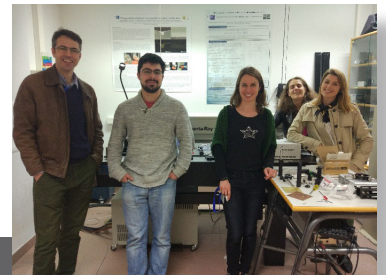


Characterization of microchannels fabricated with laser for microfluidic applications

Due to the numerous applications it presents, the microfluidics field has experienced enormous developments in the past few years. Lab-on-a-chip, organ-on-a-chip, point of care devices, cell capture, chemical and biological analysis are some of the examples for direct microfluidic applications. Regarding uses, microfluidic devices have different geometries which can be as complex as needed, but one of the basic structures that comprise these microfluidic device is the microchannel.

Several materials have been reported for the fabrication of the microchannel, and the suitability of one or another depends on the fabrication technique. Some of these materials are polymers, silicon or glass. Examples of manufacturing techniques are soft-lithography, photolithography or thermofusing techniques. But when using soda lime glass as material which was chosen due to its robustness, chemical resistance, transparency and low cost- direct laser writing presents itself as one of the most suitable techniques. It is accurate and versatile, generating very complex geometries quickly. Moreover, due to its non-contact nature, there is no contaminant and does not require clean room facilities. When working in micron dimensions for this application, it is crucial to have a very good image of the topography to ensure its quality, as well as all the information about the channel dimensions. In this report, the structures manufactured by direct laser writing are fully characterised by means of confocal microscopy.



Photonics4Life is a research group in the Optics Area of the Applied Physics Department of the [Universidade de Santiago de Compostela](https://www.usc.es/) (Spain). One of its research areas is dedicated to the fabrication of different microfluidic devices by laser processing. These devices simulate blood vessel networks and cellular behaviours in vascular pathologies such as micro-tumours, formation of atherosclerotic plaques and aneurysms for performing preclinical in vitro models.



■ **Measurements**

Microchannels were fabricated over soda lime glass by direct laser writing. The laser employed was a Rofin Nd:YVO4 system, with 20 ns pulse duration and 1064 nm central wavelength. The setup was composed by a galvanometer system that addresses the beam and allows the fabrication of complex structures with no need of sample movement. The laser beam was focused over the substrate surface by using a lens of 100 mm focal length that ensures a working area of 80x80 mm². Soda lime glass was obtained from a local supplier.

In order to obtain a proper aspect ratio of the structures, several laser scans were applied to the sample. Therefore, a study of the evolution of the topography was performed. Microchannels with scans from one to ten times were manufactured. Using Sensofar S neox 3D optical profiler, a confocal image of the structured area was captured using a 20X magnification objective. The surface profile was generated and the evolution of the depth of microchannels with the laser scans was depicted (Figure 1).

Roughness value of the microchannel walls are a critical value to know since it should be low enough for microfluidic applications. Thanks to Sensofar S neox 3D optical profiler and SensoMAP analysis software, it was possible to obtain roughness values from small areas. The topography of the bottom of a microchannel with eight laser scans, obtained with a 50X magnification objective, was selected for the study (Figure 2).

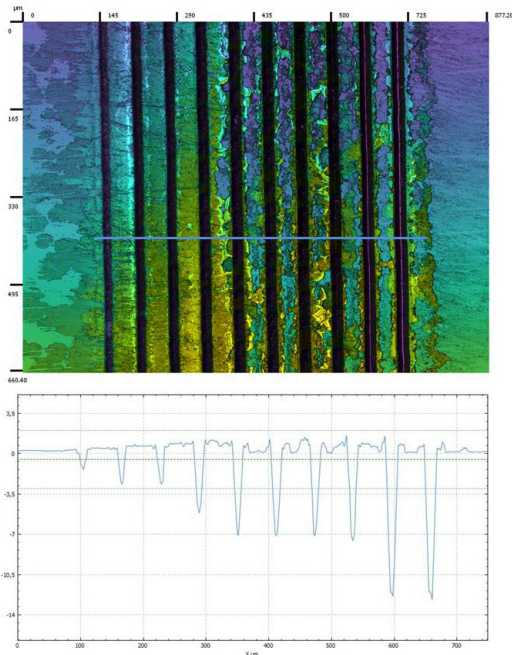


Figure [1] Confocal image of several microchannels with different laser scans, from one (left) to ten (right). The profile of the channels is also generated.

