INFLUENCE OF LASER PARAMETERS ON THE PROCESSING OF ACRYLIC

LĀZERU PARAMETRU IETEKME UZ AKRILA APSTRĀDI

Author: **Pāvels ŠČETIĻNIKOVS**, e-mail: pastyx112@gmail.com
Scientific supervisor: **Imants ADIJĀNS, Mg.sc.ing.,** e-mail: Imants.Adijans@rta.lv
Rēzeknes Tehnoloģiju akadēmija (RTA)
Atbrīvošanas aleja 115, LV - 4601 Rezekne, Latvia

Abstract*. The publication describes the obtained results of the depth and width of the engraving line and cutting line when processing materials such as acrylic. In the experiment, we used a SUNTOP ST-CC9060 CO_2 laser and an OLYMPUS OLS5000 laser microscope. The aim of the experiment was to find parameters for optimal cutting and many parameters for different engraving depths.*

Keywords*: Acrylic, CO_2 laser, Laser cutting, Laser engraving, Laser processing of acrylic.*

Introduction

Today's laser applications are widely used in industrial and technological fields such as welding and laser cutting in polymeric materials and other materials [1]. Acrylic is Plexiglas, nowadays, used for: decorative objects, plates, aquariums, plumbing, construction and architecture, part of devices and containers, as well as for prostheses. Advances in the use of poly (methyl methacrylate) (PMMA) have opened up a wide range of applications in the field of nanotechnology. The knowledge of the properties of PMMA has contributed a lot to the recent boosts in the synthesis, modification, and applications of the polymer [2]. Extensive opportunities not infrequently appear unusual orders and offers from legal entities and individuals, given the complexity of some products, it became necessary to know in more detail the possibilities of material processing with a CO2 laser. Depending on the type of acrylic you're working with, the laser can produce a smooth, flame-polished edge when laser cut, and it can also produce a bright, frosty white engraving when laser engraved. Never leave your machine unattended when working with acrylic. Many materials are susceptible to igniting, but acrylic - in all its different forms - has been shown to be especially flammable when cut with the laser. As a general rule, you should never run your laser - using any material - if you are not present[3].

Materials and methods

Poly(methyl methacrylate) (PMMA), also known as acrylic, acrylic glass, or plexiglass, as well as by the trade names Crylux, Plexiglas, Acrylite, Astariglas, Lucite, Perclax, and Perspex, among several others (see below), is a transparent thermoplastic often used in sheet form as a lightweight or shatter-resistant alternative to glass. The same material can be used as a casting resin or in inks and coatings, among many other uses[4]. The main values for the experiment were the Depth and Width of the processed material; in the case of the experiment, 4 mm of acrylic was used. The laser is capable of engraving and cutting material, so the main focus of the experiment is to find the range of parameters between what is engraving and what is cutting the material. The Variable Parameters for finding the desired results are Laser Speed and Power.

Before the experiment, the laser output power was measured. The power P adjustment curve is shown in the graph in Fig.1. This relation is logarithmic.

https://doi.org/10.17770/het2021.25.6800

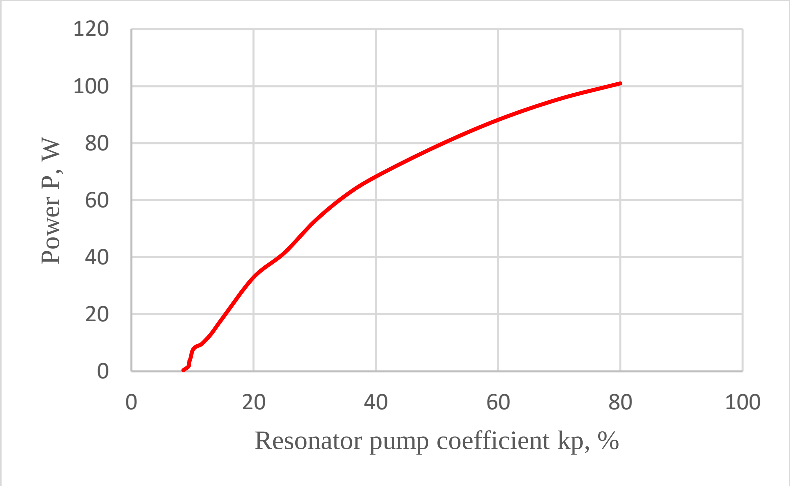

Fig.1 **Dependence of the radiation power *P* on the resonator pump coefficient *kP* %**

