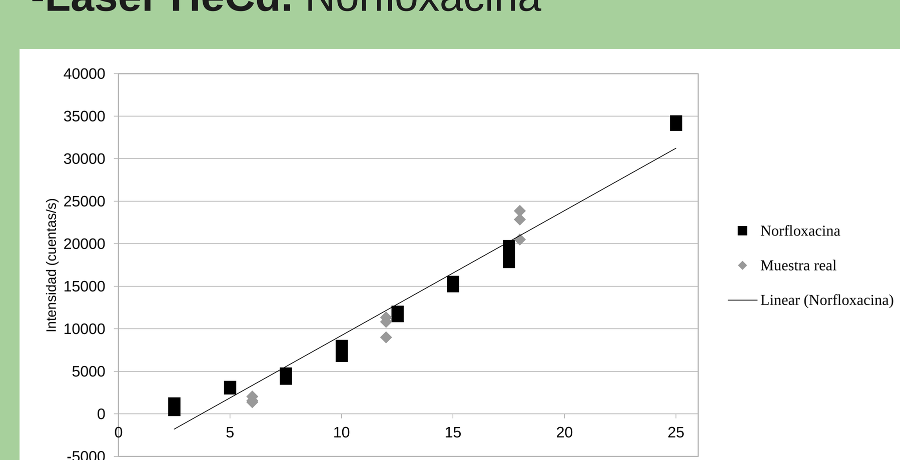
RESULTS

Real sample treatment

Adjust pH 3,5

Analysis (photonic chip)

-**Láser HeCd.** Norfloxacina



Concentrations de 2'5 a 25 ppm.

Real sample	Teoric value	Promedium real value
6	3342,9	1661,1
12	12150,3	10390,9
18	20957,7	22410,1

Calibration curve at different concentrations of norfloxacin

Compound	LoD (ppm)	LoQ (ppm)
Fluorescein	5'22	17'41
Norfloxacin	22'82	76'07

Light	LoD (ppm)	LoQ (ppm)
D+H without WG	0'89	2'97
D+H with WG	0'0852	0'284
SuperLED without WG	0'0173	0'058
SuperLED with WG	0'0171	0'057

CONCLUSIONS

This work presents for the first time the microfluidic µLPME reusable for the determination of acid drugs and its successfully application in environmental samples. This new geometry for µLPME offer higher recoveries over 83% % for all drugs in environmental samples. The new geometry of this µLPME allows replacing the membrane after extractions decreasing the cost instrumentation. This device has been demonstrated to be suitable for environmental samples (river and lake water) with excellent clean-up and baselines.

BIBLIOGRAPHY

[1] T. Sikanen, S. Pedersen-Bjergaard, H. Jensen, R. Kostiainen, K.E. Rasmussen, T. Kotiaho, Anal. Chim. Acta 658 (2010) 133.
[2] N.J. Petersen, H. Jensen, S.H. Hansen, S.T. Foss, D. Snakenborg, S. Pedersen- Bjergaard, Microfluid Nanofluid 9 (2010) 881.
[3] María D. Ramos Payán, Bin Li, Henrik Jensen, Nickolaj Jacob Petersen, Steen Honoré Hansen, and Stig Pedersen-Bjergaard. Analytica Chimica Acta. 735, 46-53