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DESIGN AND FABRICATION OF PDMS MICROFLUIDIC CHANNELS FOR LAB ON CHIP AUTOMATION

U. Hashim and Tijjani Adam
Institute of Nanoelectronic Engineering, Universiti Malaysia Perlis, Kanagr Perlis, Malaysia
E-Mail : uda@unimap.edu.my

ABSTRACT

Delivery fluid to a Nano transducer has been the quest every researcher working in this field and in-expensive way of fabricating the automatic flow delivery system is presented which can be used for both laboratory and commercial scale. The microfluidic was designed using AutoCAD for master mold preparation and subsequently created with SU8 for rapid prototyping process; the micro mixer and the whole mixer were fabricated in less than without using costly fabrication steps. The device profiles were observed for structural integrity and evaluation by dropping two food coloring dyes through the two inlets and collecting the sample at outlet. Flow rate and mixing efficiency were quantitatively measured by analyzing the recorded flow profiles and values of the image collected from the high powered microscope at inlet and outlet locations is fully obtained and will be presented in our next publication.

Keywords: PDMS, AutoCAD, micromixer, rapid prototyping, room temperature, lab on chip.

INTRODUCTION

Microfluidics in biomedical application has received in many fields of applications due its various advantages and functions and in quest for miniaturization a rapid mixing is essential in many of the micro-fluidic systems used in biomedical analysis, drug delivery and sequencing or synthesis of nucleic acids. Biological processes such as cell activation, enzyme reactions and protein folding often involve reactions that require mixing of reactants for initiation. Mixing is also necessary in lab-on-a-chip (LOC) platforms for complex chemical reaction. Micro fluidic can be integrated in a micro-fluidic system or work as stand-alone devices device for various applications such as drug production. Furthermore, the investigation of microfluidic is fundamental for understanding transport phenomena on the micro scale and beyond (Chee *et al.* 2012).

Various application such as extraction, polymerization, organic synthesis, analytical assay, drug delivery studies, clinical diagnostics the miniaturized systems, designed for the above cited applications, are generally implemented with a micro scale mixer to provide an intimate contact between there agent molecules for interactions chemical reactions. Furthermore, beside their integration in more complex micro total analysis systems (mTAS) micro scale mixers could also work as stand-alone devices for applications where a superior control and a scaling-down of the mixing process are required (Farid *et al.* 2001; Hashim, *et al.* 2012c, Tijjani *et al.* 2012f).

Through the capillarity it is possible to create spontaneous movement of liquids based on cohesive forces within the liquid and adhesive forces between the liquid and its surroundings, among the fields of application for capillarity is microfluidics, where capillarity enables the filling of micro/ Nano channels without external actuators or cumbersome fluidic connectors. The concept of capillary filling phenomenon to drive a mobile phase through a porous material, such as paper, silica gel, alumina, or cellulose, which serves as stationary phase. Difference in affinities leads to the separation of the analytes. Since recent years, advances in micro/nanotechnologies allow for the fabrication of structures at Nano scale and here in this study we would to take this advantages within enhanced approach by supporting the capillary with geometry creation for mixing and flow as well (Hashim, *et al.* 2012a).

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METHODS AND MATERIALS

The development begins with the device layout planning. Computer aided design (CAD) program will be used to define the layout and geometry of the desired pattern of the device (Low *et al.* 2013b). Micro channel or chambers will be fabricated first by developing the master template and subsequent replication process is done for various shape needed depending on the master template design and fabrication. Photolithography process of micro fabrication is performed to create patterns on the substrate. The process steps involved are spin coating, soft baking, exposure, hard bake and development (Low *et al.* 2013a). The photo resist used is SU-8 which is a negative photo resist. Initially, very small amount of SU-8 is dropped at the centre of the silicon wafer. The speed is set to 800rpm for 10s. This process step is purposed to spread the thin SU-8 layer all over the surface of the substrate and improve the adhesion of the whole SU-8 layer on the silicon segment. After that, about 3ml of SU-8 is dropped at the centre of the wafer, and undergoes the second spin coating (Hashim, *et al.* 2012a). The spin speed is set to 2000 rpm for 20s with the ramp up speed at 800rpm for 20s. After spin coating with SU-8, the wafer is soft baked at temperature of 65ºC for 10 minutes by using hot plate. After that, the wafer is baked at the temperature of 95ºC for 20 minutes. This soft baking process is to produce the high aspect ratio imaging. During the soft baking process, the solvent level of SU-8 layer is reduced, and hence decreases the risk of exposed resist loss, swelling and the adhesion defects. The wafer is

then left on a cold plate to cool down for 30 minutes. Upon cool down, the wafer is exposed to UV light by using mask aligner through the designed mask. Since negative photo resist is used in our cases, the exposed region will remained after development. The exposure process goes on for 55s. After exposure, the wafer is transferred to hot plate to hard bake at the temperature of 95ºC for 20 minutes. Shapes of patterns can be observed clearly on the SU-8 layer of wafer after the post exposure baking. The wafer is then proceeding to development (Tijjani *et al.* 2013d).

