Multivariant Measurement Methods Group

Rapid Prototyping and Fabrication of Solvent-Resistant Fluidic Devices

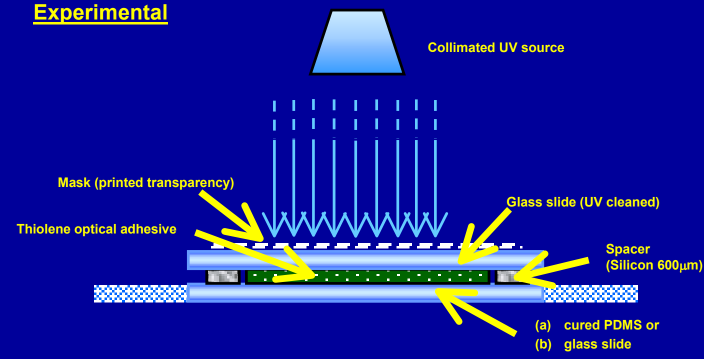
Introduction

We describe a rapid prototyping technique for the fabrication of fluidic channels in a solvent-resistant polymeric matrix. Using conventional contact lithography and a commercially available thioelene-based adhesive, we demonstrate the fabrication of 600 micron deep fluid channels with width of one millimeter, dimensions that challenge conventional photolithography techniques. These channels are impervious to a wide range of aggressive solvents, including toluene (method a). Additionally, we demonstrate that siloxane-based elastomer molds of these channels can be readily made for aqueous applications (method b).

The procedure described is well suited for applications in fluidics. As an example, two combinatorial mixers (passive and active) for polymeric formulations were fabricated.

Both methods produce *optically transparent*, *glass-sealed*, *micro/millimetric* fluid handling devices. Devices (a) are entirely fabricated of UV curable adhesive and glass, being ***solvent resistant***. Devices (b) consist of PDMS sealed to glass. While this method offers fast replication and convenient interfaces with tubing/pumps, it is incompatible with most solvents.

Experimental

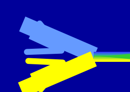


(1) Glass slide (method a) or cured PDMS tray (method b) or is chosen as workspace.
(2) Spacers are placed on either side.
(3) Optical adhesive spread and covered with second glass slide (determining the channel depth).
(4) UV mask (printed on a transparency with conventional laserjet/solid ink, 600dpi+) placed on top.
(5) UV exposure for 60-120 s.
(6) Uncrosslinked adhesive washed away (flushed with ethanol/acetone).
(7) Final UV exposure of whole specimen (~1 hour) and oven cure (50 °C).

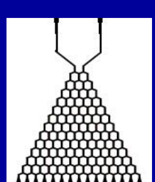
Method b: (8) PDMS replication (10:1, 20:1) of cured adhesive.

Diffusive (passive) mixer

This binary combinatorial mixer generates a discrete composition gradient. However, since flow is laminar, mixing relies solely on component interdiffusion, which limits its applicability to very low viscosity fluids and low flow rates (such that diffusion is effective within each path length).



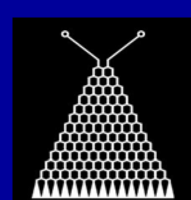
Method a



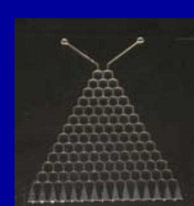
UV mask

Glass/adhesive/glass final prototype

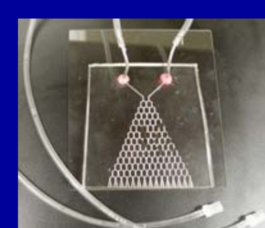
Method b



UV mask



glass/adhesive mold

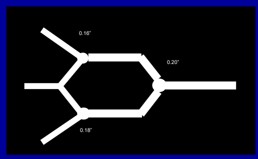


PDMS replica sealed with glass

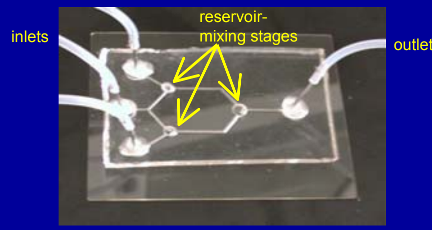
Active mixer

Method b

This prototype is a ternary active mixer (illustrated with method b). It has three inputs, one output and three reservoir/stirring stages. By varying the relative pumping rates and residence mixing time, ternary mixtures are produced as a function of time.



UV mask



PDMS replica sealed with glass

Future work

– Optimization of mixing geometry.

– Integrated modular design of mixing, analysis and feedback loop.

– Interface output with flow-coating and discrete liquid arrays.

NIST Combinatorial Methods Center

Joao T. Cabral, Christopher Harrison, Kathryn L. Beers, Alamgir Karim, Eric J. Amis

Polymers Division • National Institute of Standards and Technology • Gaithersburg, MD