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Use of CO_2 Laser Machining for Fabrication of Micro Channel with Chambers

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***Abstract*— Micro channels are the most notheworthy components of the Micro Total Analysis System (µTAS) and Lab on a Chip (LOC) device. The different configuration of microchannels are used for various applications. The fabrication of micro channels with various configurations is critical task. In this paper, an attempt is made for fabrication of microchannels with chambers by employing CO2 laser system. A microchannel with Y shaped inlet and with two chamber configurations viz. circular and rhombus is fabricated using CO2laser machining on Polymethylmethacrylate(PMMA) material. The process parameters considered were the laser power and scanning speed and the influence of theses parameters on depth of the fabricated microchannel is analysed. It is noted that the microchannel depth increases with the increase in laser power and decreases with increases in the scanning speed.The characterization of the fabricated microchannels is carried out by RAPID I Vision 5 microscope. The study recoomend use of CO2laser machining for fabrication of microchannels on PMMA material.**

***Index Terms*— Microchannel, chamber, PMMA, CO2Laser Machining.**

I. Introduction

Now a day's micro total analysis systems (µTAS) plays significant role in many of the applications and microchannel is one of the prominent part of these systems. The microchannels are having applications in various fields like medical, diagnostics, chemical, biological, etc. There are different configurations of microcahhnels like straight, serpentine, microchannel with obstacle, baffles, ribs, microchannels with chambers, split and recombine type microchannels,etc. Each of the configuration has its mixing performance characteristics.and accordingly use in specific applications The fabrication of these type of microchannels is a crucial task and there are different non conventionalmethods employed for fabrication of various configurations of microchannels which includes micro milling, ultrasonic machining, laser machining, lithography, photochemical machining,etc.Each of the processes have their benefits and limitations. The different types of materials are preferred for fabrication of microchannels and molds required in soft lithography process. The one of the preferred material for microcahhnel molds is polymethylmethacrylate (PMMA) or Acrylic material. The channels can be fabricated by using the Acrylic material in more efficient and economical way as compared to commercial materials like Silicon, Glass, and Polymers, etc. CO2 laser machining is one of the significant process to fabricate the microchannels on PMMA material.

Various researchers have reported work related to fabrication of micro components and polymers by employing the CO2 Laser machining. The parameters considered were laser power,the scanning speed of laser, etc. It has been noted from the studies that the microfluidics related components can be fabricated using CO2 laser machining [1-6]. Some of the researchershave also reported the fabrication of microfeatures, microchannels, microchannel heat sinks, bearings with micro textures using photochemical machining and CO2 laser machining and the fasibility of fabrication of micro componenents using photochemical machining and CO2 laser machining [5-20].From the reported studies, it is observed that the CO_2 Laser machining is efficient for fabrication of microfaetures and microfluidics related components. In this paper, the Y shaped inlet micro channel with circular and rhombus shaped chabers are fabricated with the help ofthe CO_2 Laser machining and further characterization is carried out using microscope.

II. Materials and Methods

- **Material:** The material used for fabrication of microchannel mols is acrylic having thickness of 2 mm and chemical formula (c5o2h8)n. Acrylic material is light in weight with good impact resistance and also UV radiant.
- **Methodology:** There are three main stages as mentioned below:
  a) **Geometry Design by using software**
  b) **CO2 Laser Machining Experimentation**
  c) **Characterization and Data Analysis**

a) **Geometry Design by using Software:** This is the first stage in which the required microchannel configuration is prepared withthe help of two-dimensional drawing in AutoCAD software. The considered configurations are microchannel with Y shaped inlet and with circular and rhombus chambers. The geometry designed will act as an input for the CO2 laser machining.

b) **Experimentation:** The photograph of CO2 laser machine is shown in figure 1. The CO2 laser is a multi-gas laser cutting machine which prominently employs carbon dioxide, nitrogen, hydrogen and helium gas.The CO2 laser machining is performed selecting the values of power and scanning speed parameters. The specifications of the CO2 Laser Machine are given below:

1. Model- TIL6090
2. Laser Type Sealed Hermetic CO2 Laser Tube

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3. Laser Power 60W/80W/100W
4. Engraving Area 600 x 900 mm
5. Accuracy± 0.025 mm
6. Power Supply220 V±10%/50HZ.
7. Gross Power1800 watt. Approximate
8. Cutting Speed 500 mm/S (Max)
9. Engraving Speed 500 mm/S (Max)

Fig.1:CO_2 Laser machine set up

c) Characterization and Data Analysis: The characterization of the fabricated microchannel with circular and rhombus type chambers is carried out by using Optical Microscope. Further, the experimental data analysis is carried in order to analyse the parametric effect.

III. RESULT AND DISCUSSION

The CO_2 Laser machining is carried out on acrylic material in order to fabricate the microchannels with circular and rhombus chambers. The laser power is varied as 40, 50 and 60 and laser scanning speed varied as 100, 150 and 200. The experimentation is carried out for the fabrication of considered configuration of microchannels. The effect of the laser power on the depth of microchannel is analysed and it is noted that the engraving depth increases with increase in laser power and decreases with the increase in scanning speed. The fabricated Y shaped inlet micro channel mold with rhombus and circular chambers is depicted on Fig. 2.

