LOW-COST OPTICAL-MICROFLUIDIC SENSOR DEVICE FOR SENSING APPLICATIONS USING A PHOTODEFINABLE EPOXY

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1. ABSTRACT

The increasing demand of more specific and accurate biological and/or chemical analysis in challenging fields such as Biomedicine, Genomics or Proteomics has led to the miniaturisation of the analytical devices [1]. The so-called Lab-on-a-chip devices can provide full analysis compatible with specificity, accuracy, portability and mass production at low cost. These Lab-on-a-chip devices are currently behind research because they cannot be offered at low cost, in spite of integration has being achieved and reported. These devices must be able to analyze different substances and compounds of interest, and determine their nature as well.

This abstract describes a novel use of the photodefinable epoxy SU8 [2,3] to monolithically integrate low cost optical-microfluidic sensor devices. The chip consists of 3D microfluidic channels, multimode sensing waveguides and optical connectors (U-grooves, as optic insertion tools). An schematic of the chip is shown in Figure 1. The use of the photosensit SU8-50 is three-fold: (i) as optical waveguiding material (core and cladding), (ii) as structural material for microfluidic elements and (iii) it allows to integrate the optical connectors. All these components are patterned in SU8 along a set of photolithography steps, that ease the process and low the cost in manufacturing these devices.

The sensing elements are SU8 waveguides. The core of the waveguide consists of pure SU8-50, whereas the cladding is fabricated by diluting the SU8 in a liquid aliphatic epoxy resin. This dilution can be patterned as well as the SU8, and it provides a 0.01 lower refractive index. To our knowledge, this is the first time that SU8 has been used to monolithically integrate components with another SU8 crosslinked layer with optimum results. The design of the waveguides was simulated by using Olympos software. The light is provided by a He-Ne laser device, with a 633 nm wavelength.

The microfluidic 3D circuitry consists of input/output microchannels and reservoirs that are perfectly sealed with a bonding process [4]. All these components are patterned by photolithography of the SU8 (Fig.2). The substance of interest is placed in an analytical chamber that crosses the path of the light. Absorption is then performed by the substance, at different levels depending on the nature of the substance. As a consequence of this phenomenon, the output power is lower than the input power, and substances can be characterized by means of these losses.

The optical connectors (U-grooves) are patterned in SU8 (Fig.3), as well as the rest of the components, and placed in front of the waveguide, that is pigtailed by the U-groove. The U-grooves are as wide as the optic fibre is (125 µm) and 3 mm long, and the optic fibre can be straightforwardly inserted by using micropositioners and a microscope, being this an advantage in comparison with complicated inserting techniques.

Further research on this is being performed by our group, being our next goal to integrate photodiodes to collect the output light and monitor the device by means of bulk electronic circuitry connected to a PC.
REFERENCES

2 http://www.microchem.com/

FIGURES

Figure 1a: Schematic representation of the optical sensor

Figure 1b. Optical image of the chip

Figure 2. SEM picture of the bonding interface and the embedded channel

Figure 3. SEM picture of the U-groove fiber connector