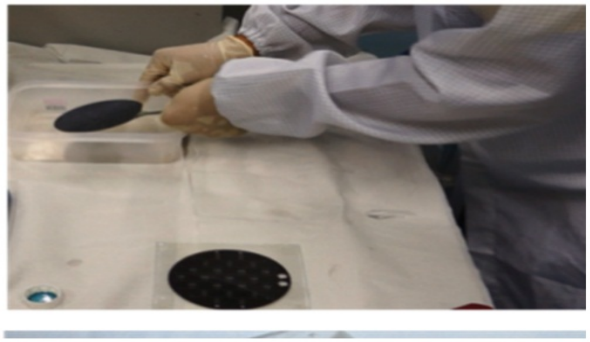

Figure-1. Process block undergoing photholithography by using Su-8 photoresist. , Wafer is cleaned, SU-8 is spin coated and soft baked, UV light exposure through mask aligner.

RESULTS AND DISCUSSION

Figure-2, show geomtry enhanced micromixer mask that will support capillary and capillarity is the spontaneous movement of liquids based on cohesive forces within the liquid and adhesive forces between the liquid and its surroundings, among the fields of application for capillarity is microfluidics, where capillarity enables the filling of micro/ nano channels without external actuators or cumbersome fluidic connectors (Tijjani *et al.* 2012a). The concept of capillary filling phenomenon to drive a mobile phase through a porous material, such as paper, silica gel, alumina, or cellulose, which serves as stationary phase. Difference in affinities leads to the separation of the analyte. Since recent years, advances in micro/nanotechnologies allow for the fabrication of structures at nanoscale (Tijjani *et al.* 2012b).

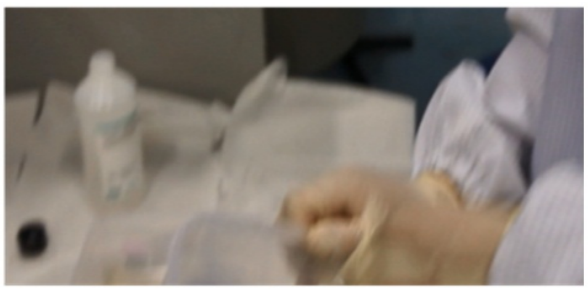

Figure-2. printed transparent mask for the mast mould fabrication.

One of the characteristic features of microfluidics is the dominance of surface effects due to the large surface to bulk ratio on the micrometer scale (Tijjani *et al.* 2012c; Tijjani *et al.* 2013a). A prominent class of surface effects is known as capillary effects particularly strong in microchannels having bore diameters equal to or less than about 50 μm Various researchers investigated the flow characteristics of different fluids in Microchannels including nitrogen and helium gases, isopropyl liquid and silicone oil (Tijjani *et al.* 2012d; Tijjani *et al.* 2013b).

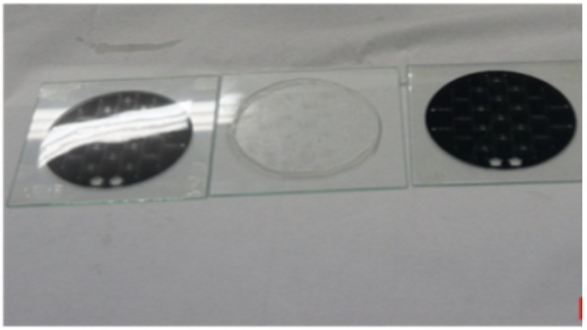

Figure-3. Fabricated multistages microchannels.

The study focus on design and fabrication of an inexpensive and rugged sample delivery system, namely PDMS Microfluidics, which has capabilities of higher efficiency permitting greater probabilities of interactions between bio-samples (analyze) and fabricated nano based transducer as shown in Figure-3. We specifically interesting to study the influence of Microfluidics chamber and tube (inlet and outlet) design and sizes for capillary and flow mechanic effect of bio-molecule sample dynamic flow (Tijjani *et al.* 2012e). and to understand the performance of the proposed integrated PDMS Microfluidics with nano size transducers to function as Nano LAB-On-Chip for smooth delivery of bio-molecule samples to the fabricated nano based transducer for sensitivity and selectivity detection using electrical measurement (Tijjani *et al.* 2012c).

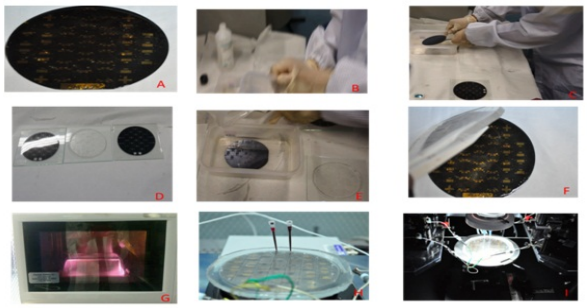

Figure-4. completed microchannels device with sensor.

CONCLUSIONS

The study demostrated a simple design and fabrication of geometry enhanced micro mixer that the is supprot by capillary based within microfluidic channel,

the channels were used to create micromixer focus on obtaining minimum possible gab between two surfaces to enhance flow aand mixing profile. We have fabricated two different geometry structures of 1µm and 2µm roughness between within the micro channel and the feature study will be focused on flow and mixing mixing profile optimisation.

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