In the experiment uses a CO_2 laser system SUNTOP ST-CC9060 (See in Fig. 2)

Fig.2. ***Laser machine SUNTOP ST-CC9060***

Table 1. Laser machines SUNTOP ST-CC9060 technical specifications

Laser Type	CO2 laser, CW mode
Wave length	10640 nm
Maximum power	100W
Workspace(Cutting area)	900x600 mm
Scanning speed	0-1000 mm/s
Precision	0,02 mm
Laser Safety Class	4
Cooling System	Water cooling

Table 2. **Used Power**

Power	20%	30%	40%	50%	60%	70%	80%
	~33 W	~52,7 W	~68,3 W	~79W	~88,2 W	~95,5 W	~100 W

Table 3. **Used Speed**

Speed	10 mm/s	20 mm/s	30 mm/s	40 mm/s	50 mm/s	100 mm/s	200 mm/s	300 mm/s

Fig.3. ***Laser microscope OLYMPUS OLS5000***

For measuring line depth *h* OLYMPUS OLS5000 was used. Microscope is shown in Fig.3.

Technical parameters for OLYMPUS OLS5000 laser microscope:

- Max magnification 100x,
- Z measurement pitch: 2μm,
- X and Y axis resolution: +/- 1.5%

Results and discussion

In the course of the experiment, the parameters of working with the material were found for both its engraving and cutting. Standing out parameters turned out precisely for cutting acrylic, the most important parameter in order to process acrylic, according to the data obtained, is the speed of the laser, the power of the lasers affects the result less.