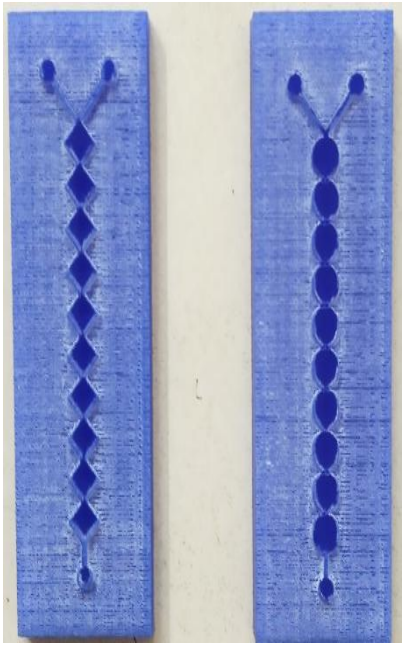

Fig.2: Y-shaped Micro Channel Molds with rhombus and circular chambers

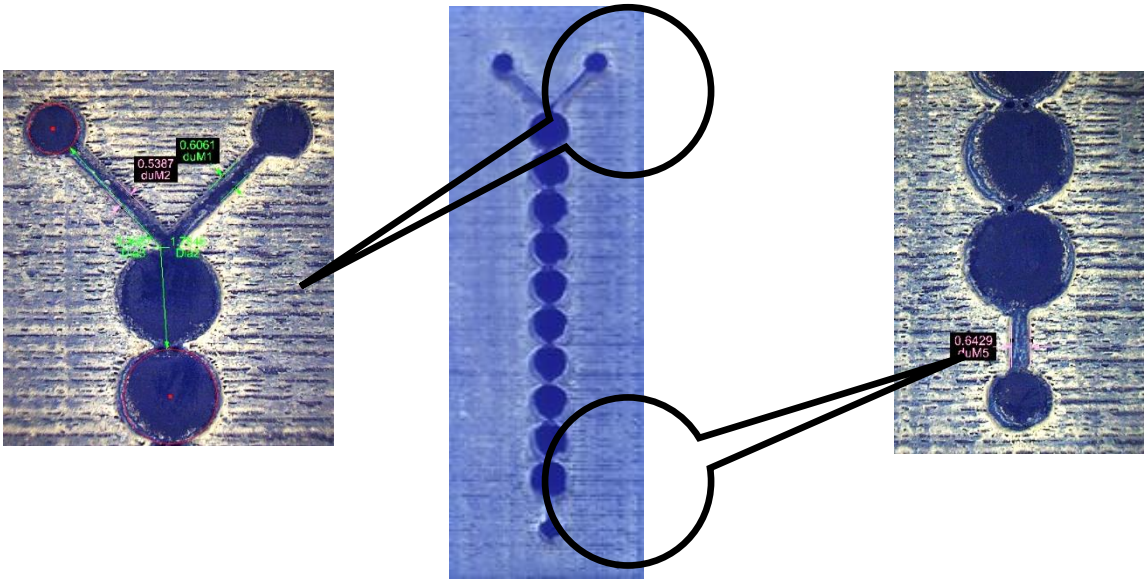

Fig.3: Characterization for Micro Channel Molds with circular chambers

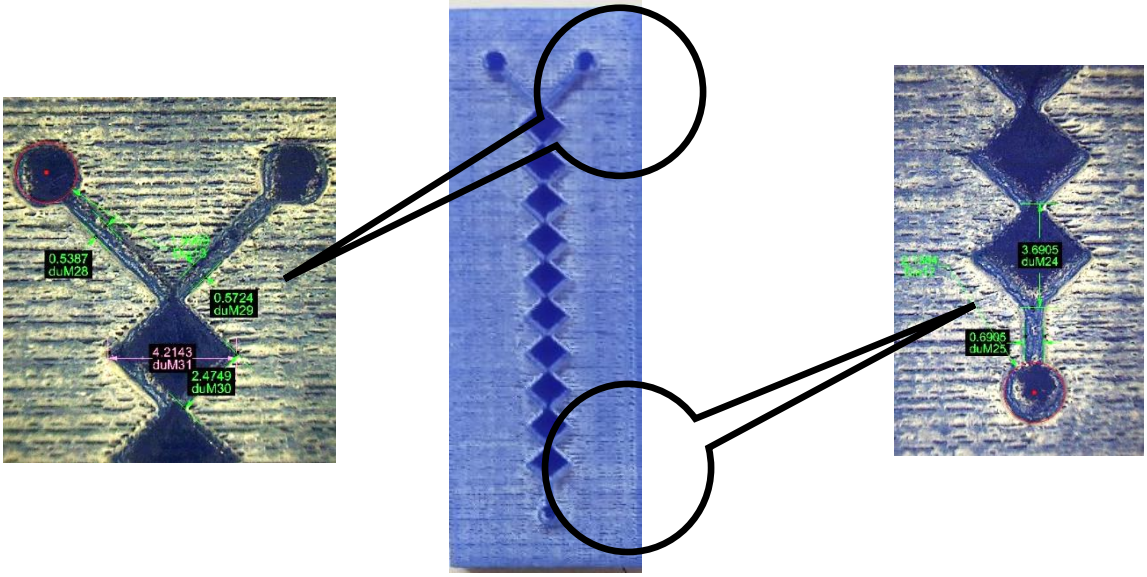

Fig.4: Characterization for Micro Channel Molds with rhombus chambers

The characterization of the fabricated micro channel configurations was carried out using optical microscope. Figure 3 and 4 presents the characterization images for the micro channel molds with circular and rhombus chambers, respectively. This shows that the micro channels are fabricated as per the requirement.

IV. CONCLUSION

Microchannels are on the noteworthy components in Lab on a chip devices. The fabrication of Y shaped inlet microchannels with circular and rhombus chambers is carried out using CO2 laser machining on acrylic material. Based on the experimentations, the following conclusions are drawn:

- The depth of engraving increases with increase in power and decreases with rise in scanning speed.
- The fabricatedY shaped inlet microchannels with circular and rhombus chambers are observed to be in good agreement with the requirement.

The fabrication and analysis study further can be extended by adding obstructions into the chamberwhich leads to the configuration of split and recombine (SAR) type microchannel.

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