

Fabrication of Split and Recombing Microchannel Mold Using Photochemical Machining

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Abstract: For Lab on chip devices micro-channels are most crucial. Fabrication of micro-channel is the difficult task by using the conventional machining process. Hence, unconventional machining process like photochemical machining (PCM) can be preferred. It is widely retained in fabrication of components which are used in fields like microelectronics, medical, energy fuel cell, defense, telecommunication, aerospace etc. In this paper PCM is used in the fabrication of the mold. Copper material is selected for the fabrication of mold. Copper is having good machinability. The necessary photo tools were created on trace paper, after this fabrication of micro-channel is done by using photo chemical machining. Additionally, the enactment of fabricated micro-channels was executed using RAPID I Vision 5 microscope. The accuracy analysis of fabricated micro-channel mold was executed with reference to photo tool measurements, and the inaccuracy is noticed to be minimal. So it is concluded that micro channels are fabricated by using PCM up to acceptable level.

Keywords: Photochemical machining, Copper, Split and Recombine, MicroChannel.

1. INTRODUCTION

Micro total analysis systems (μ TAS) presently have consequential part in various applications and micro- channel is one of the acclaimed parts of these systems. The micro- channels are used in the various applications viz, biological, chemical, diagnostics, medial and so on [1-4]. The fabrication of micro-channel using copper material will be more effective and cheaper as that of other commercial materials such as polymers, silicon glass and so forth. Due to the ease of operation these micro-channels are generally utilized in engineering as well as in medical fields. The different techniques to manufacture the micro-channels, for example, injection molding, hot embossing, infrared laser ablation, micro milling, CO2 laser machining, PCM is likewise an appropriate alternative for creation of molds or direct micro-channels. The utilization of PCM speeds up the manufacture procedure along with the high adaptability of changing the design. It also produces burr free and stress free flat complicated metal components. Therefore, the PCM particularly valuable for micro machining. Various researchers have used PCM for fabrication of microchannels, heat sinks, micro texturing in journal bearing, etc. [5-17]. The SAR micro-channel with 'Y shaped mold with straight and circular hurdle' composition has been fabricated in this paper. With the three distinct widths the fabrication has been done by the PCM. The intake parameters are likewise fluctuated so as to accomplish the various depths for the micro-channel molds.

2. METHODOLOGY

The initial step for creating the mold is preparation of the 2D CAD drawings in AutoCAD software which is an input to the PCM. The PCM takes the drawing from the computer data and photo plating on the film. PCM machining accepts input as 2D CAD drawings in dxf configuration and it examines the way of channel which is given in CAD drawing. The SAR micro-channel with Y shaped molds drawing with various arrangements are appeared in Figure 1. The material chosen for the micro-channel fabrication is copper due to its great machining property. After the selection of the material the sheets are cut to match the size of the film created the mold. The photo tool negative film of the image which is required to be generated is created by the CAD drawing is printed on the tracing paper the drawing of the photo tool is indicated in the Figure 2.