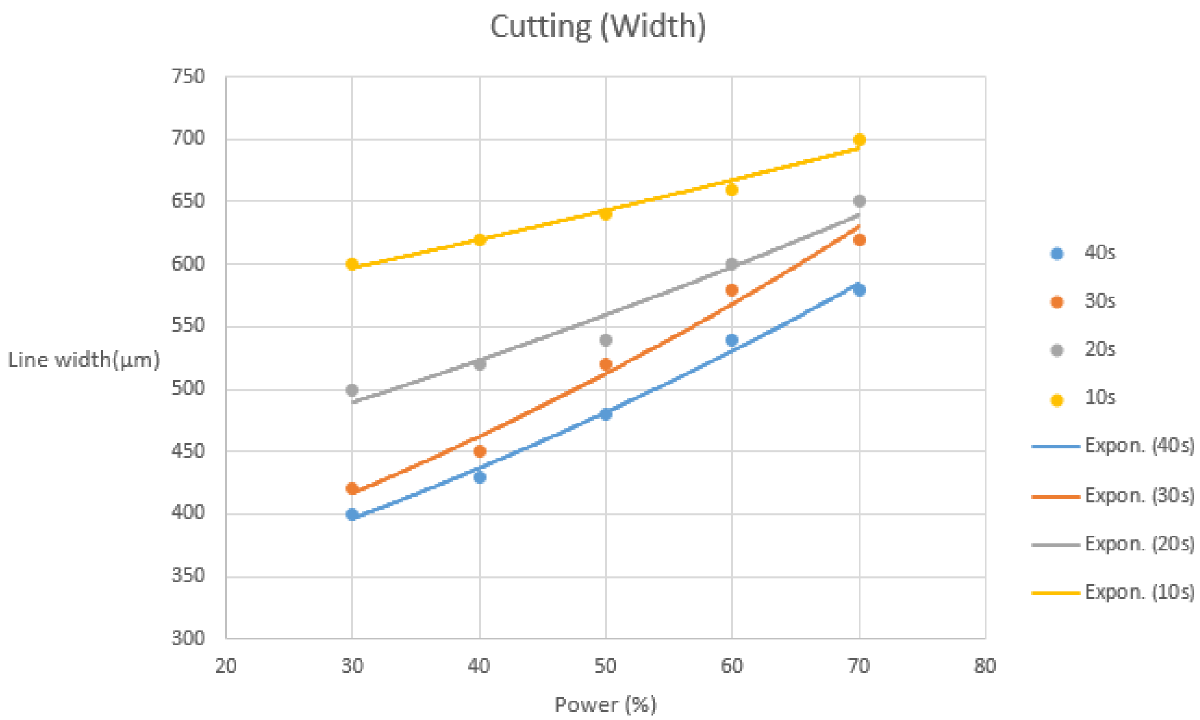

Fig.4. ***Plot of parameters for cutting. Line width. Power***

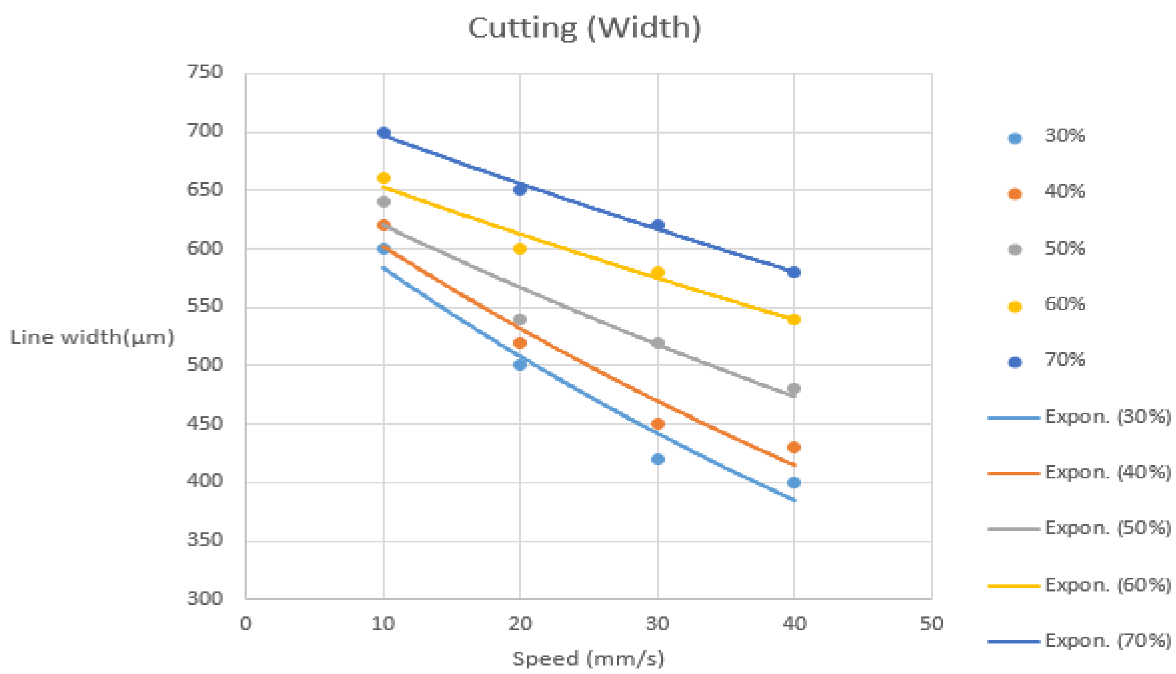

Fig.5. ***Plot of parameters for cutting. Line width. Speed***

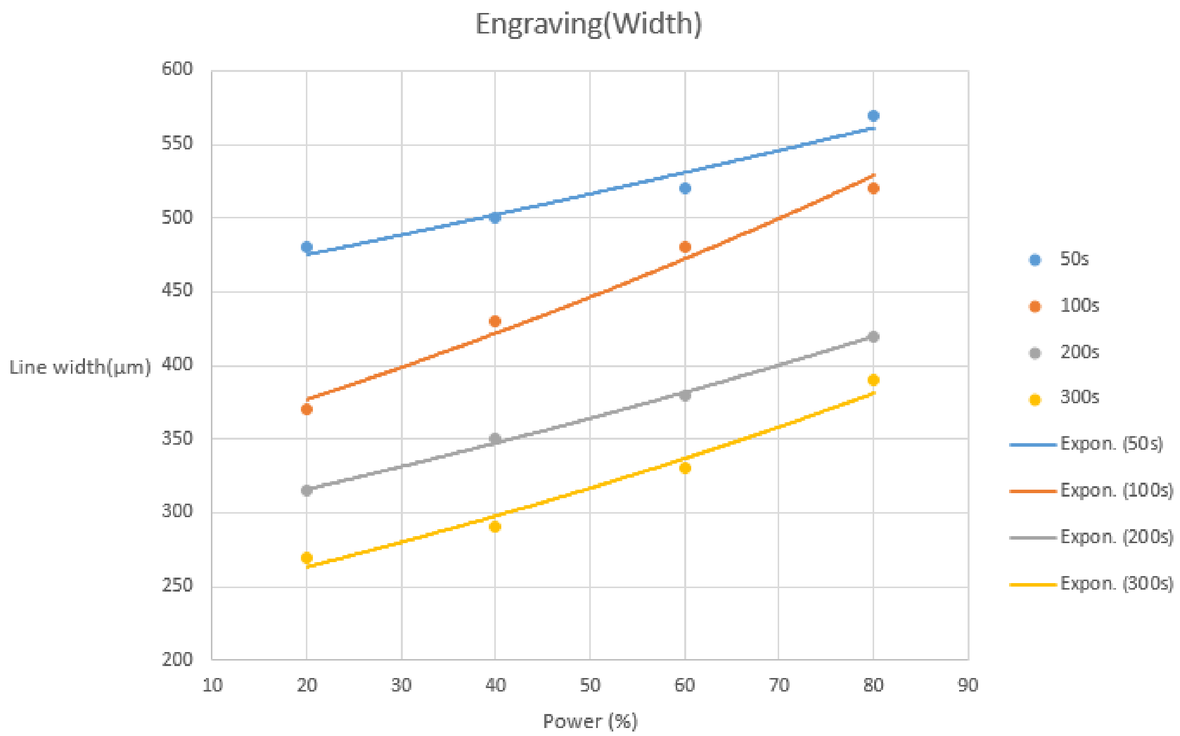

