XXII. Fiatal Műszakiak Tudományos Ülésszaka, 2017. Kolozsvár, 71–74. *DOI: 10.33895/mtk-2017.07.10*
http://hdl.handle.net/10598/29748

LÉZERGRAVÍROZÁSI KÍSÉRLETEK

LASER ENGRAVING EXPERIMENTS

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Abstract

The thermal cutting processes have come a long way in the last decade, but we still don't use the wide application variety for the laser equipment. Nowadays laser cutting is very popular and is one of the most widely applied technology in car industry too. Our goal is to experiment the possibility of engraving with laser equipment, and if possible then what can we expect along later experiments.

Keywords: *Engraving, Laser engraving, Laser*

Összefoglalás

A termikus vágási eljárások jelentős fejlődésen mentek keresztül az elmúlt évtizedekben, azonban a lézergépek sokoldalúságát közel sem használjuk ki. Manapság a lézervágás nagyon elterjedt és az egyik legszélesebb körben alkalmazott technológia az autóiparban is. Célunk az, hogy megvizsgáljuk, mennyire lehetséges a gravírozás végrehajtása lézergépekkel, és ha lehetséges, milyen eredményességre számítsunk a későbbi kísérletek során.

Kulcsszavak: *Gravírozás, Lézergravírozás, Lézer*

Introduction

Nowadays a lot of different laser technologies are available for anybody. The laser beam is a concentrated light that we can use for cutting and for engraving. We can find different installations and applications possibilities for laser. In this work we wanted to find the best parameters for engraving the used material with experiments [1, 2, 3].

1. The processed material

For our experiments we used an aluminium alloy with high mechanical strength and corrosion resistance: AlSi1MgMn. In addition to that it is very well polishable and has good welding properties, this alloy is hardenable by heat treating. Exposure to high temperature may cause it to ignite.

Even when not heat treated it still provides the aluminium sheet a higher than average mechanical strength. Although it's malleability is reduced, but it's machinability and polishability is more superior to the non-treatable Al sheet types. It's over the average strength makes it possible to make machine parts capable of enduring high stresses. It's thread tolerance mostly shows in making blind holes in sheets.

Range of use: it's used in every branch of machine industry, custom machine production, shipbuilding industry; also where corrosion resistance is of key importance; pneumatic unit's inner parts.

Machinability: easily machinable with traditional and CNC-machines with HSS and HM tools, also in turning it makes spiral shavings, which makes it harder to turn on automatic machines [4].

1.1. Main areas of application

- High strength parts;
- Ships, cars and electric appliances;
- Precision micromechatronics.

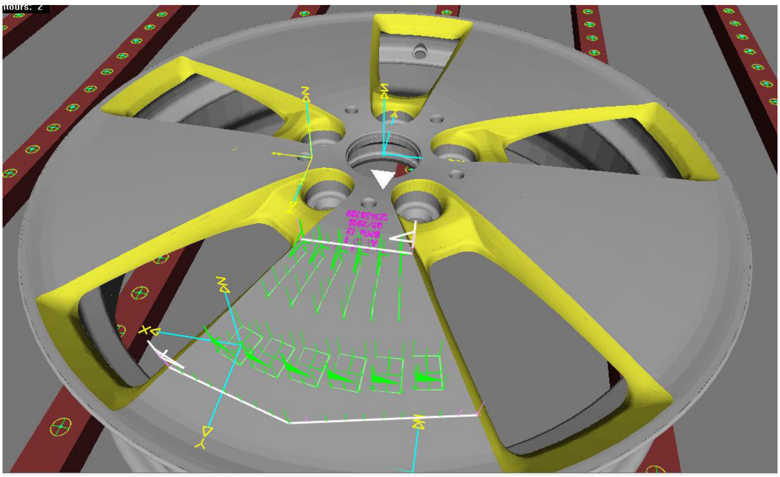
1. table. *The chemical composition of AlSi1MgMn [2]*

Si	0,7-1,3%
Fe	0,50%
Cu	0,10%
Mn	0,40-0,60%
Mg	0,60-1.00%
Cr	0,25%
Zn	0,20%
Ti	0,10%
Other	0,05%
Al	balance

2. Experiment

We engraved a car rim (1. figure) made of aluminium alloy with TruTops Cell program with letters and different figures (**2. figure**). Most of the times the process is done with a number or letter punch, which has to be changed regularly as the text changes. The lengthy swap time causes for a longer cycle to be marked the same way, which makes manufacturing hard to check back. By the introduction of laser marking we can even make unique markings or figures feasible. At the same time we also wanted to examine, how effectively can we remove the material off the worked surface.