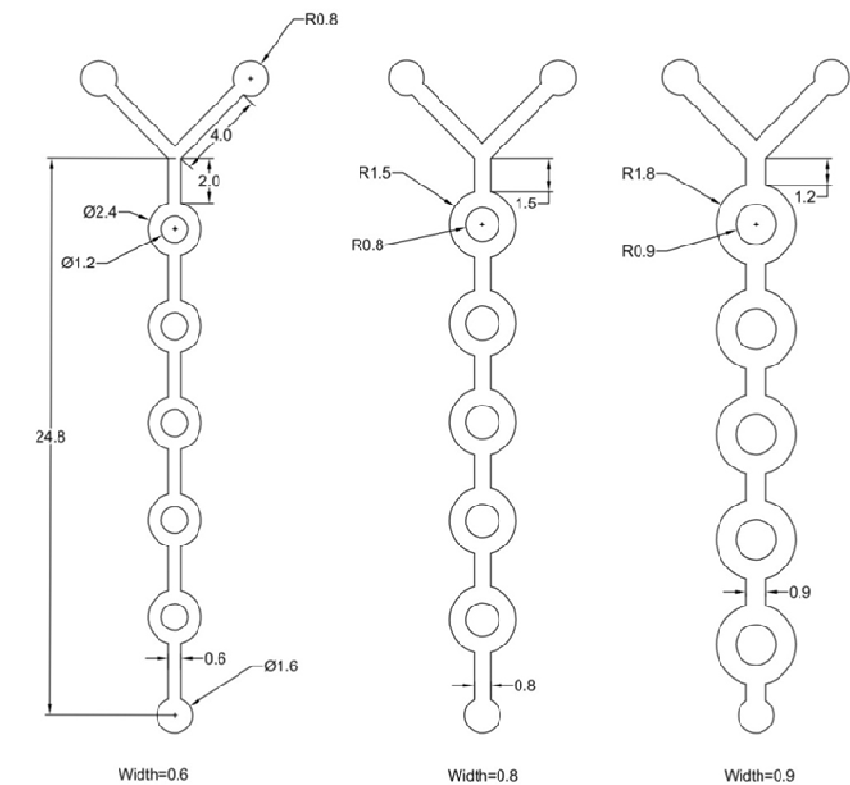


Figure 1: SAR micro channel with Y-shaped mold with different dimensions.

The surface of specimen used for experimentation is made clean to evacuate the burr, oxide layer, dust, and so forth. By this the photoresist can simply adhere to the surface. The PCM arrangement is appeared in Figure 3. The cleaning of the surface is done by polish paper and thinner (trichloroethylene or CH_3CO) to detach traces of grease or oil. Subsequent to cleaning the specimen was dunked out in the photoresist and dried it to get a layer of photoresist on the surface of the specimen. By utilizing CAD drawing, the photo tool which is a negative film of the image that required to be produced is printed on the trace paper.

The prepared photo tool is then kept on the photoresist coated specimen which is sensitive to the ultraviolet radiation and it is exposed to the ultraviolet source. Further, the specimen is held in developer and the unexposed area of the photoresist will get removed by it. After the specimen is washed in water and dried. With the continuous heating the specimen is put in the etchant that dissolves the metal chemically. The process can be characterized by the parameters such as temperature and dilution of the etchant. Lastly, the specimen is washed with help of water and dried it. After the specimen is kept under the RAPID I Vision 5 microscope, and the different dimensions of the specimen are measured. And by the same method the dimensions of the photo tool are measured.

