Micromolds fabrication by laser lithography for biosensing applications

Silvino José Antuña[1], Adrián Fdez Gavela[2], María Rodríguez[3], José Rodríguez[4]
Physics department
University of Oviedo
Oviedo, Spain
[1]antunasilvino.uo@uniovi.es [2]fernandezgadrian@uniovi.es
[3]rodriguezlmaria.uo@uniovi.es [4]jose@uniovi.es

Isabel Álvarez[5], María Teresa Fernández[6], Agustín Costa[7]
Physical chemistry department
University of Oviedo
Oviedo, Spain
[5]alvarezmisabel@uniovi.es [6]mtfernandeza@uniovi.es
[7]costa@uniovi.es

***Abstract*— In this work, we manufacture micromolds by using as materials soda-lime glass and SU-8. In order to copy the scheme that we need in the micromold, an aluminum mask was fabricated by laser lithography containing the scheme. To improve the durability of the micromold, a layer of acrylic conformal coating is deposited over the sample. PDMS polymer was used to manufacture the microchannels by using these micromolds. The confocal microscope was used to characterize all samples.**

Keywords-component; glass, PDMS, SU-8, lithography

I. Introduction

The fabrication of channels in PDMS is a technique already known [1] as well as their use in electrochemical biosensors as, in this case, capillary electrophoresis microchips. In this work, it has been developed a manufacturing process of micromolds in SU-8 (formulation 50) on a glassy substrate using lithographic processes. The interest in fabricating these micromolds is focused on getting a way of manufacturing PDMS microchannels in a fast, effective and highly repetitive way. In order to achieve that, it is need to focus on increase durability and decrease the degradation.

II. Fabrication

The micromolds fabrication requires the prior manufacture of a mask containing the pattern of the microchannels to implement. This is done by laser lithography which allows the design of the micromolds with a variety of possibilities. Prototypes we have manufactured so far have been designed with two cross-shaped microchannels. Recently we have begun the manufacturing of prototypes with different shapes. Once the mask has been obtained, its pattern will be transferred by an UV exposure to the SU-8 photoresist.

The manufacture of SU-8 molds is well known [2]. Briefly, in a clean room environment, the first step was cleaning the substrate of soda-lime with piranha, and then on this substrate the SU-8 was coated. The photoresist was prebaked in a hot plate at 95 °C for 15 minutes in contact with the substrate. This step serves to densify the small film deposited during this process since different solvents substances are volatilized. The UV exposure was made with an ultraviolet lamp using the previous made mask in contact with the substrate for 12 minutes. The commercial computational fluid dynamics code Fluent was used in order to optimize the Aluminum mask fabrication. The following steps, due to the characteristics of the mold are the most sensitive for being success in the manufacture process. It should be minimize the tensions existing between glass and SU-8 due to different expansion coefficients they have, allowing the channels to be well attached. Also, the SU-8 at a temperature of 55 ºC improves its internal structure getting better physical properties. A postbake that improves the internal improvement of the SU-8 and the good adhesion to the glass must be done, and this was achieved doing a gradually postbake. First, the sample was placed on a hot plate at 50 °C and gradually the temperature was raised to 95 °C. Once the temperature was achieved, the micromold was postbaked for 15 minutes. After this time, it is absolutely necessary to cool the sample slowly back to 50 °C because the development was carried out with acetone. Acetone has a high capacity for absorbing heat and, if the sample is not cooled, the developed will increase the tensions between the soda-lime and the SU-8 causing it detaching from the substrate. Then, to improve the mechanical properties of SU-8, a cure cycle was done in two steps, for 5 minutes at 150 ºC and 10 minutes at 200 °C. This quickly eliminates acetone by evaporation and the sample was ready for the next step.

To improve the durability of the micromold, a layer of acrylic conformal coating performance was deposited. The product is the 714-462 RS aerosol which allows spray deposition, although this layer was centrifuged to improve the flatness and reduce its thickness. After this last step the micromold is ready to be used.

Finally, the PDMS polymer was deposited over the whole sample and a postbake process was done to 35ºC overnight.

Fig. 1 shows a scheme of the complete manufacture process.

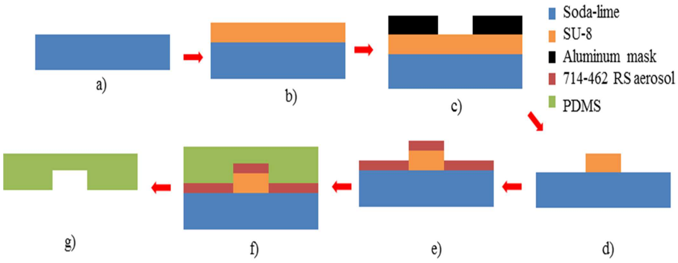

Figure 1. Manufacture process: a) Soda-lime glass was conditioned in a clean room. b) Spin-coating technique was used to deposit SU-8 layer over the glass. c) UV exposure by using an aluminum mask. d) SU-8 developed with acetone. e) A layer of acrylic was centrifuged. f) PDMS was deposited over the sample. g) The mold was retired and the process was finished.

