

Fabrication of Micro Channel Mold by using CO₂ Laser Machining

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Abstract—Mostly the micro channel parts are significant for lab on a chip device. Use of micro channels is in biomedical devices and micro fluidic applications. The fabrication of micro channel is quite tough by using conventional manufacturing. To characterize technology, different methods are used for the fabrication of micro channel. By using both conventional and non-conventional techniques, like micro milling, lithography, embossing processes and laser ablation processing. In this paper, a study on the use of a commercial CO₂ laser system for fabrication of micro-channel molds using Acrylic material. The accuracy of micro channel mainly depends on the fabricated molds. by using laser power and scanning speed we can control the depth of micro channel. To analyze the effect of Laser power and scanning speed on the depth of the Micro channel mold primary experimentation is performed. According to analysis, it is observed that the depth of micro channel mold increasing linearly with an increase in laser power and decreasing with increasing speed. the micro channel with a straight configuration having Y shaped inlet with triangular obstacles .by using the CO₂ Laser machining on Polymethylmethacrylate(PMMA) the (split and recombine approach, SAR) is fabricated. The fabricated mold can be used for the soft lithography process. The fabricated Micro Channel mold has been performed using RAPID I Vision 5 microscope and Mitutoyo surface roughness tester.

Index Terms— PMMA, Micro-Channel, CO₂ LASER Machine, SAR.

I. INTRODUCTION

Mostly Use of micro channels is in biomedical devices and micro fluidic applications. Nowadays for manufacturing of the micro channel number of fabrication methods are developed and adopted. Like micro milling, lithography, embossing processes and laser ablation processing. Due to straight forward fabrication and cheap in cost these Micro channels are widely used in Medical and Engineering fields. The conventional methodology is time-consuming method or technology depending on the application different type of materials are preferred due to increase in demand of the devices based on micro channel causes to development of

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the different methods for fabrication which are easy, accurate and efficient. by using the Acrylic material we can manufacture the channel more efficient and economical as compared to commercial material like Silicon, Glass, and Polymers, etc. The different processes like photochemical machining, micro milling, electric discharge machining, ultrasonic machining, CO₂ laser machining can be employed for the fabrication of micro components.

Various researchers have reported work related to fabrication of polymers and micro components using the CO₂ Laser machining. The parameters considered were laser speed, power, etc. It has been noted from the studies that the microchannels can be fabricated using CO₂ laser machining [1-4].

Some of the researchers also reported the fabrication of microchannels using photochemical machining and the feasibility of fabrication of micro components using photochemical machining. By studying the details parametric effect analysis, it can be noted that photochemical machining is also a good candidate for fabrication of microchannels [5-10].

From all the methods the CO₂ Laser machining efficient not only in speed but also in accuracy. So CO₂ Laser machining is very useful for fabricating micro channel. In this paper the Y shaped micro channel with triangular obstacles is manufactured with the help of the CO₂ Laser machining with three different widths. Changes in input parameters are taken under consideration to achieve different depths for molds.

II. MATERIALS AND METHODS

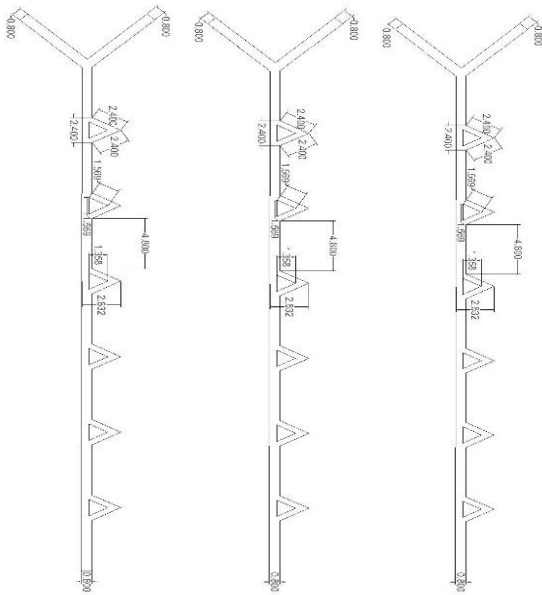
Step first includes the design of the micro channel with the help of two-dimensional drawing in AutoCAD software and as per the design fabrication is taken under consideration. the designed diagram is input to a laser machine for fabrication of mold. The design of drawing with Y shaped inlet micro channel fabricated are shown in fig.1 the acrylic (PMMA) material is selected for fabrication of mold because it is often preferred because of its moderate properties, easy handling & processing, lightweight and low cost. The laser cut awaits on the acrylic material and cut as given drawing input of AutoCAD design. After fabricating micro channel as per required shape and size. For that fabricating various cuts are given for machining.