*Fig.6. **Plot of parameters for engraving. Line width. Power***

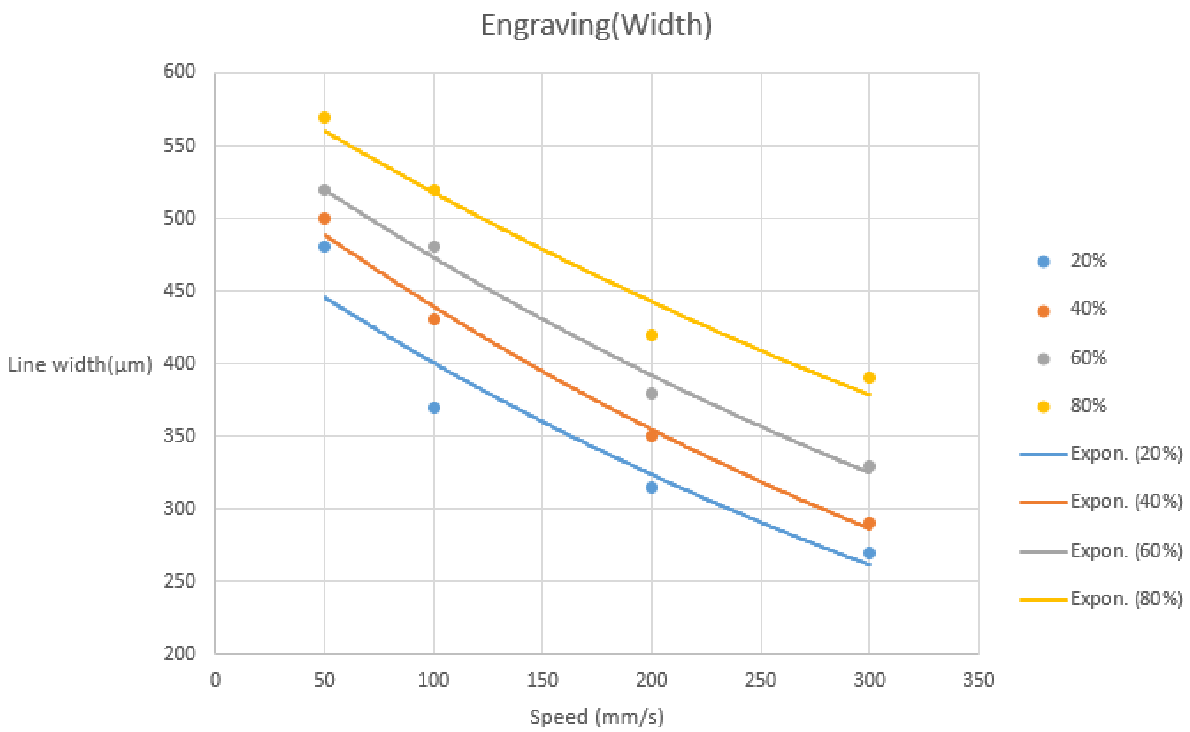

Fig.7. ***Plot of parameters for engraving. Line width. Speed***

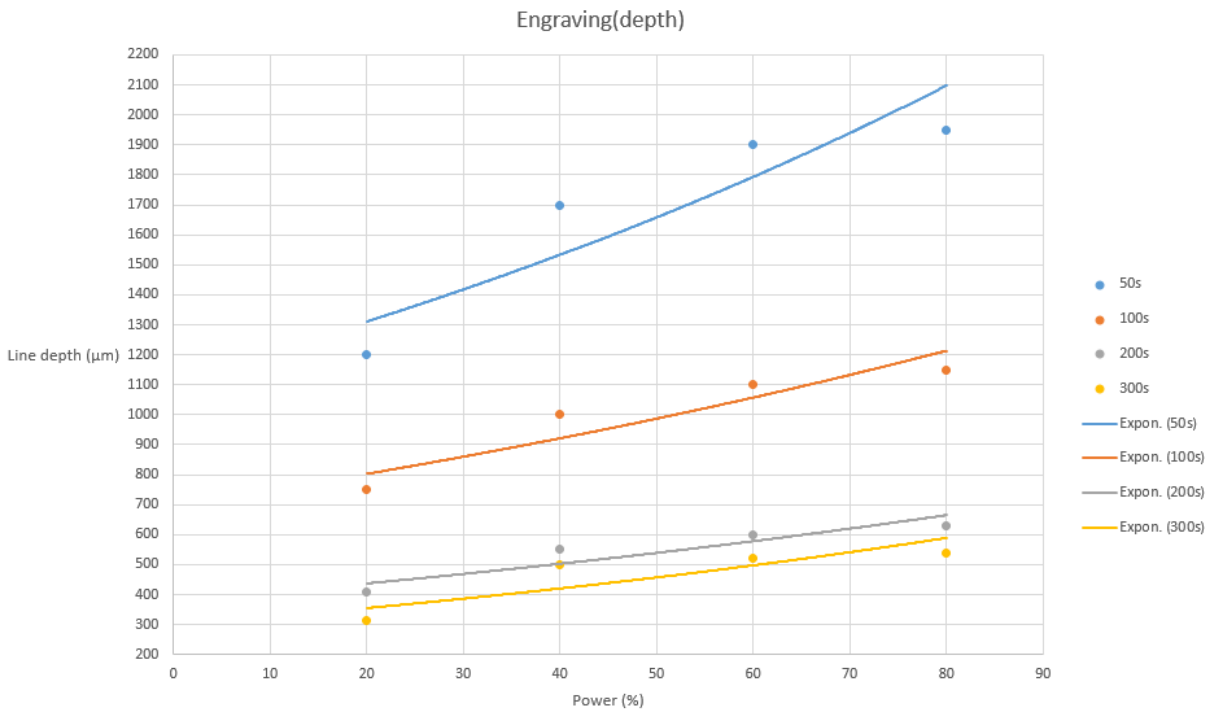

Fig.8. ***Plot of parameters for engraving. Line depth. Power***

