Parametric Influence Study for Laser Cutting on Acrylic

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ABSTRACT

Laser has been employed for producing the complex specimens very efficiently and magnificently. The use of acrylic components is becoming prevalent day by day. Hence it is required to study the various machining techniques for engraving or cutting of acrylic material. The one of the non-traditional machining processes which can be employed efficiently for machining of acrylic is CO_2 laser machining. The parametric study of acrylic materials by using CO_2 laser machining is discussed in this paper. The scanning speed and the laser power were considered as process parameters and the influence of these parameters is studied on the depth as response measure. The engraving depth is observed to be increasing with increase in power and noted to be decreasing with increase in the scanning speed.

Keywords: CO_2 laser machining, acrylic, laser power, scanning speed.

1 Introduction

The use of non-conventional machining processes is continuously increasing day by day due to growing demand for machining accuracy, quality and efficiency. CO_2 laser machining can be effectively used for engraving the different shapes on metals, acrylic and woods. There are other techniques also available like CNC engraving, milling, etc. The conventional methodology like hand graving using knife or some other tools is time consuming method and also less accurate for producing intricate parts or shapes.

For a cutting metal and non-metallic Material, CO_2 laser is acting as an appropriate tool which is frequently employed in industry. It's application in the non-metals extends in acrylic cutting and engraving, wood material cutting and engraving, etc. The advantage of CO_2 laser cutting is its capability to produce complex shapes easily with at micrometer scale [1-6]. Various researchers have reported the similar type of study using different non-conventional machining processes like photochemical machining, laser engraving, laser cutting for the fabrication of different components like microchannels, microchannel heat sinks, micro components, etc. [7-20]. CO_2 laser machining is efficient not only in speed but also in accuracy. So, CO_2 laser machining is useful for fabrication micro channel. The parameters reported in CO_2 laser machining were laser power, scanning speed, etc. In this paper, the square shaped geometry is manufactured with the help of CO_2 laser machining with six different parametric combinations.

2 Materials and Methods

The methodology is explained in Figure 1.

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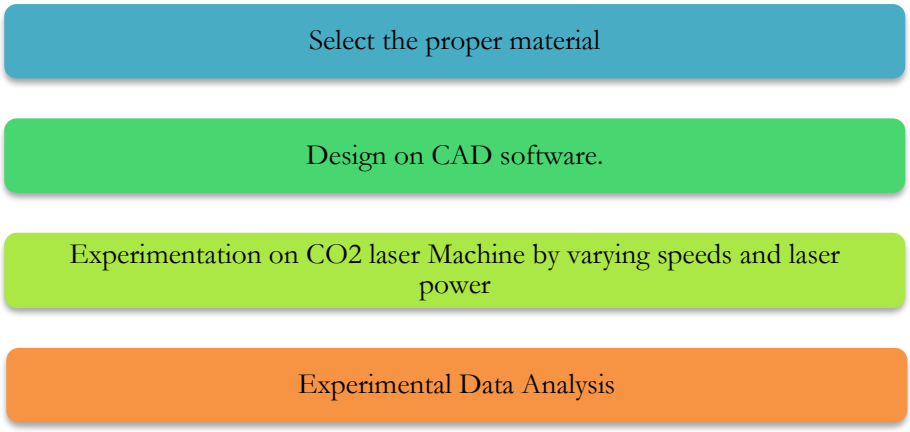

Figure 1*: Methodology*

- **Material:** In this research, the material used was acrylic having thickness of 2 mm. It's Chemical formula is $(C_5O_2H_8)n$. The properties of acrylic material are mentioned below:
  - Acrylic material having good impact resistance.
  - Acrylic Material is light weight.
  - It also UV radiant.
- **Design on CAD Software:** At first, the design of the required configuration is prepared with the help of two-dimensional drawing in AutoCAD software. The designed diagram is acting as an input for a CO_2 laser machining. The CO_2 laser cut machining takes input as 2D CAD drawing in dxf format and it analyses the path of channel which is given in CAD drawing.
- **Experimentation:** The CO_2 laser machining setup is as depicted in figure 2. The CO_2 laser is a multi-gas laser cutting machine. It mainly uses carbon dioxide, nitrogen, hydrogen and helium gas. This gas combines to form a laser beam. It can work on wood, plastic, metals. When power is supplied to the machine light is formed in it and the same light passes through the tube containing gas. There are mirrors on both sides of the tube. With the help of this mirror, they pass through the resonator that generates light energy in the beam and this beam comes to the nozzle with high intensity and collides on the acrylic sheet. As soon as the input is given, the machine starts working with the help of laser and the output is observed as the somewhat small cut on acrylic, The CO_2 laser cutting is performed selecting the values of power and scanning speed parameters.