1. figure. *The workpiece*



2. figure. *3D design plan*

The determination of the starting laser technology parameters was done empirically, followed by visual evaluation to modify the parameters. We preformed 39 preliminary experiments, after that we inspected them. Following that we chose 6 appropriate parameters, which were further examined and analysed [5].

2.1. Experimental parameters

Material quality: AlSi1MgMn

The engraving parameters are collected in the ***table. 2.*** and the constant values are showed in ***table. 3***.

2. table. *Engraving settings*

No.	Output	Frequency	Method
1	800W	5010 Hz	Line engr.
2	810W	5010 Hz	Line engr.
3	820W	5010 Hz	Line engr.
4	830W	5010 Hz	Line engr.
5	840W	5010 Hz	Line engr.
6	810W	1500 Hz	Double line engr.

3. table. *Constant values*

Nozzle diameter	1,7 mm	**Focus**	-3
Nozzle distance	5 mm	**Auxiliary gas**	N_2 (Nitrogen)
Auxiliary gas pressure	0,8 (Bar)	**Speed**	2m/min

2.2. Measuring surface roughness

We controlled the surface roughness (Ra, Rz) to find on base of our result some difference and declare the best parameters for engraving this material. ***Table.4***. shows the test results.

4. table. *Surface roughness results*

Exp. no.	Ra (µm)	Rz (µm)
1	1.0413	5.1237
2	1.0620	5.6947
3	1.0816	5.2714
4	1.1122	6.4642
5	1.4379	7.6073
6	1.5818	10.0436

2.3. HAZ hardness testing

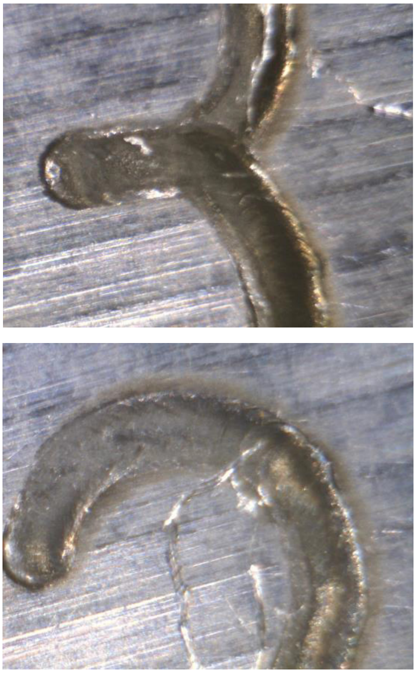
We inspected the hardness changing in the heat affected zone (HAZ). We used for this test a microvickers hardness tester with 0,4 kg load. We tried to position it in the HAZ to find out what changes occurred due to the heat input. The hardness test was done on both sides of the engraved line and the test results are showed in **table. 5**. [5].

5. table. *Hardness test results ($HV_{0,4}$)*

Exp, no.	Side 1	Side 2
1	79	75
2	74	86
3	71	49
4	76	92
5	74	91
6	56	87

2.4. Visual inspection

Since in the case of number markings it wasn't possible to do a surface roughness test, we tried to evaluate it visually, which parameters are the best. To find it the preliminary experiments helped us alot, so we already knew what parameter range works best for engraving shown in ***figure. 3***.



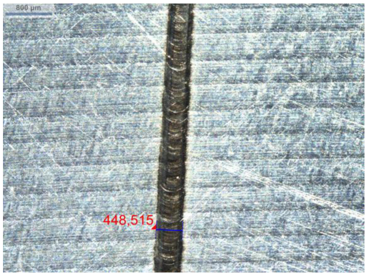
3. figure. *Optimized experimental setting marking the number 3*

2.5. Width of the engraved surface

In our microscopic examination we determined that the number 1-5 experiments (line engravement) the width moved between 400-450 µm in all position. This value in the experiment number 6 (double line engravement) approaches the 600 µm [5].

Acknowledgement

We acknowledge the financial support of this work by the Hungarian State and the European Union under the EFOP-3.6.1-16-2016-00010 project**.**



4. figure. *No.1. engraving experiment*

3. Conclusion

Based on the experiments preformed we determined that laser material removal can be an alternative to machining. We have to take into consideration that using laser causes high temperature stress to the base material, and it can cause changes that doesn't occur in machining. The surface roughness produced by the laser engraving is almost the same as the machined surface roughness. Since the material used for the experiment is a temperable aluminium alloy we expected that there will be structural changes in the HAZ. The hardening in the tested HAZ was not relevance.

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