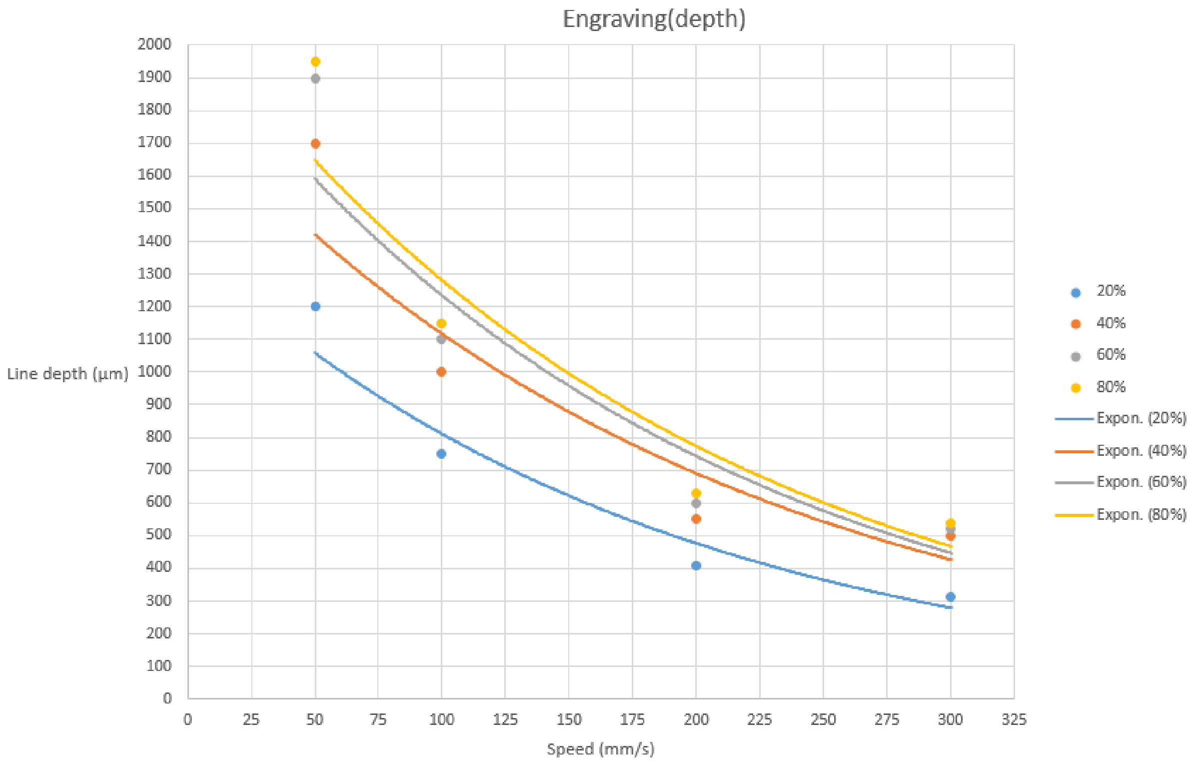

Fig.9. ***Plot of parameters for engraving. Line depth. Speed***

The Fig.4. graph is the dependence of the line width on the power.(Cutting)
The Fig.5. graph is the dependence of the line width on the speed.(Cutting)
The Fig.6. graph is the dependence of the line width on the speed.(Engraving)
The Fig.7. graph is the dependence of the line width on the depth.(Engraving)
The Fig.8. graph is the dependence of the line width on the depth.(Engraving)