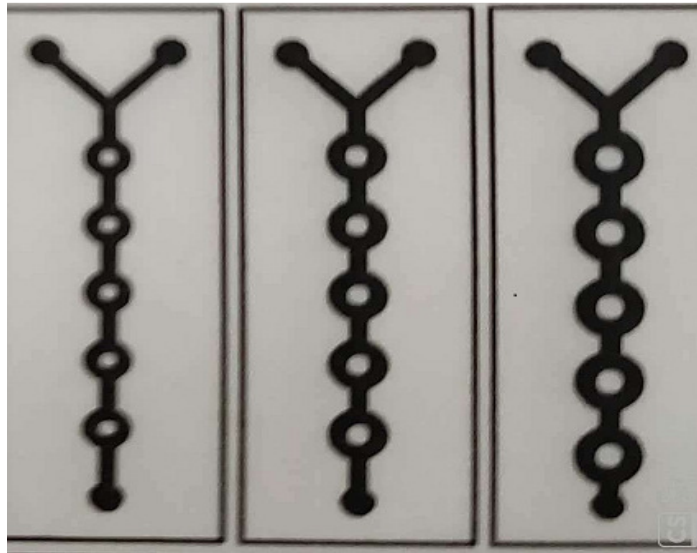


Figure 2 : Prepared Photo tool



Figure 3: PCM Experimental Set-up

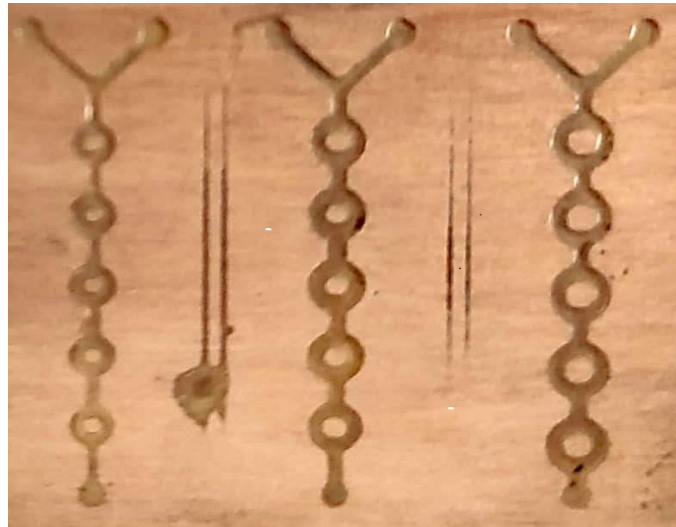


Figure 4: Fabricated SAR Microchannel

3. RESULTS AND DISCUSSION

The experimentation for photochemical machining has been performed on copper material at 500 g/L concentrations of ferric chloride, 48°C etchant temperature and 5 minutes etching time. The fabricated SAR microchannels are presented in Figure 4. The characterization of the fabricated SAR microchannels like dimensional analysis has been performed using RAPID I Vision 5 microscope and the microscopic images are depicted in Figure 5.

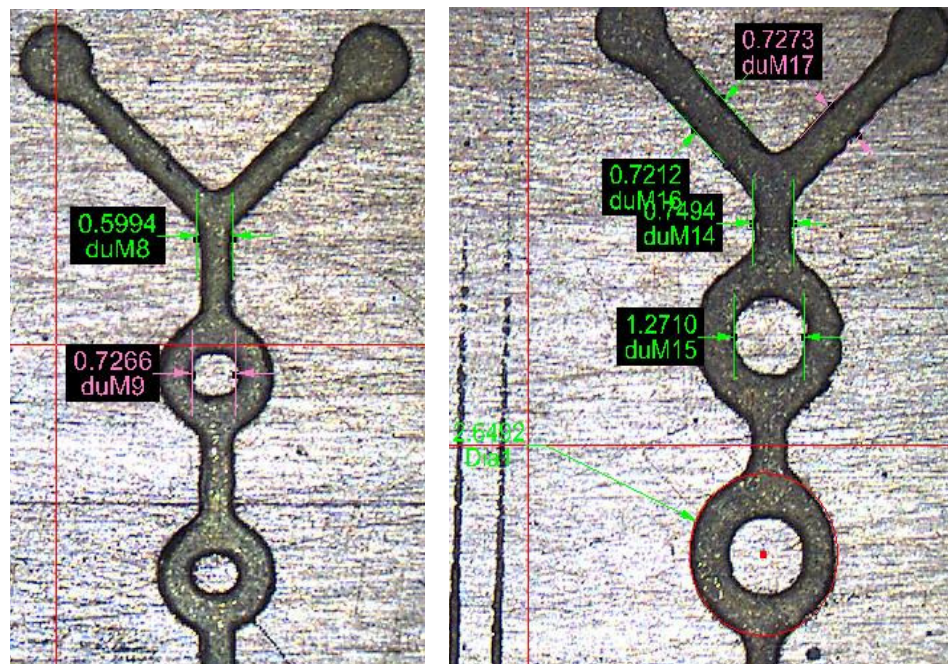


Figure 5: Sample Microscopic Images of SAR Micro-channel

4. CONCLUSION

The microchannels are significant part required in Lab on a chip device. The manufacturing of 'SAR micro channel with Y-shaped mold with various arrangements like straight with circular obstructions' has been completed utilizing Photo chemical machining. The molds are generated for three various widths and utilizing two contrasting parametric conditions. The manufactured molds can be utilized for fabrication of PDMS micro-channels utilizing soft lithography process. The study further can be reached out for the parametric improvement of photo chemical machining for fabrication of Micro-channels with various widths.

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