Figure 2: *CO_2 Laser Machining Set-up*

The specifications of CO_2 Laser machine is as given below:

1. Model- TIL6090
2. Laser Type Sealed Hermetic CO_2 Laser Tube
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)

Experimental Data Analysis: By using digital micrometer, the depth of cut is measured and the readings at different laser power and laser scanning speeds are recorded and further analysed.

3 Results and Discussion

CO_2 laser machining is performed on acrylic sheet varying the laser cutting machining parameters like power and scanning speed. The sample specimens after CO_2 laser machining are depicted in Figure 3

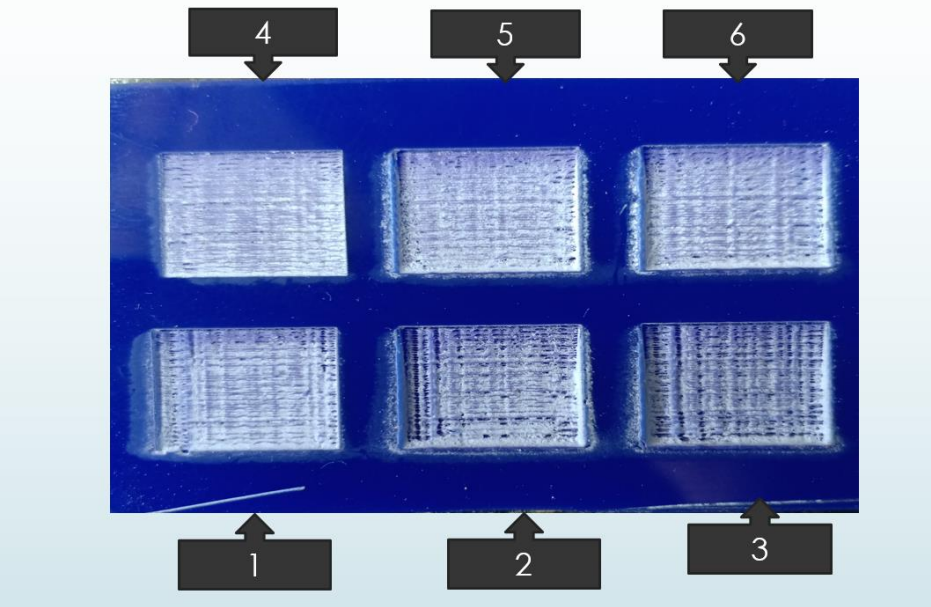

Figure 3: *Sample specimens*

The experimentation details with the recorded depth for various speed and power combinations are presented in Table 1.

Table 1: *Recorded depth for Speed and power combinations*

Expt. No.	**1**	**2**	**3**	**4**	**5**	**6**
Speed (mm/sec)	100	100	100	150	150	150
Power (Watt)	30	60	90	30	60	90
Depth (mm)	0.254	0.368	0.527	0.195	0.274	0.416

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It is observed from the table 1 that as power increases the depth also increases. Further, the depth is noted to be decreasing with increase in the scanning speed.

4 Conclusions

The parametric influence study for CO_2 laser machining on acrylic material is carried out and based on the experimentations, the following conclusions are drawn:

- Higher the intensity of power then greater the engraving in acrylic and increases depth of cut.
- As the scanning speeds increase, engraving on acrylic decreases and also depth of cut decreases.

References

[1]. N.V.Chavan , R.M.Bhagwat, S.S. Gaikwad, S. S. Shete , D.T. Kashid and S.S.Wangikar, " Fabrication & Characterization of Microfeatures onPMMA Using CO2 Laser Machining," *International Journal for Trends in Engineering and Technology, vol. 36(1), pp.39-32,(2019).*

[2]. H. Klank, J. P. Kutter and O. Geschke , "CO2-Laser micromachining and back-end processing for rapid Production of PMMA-based microfluidic systems*", Lab on a Chip, vol. 2 pp.242–6, (2002).*

[3]. Ã. Choudhury and S. Shirley,"Optics & Laser Technology Laser cutting of polymeric materials: An experimental investigation,"*Optics and Laser Technology, vol. 42, no. 3, pp. 503–508, (2010).*

