POLYMERIC MICROSCOPIC HYDRODYNAMIC FOCUSER FOR COULTER COUNTER APPLICATIONS

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Large scale production of microfluidic devices may become necessary in the near future in applications such as biomedicine. Requirements for such production include, rapid design realisation times, simple, effective production apparatus and low energy/low cost fabrication techniques. Replication techniques based on polymer as a fabrication material satisfy these conditions producing large numbers of structures with the dimensions required for biomedical applications (typically from hundreds of microns to tens of nanometers) in materials which can be utilised by biologists, i.e. transparent, biocompatible polymers.

One of such microfluidic devices of interest is a microscopic on chip version of a Coulter counter. A Coulter counter is a device able to count particles in suspension based on the change of the resistance of a fluid element in a little orifice due to the transition of a particle. Developments of microscopic Coulter counters have been already reported in the literature in recent years, some of them able to detect particles whose diameter is as small as 87 nm. However, none of them has been developed on biocompatible materials (e.g. polymers) and does not include hydrodynamic focussing (necessary to avoid the simultaneous passage of two particles through the orifice). The objective of our work is precisely the development of a microscopic Coulter counter fabricated on a biocompatible material (a polymer) and which includes hydrodynamic focussing. In the present contribution we report on the development of the polymeric microscopic hydrodynamic focuser.

To this purpose we have fabricated masters for use in the imprint process defined via conventional lithography. The masters have been fabricated in silicon substrates with layers of silicon nitride or oxide to prevent adhesion to the polymer. To further facilitate this, a fluorosilane monolayer (Figure 1) was also added, from solution, to the milled surface, to act as an anti-sticking layer. Two types of hydrodynamic focusing masters have been fabricated and characterised by white light interferometric technique (figures 2(a) and 2(b)). In both cases, the channel height is 5 μm and the width 50 μm, with the connector width being 300 μm.

The structures have been replicated on thin freestanding polymer films of poly(methyl methacrylate) (PMMA) by hot embossing as shown in figure 3. Results show a perfect reproduction of the masters as expected. The fabricated structures are being sealed and characterized, in order to identify the best design to be incorporated into the final device.

In summary, we have accomplished the first step in the development of a microscopic Coulter counter fabricated on polymer and including a hydrodynamic focussing.

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Figures:

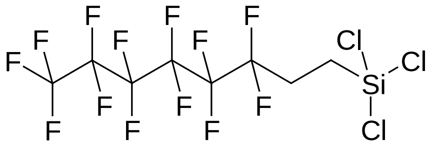
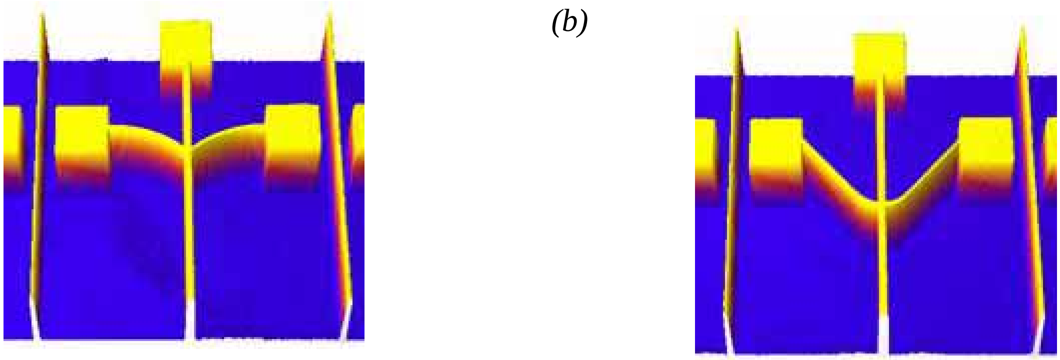


Figure 1 Chemical structure of the fluorosilane compound used as an anti-stick monolayer on the imprint masters.

(a) *(b)*



Figures 2 Interferometric image of the hydrodynamic focuser masters used in the imprint process. In both cases the channel height is 5 μm and the width 50 μm.

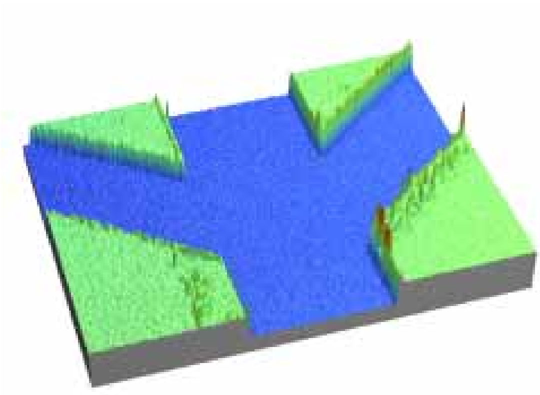


Figure 3 Interferometric image of the central part of the PMMA replica of the structure in figure 2(a). The replica follows tightly the master features.