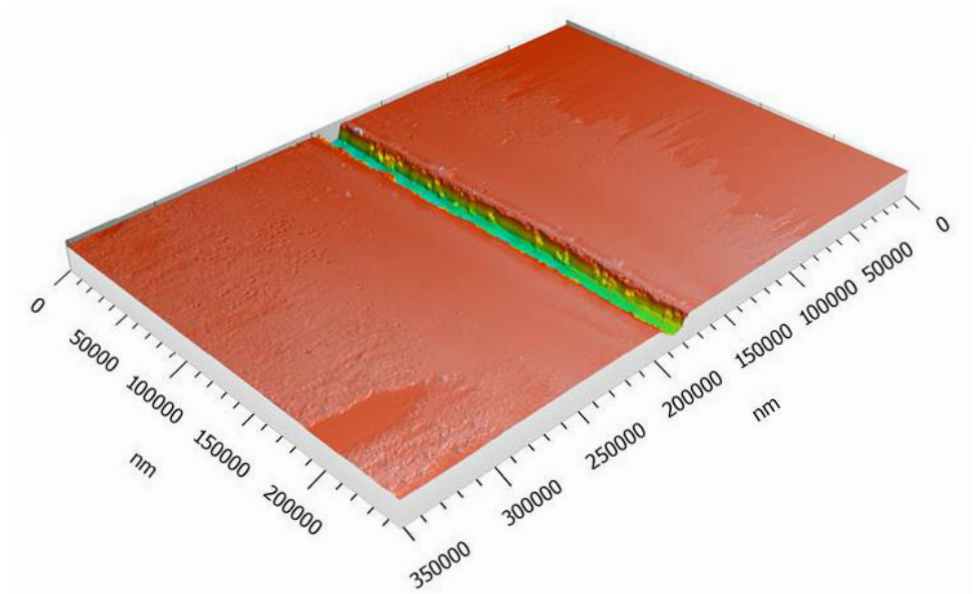
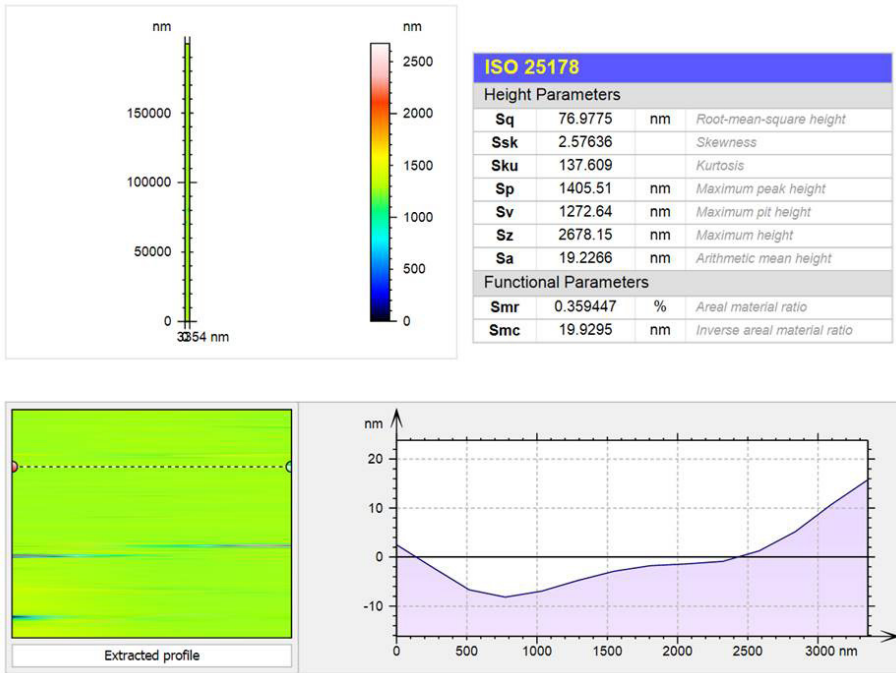


Figure [2] 3D topography of one microchannel fabricated with laser and the roughness parameters of the bottom of the channel, according to ISO 25178.



Thanks to the versatility and accuracy of laser direct writing, several microfluidic devices can be manufactured. Here we show some 3D confocal topographies of some of those examples obtained with a 20X objective (Figure 3).

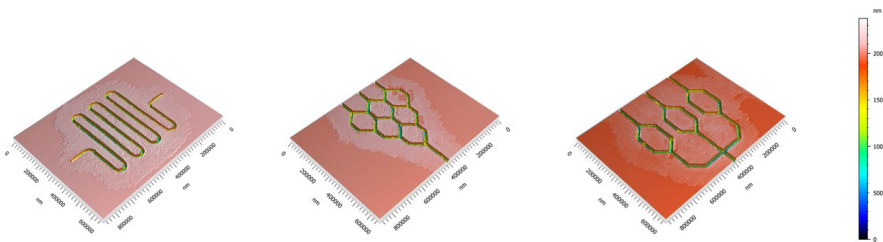


Figure [3] 3D confocal topographies detail some examples of microfluidic devices performed with laser over soda lime glass.

Conclusions

Thanks to the S neox, 3D optical profiler from Sensofar, it was possible to easily characterise the topography of the microchannels fabricated with laser technologies. The evolution of the profile of the structures with the laser scans was analysed by using the confocal technique with a 20X magnification objective.

Moreover, in combination with the SensoMAP analysis software, the roughness parameters of the manufactured channels were calculated. In this case, a 50X magnification objective was employed when acquiring the confocal topography.

In conclusion, by using the S neox, 3D optical profiler, each structure can be perfectly characterised in dimensions and roughness.



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HEADQUARTERS

SENSOFAR METROLOGY

Parc Audiovisual Catalunya
Ctra. BV-1274, KM 1
08225 Terrassa (Spain)
T. +34 937 001 492
F. +34 937 860 116
info@sensofar.com
www.sensofar.com

SALES OFFICE

SENSOFAR ASIA

Room 102, Building C, No. 838
GUANGJI Road, HONGKOU District
Shanghai 200434 (PR China)
T. +86 021 51602735
F. +86 021 61400059
info.asia@sensofar.com

SENSOFAR USA

P.O. Box 310-361
Newington
CT. 06131-0361 (USA)
T: +1 617 678 4185
info.usa@sensofar.com