This work has been supported by PhD grant BP09-007 "Severo Ochoa" from FICYT (Principado de Asturias) and by the MICINN (Government of Spain) under project CTQ2011-25814.

III. Results

A confocal microscope was used to characterize the micromolds manufactured and the microchannel obtained.

Fig. 2 shows a 3D profile of a micromold. In Fig. 3 we can observe a 2D profile of the same micromold, as well as the thickness, t_1, and width, w_1. The microchannel characteristics can be measured with the following results: t_1=35 µm and w_1=150 µm.

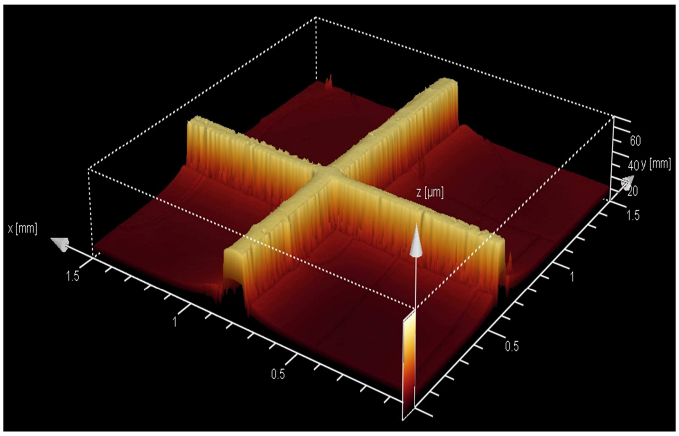

Figure 2. 3D profile of a SU-8 micromold observed with confocal microscope.

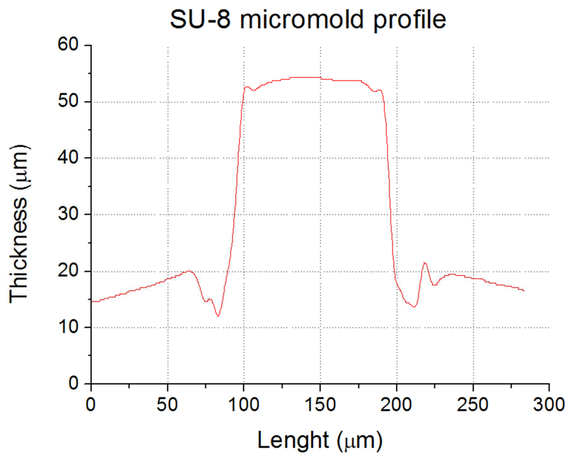

Figure 3. 2D profile of a SU-8 micromold observed with confocal microscope.

Fig. 4 shows a 3D profile of a microchannel manufactured with PDMS by using the micromold in Fig. 2 and Fig. 3. In Fig. 5 we can observe a 2D profile of the same microchannel as in Fig. 4. The thickness, t_2, and width, w_2, of the microchannel can be measured with the following results: t_2=35 µm and w_2=150 µm.

We have manufactured several PDMS microchannel with the same micromold. We have noticed that the micromold has not been modified. If we compare the SU-8 micromold confocal microscopy measurements with the obtained from its inverse replica in PDMS, we obtain a very good agreement in all cases.

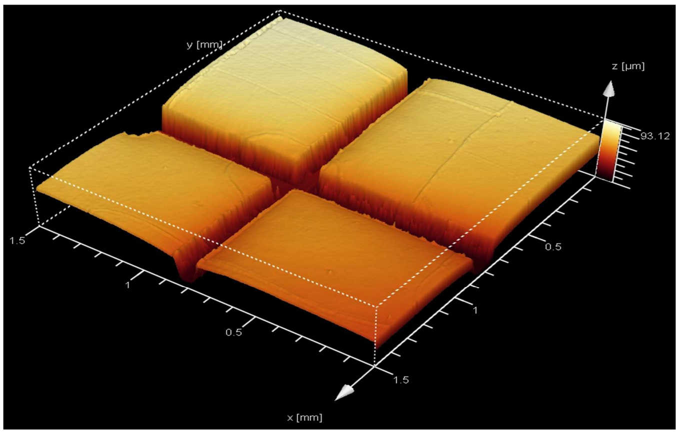

Figure 4. 3D profile of a PDMS microchannel observed with confocal microscope.

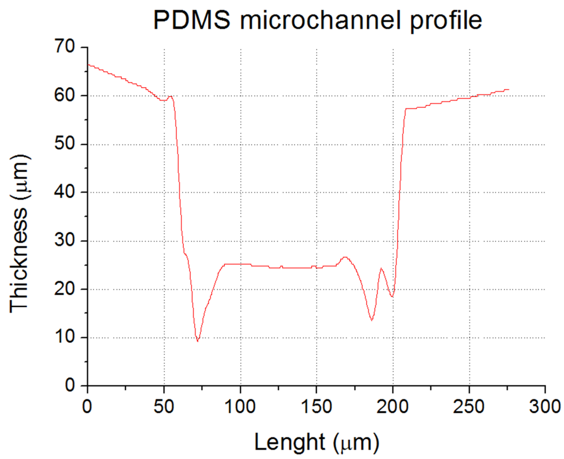

Figure 5. 2D profile of a PDMS microchannel observed with confocal microscope.

References

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