The specifications of the Laser cut machine (Fig. 2) are given below:

1. Model- TIL6090
2. Laser Type Sealed Hermetic CO₂ Laser Tube
3. Laser Power 60W/80W/100W
4. Engraving Area 600 x 900 mm

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5. Accuracy ± 0.025 mm
6. Power Supply 220 V $\pm 10\%$ / 50HZ.
7. Gross Power 1800 watt. Approximate
8. Cutting Speed 500 mm/S (Max)
9. Engraving Speed 500 mm/S (Max)



(a) width-0.4 (b) width-0.5 (c) width-0.6

Fig.1 Drawing of Micro Channels with Different Configuration

slower laser velocity and higher laser power. The highest aspect ratio can be achieved. The manufactured micro channel mold for channel shown in below fig. 3.



(a) width-04 (b) width-0.5 (c) width-0.6

Fig.3 Y-shaped Micro Channel Molds Fabricated using CO₂ Laser Machining.

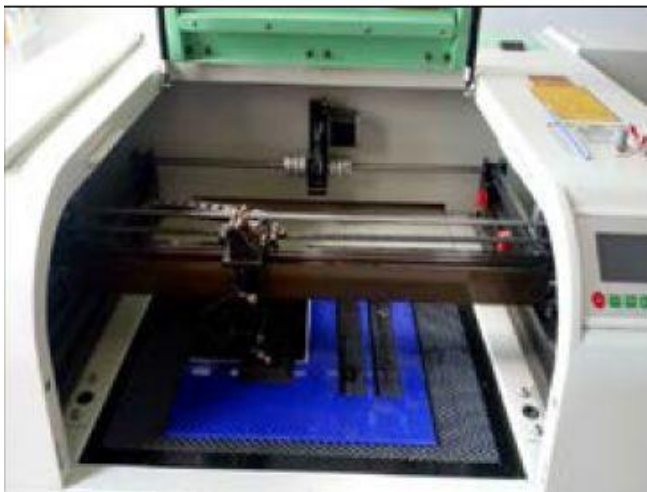


Fig.2 CO₂ Laser Cut Machining Set Up

III. RESULT AND DISCUSSION

According to methodology and parametric process the fabrication of required mold is carried out by using CO₂ laser machining on acrylic material. All several parameters are taken under consideration during fabrication. The most important parameters in laser cutting machine are preferred speed and power. The width and depth varies with increase or decrease in machining parameters like speed and power. While it is observed that increase in the laser power and decrease in the laser beam velocity the depth of micro channel enhanced for both channel. Also when slow moving velocity and high laser power it is observed that the depth of micro channel is quite big for both the channels. By using

Table 1. Performance parameter of laser machine

S p e e d	P o w e r	No. of Pass	W i d t h	Depth Achieved
1 0 0	4 0	2	0 . 4	0 . 3 1 4
1 0 0	5 0	2	0 . 5	0 . 4 0 2
1 0 0	6 0	2	0 . 6	0 . 6 3 3

IV. CONCLUSION

The Micro channels are major components required in Lab on a chip device. The fabrications of Y-shaped Micro channels with different configurations like straight with circular obstacles' have been carried out using Laser cut machining. The molds are fabricated for three different widths and using two different parametric conditions. The depths recorded are as 0.5 mm and 0.52 mm. The fabricated molds can be employed for the fabrication of PDMS Micro Channels using soft lithography process. The study further can be extended for the parametric optimization of laser cut machining for fabrication of Micro channels with different widths.

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