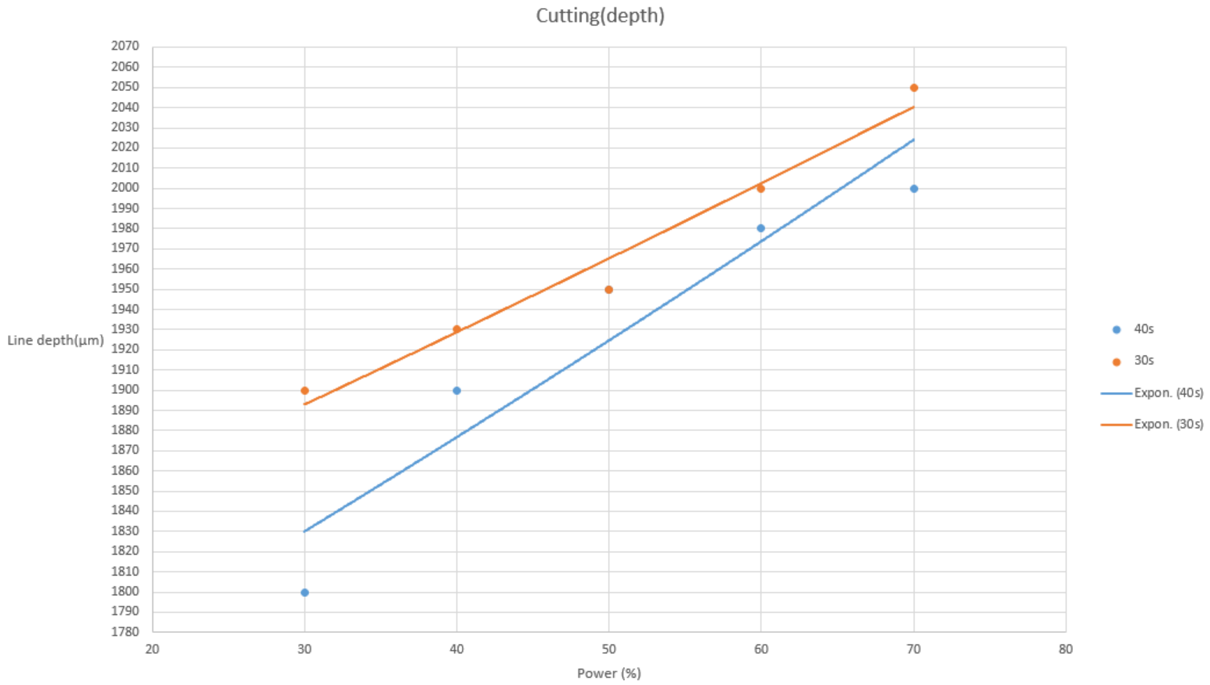

Fig.10. ***Plot of parameters for cutting. Line depth. Power***

Fig. 10. - At speeds starting from 20 (mm/s), 4 mm of acrylic is cut through at all power settings.

The graphs show that:

1. the results of the dependence of the width of the engraving line, the cutting line depending on the power is almost linear (Fig. 4. and Fig.6.)
2. the results of the dependence of the width of the engraving line, cutting line depending on the speed is almost linear (Fig.5. and Fig.7.)
3. the results of the dependence of the depth of the engraving line, the cutting line depending on the power is almost linear (Fig.8.)
4. the results of the dependence of the depth of the engraving line, cutting lines depending on the speed are not linear (Fig.9.)

Conclusions

The results of the experiment that we see in the graphs showed:

- Acrylic is easy to laser processing (cutting and engraving).
- The strongest factor affecting the processing of acrylic is the laser speed.
- The changes in the result to a lesser extent than the speed of the laser are influenced by the laser power when processing acrylic.
- For a 4 mm Acrylic cut, the initial parameters will be 20 (mm/s) speed starting from 10% power.
- During the experiment, rather large intermediate parameters were used, due to which the trend of changes varies slightly (or is not constant).

Fig.11. ***"Rēzeknes Tehnoloģiju akadēmija" Logo***

An example of the applied parameters obtained during the experiment in practice, logo "Rēzeknes Tehnoloģiju akadēmija" (RTA) (Fig.11.). Considering the current standards of the academy[5]. The logo was made for the main entrance "Information Technology Center" of "Rezekne Academy of Tehnologies".

Bibliography

1. https://www.researchgate.net/publication/335209027_Improving_the_Properties_of_Acrylic_by_Creating_Crack_Using_Laser_Beam
2. https://www.tandfonline.com/doi/abs/10.1080/15583724.2015.1031377 (15.04.2021)
3. https://www.epiloglaser.com/how-it-works/applications/laser-cutting-acrylic/(18.04.2021)
4. https://en.wikipedia.org/wiki/Poly(methyl_methacrylate) (15.04.2021)
5. RTA Brand Book (Korporatīvās identitātes stila gramata - Natālija Losāne)