[4]. A Gerlach, G. Knebel, A. E. Guber, M Heckele, D.Herrmann., A. Muslija, and T.H. Sshaller,"Microfabrication of single-use plastic microfluidic devices for high-throughput screening and DNA analysis," *Microsystem Technologies, vol. no.5-6, pp.265-268, (2002).*

[5]. O. Rotting, W. Ropke, H. Becker and C. Gartner,"Polymer microfabrication technologies," *Microsystem Technologies, Vol.8, pp.32–36, (2002).*

[6]. H. Qi, T. Chen, L. Yao and T. Zuo, "Micromachining of microchannel on the polycarbonate substrate with CO 2 laser direct-*writing ablation,"vol. 47, pp. 594–598, (2009).*

[7]. S.S.Wangikar,P.K. Pattowari and R.D. Mishra, " Effect of process parameters and optimization for photochemicalmachining of brass and germen silver," *Materials and Manufacturing Processes, vol.32(15), pp.1747-1755,(2017).*

[8]. S.S.Wangikar, P.K.Patowari, and R.D.Misra, "Parametric Optimization for Photochemical Machining of Copper Using Grey Relational Method*,"In Techno-Societal 2016,International Conference on Advanced Technologies for Societal Applications , pp.933-943, Springer(December 2016).*

[9]. S.S.Wangikar,P.K. Patowari, and R.D.Misra," Parametric Optimization for Photochemical Machining of Copper using Overall Evaluation Criteria*," Materials Today Proceedings, vol 5(2), pp.4736-4742, (2016).*

[10]. R. R. Gidde, P. M. Pawar, B. P. Ronge, A. B. Shinde, N. D.Misal and S. S. Wangikar, "Flow field analysis of a passive wavy micromixer with CSAR and ESAR elements*,"Microsystem Technologies, vol. 25, (2019).*

[11]. S. S. Wangikar, P. P. Patowari, R. D. Misra, and N. D.Misal,"Photochemical Machining: A Less Explored Non-Conventional Machining Process," *In Non-Conventional Machining in Modern Manufacturing Systems, pp. 188-201,(2018).*

[12]. S. S. Das, S. D. Tilekar, S. S. Wangikar, and P. K. Patowari,"Numerical and experimental study of passive fluids mixing in micro-channels of different configurations,"*Microsystem Technologies, Vol. 23(12), pp. 5977-5988, (2018).*

[13]. S. S. Wangikar, P. K. Patowari and R. D. Misra, "Numerical and experimental investigations on the performance of a serpentine microchannel with semicircular obstacles*", Microsystem Technologies, Vol. 24(8), pp.3307-3320, (2018).*

[14]. S. V. Jadhav, P. M. Pawar, A. B. Shinde and S. S. Wangikar, "Performance Analysis of Elliptical Pin Fins in the Microchannels*"In Techno-Societal 2018, pp. 295-304, Springer, Cham.*

[15]. H. D. Kulkarni, A. B. Rasal, O. H. Bidkar, V. H. Mali, S. A. Atkale, S. S. Wangikar and A. B. Shinde, "Fabrication of Micro-Textures on Conical Shape Hydrodynamic Journal Bearing*", International Journal for Trends in Engineering and Technology, Vol. 36(1), pp.37-41, (2019).*

[16]. M. A. Raut, S. S. Kale, P. V. Pangavkar, S. J. Shinde, S. S. Wangikar, S. V. Jadhav and D. T. Kashid, "Fabrication of Micro Channel Heat Sink by using Photo Chemical Machining" *International Journal of New Technology and Research, Vol. 5(4), pp.72-75, (2019).*

[17]. Patil P. K., Kulkarni A. M., Bansode A. A., Patil M. K., Mulani A. A., Wangikar S. S. (2020) Fabrication of Logos on Copper Material Employing Photochemical Machining. *NOVYI MIR Research Journal, 5(6), 70-73.*

[18]. Wangikar SS, Patowari PK, Misra RD, Gidde RR, Bhosale SB, Parkhe AK (2020) Optimization of photochemical machining process for fabrication of microchannels with obstacles. *Materials and Manufacturing Processes, 36:5, 544-557*

[19]. Bhagwat RM, Gaikwad SS, Shete SS, Chavan NV, Wangikar SS (2020) Study of etchant concentration effect on the edge deviation for photochemical machining of copper. *Novyi MIR Res J 5(9):38–44*

[20]. Kame MM, Sarvagod MV, Namde PA, Makar SC, Jadhav SV, Wangikar SS (2020) Fabrication of microchannels having different obstacles using photo chemical machining process. *Novyi MIR Res J 5(6):27–32*