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THE ROUGHNESS OF CUT SURFACE OF DIFFERENT MATERIALS AFTER LASER CUTTING

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ABSTRACT:
The article describes the technology of cutting material using the laser. In the introduction are theoretical knowledges of lasers, definitions and generation. It deals about principle of laser thermal cutting and current use of the technology in production industry. The cut surface of products of this technology is smooth and accurate but reaches variant values of roughness. This article presents quality of laser cutouts mainly in dependence on the different materials.

KEYWORDS:
laser, the speed of cutting, roughness

1. INTRODUCTION

Today, laser cutting is used extensively for producing profiled flat plate and sheet, for diverse applications in the engineering industry sectors. For three dimensional components, multi-axis gantry laser beam manipulators have extended laser cutting to the automotive sector, this type of equipment being used for trimming pre-production body panels at all leading car manufacturers. More recently laser cutting has also found its way, very successfully, into other industry sectors such as shipbuilding, traditionally seen as fairly slow to adopt high technology processes.

FIGURE 1. EXAMPLE OF PARTS MADE USING 2D AND 3D LASER

Metals, ceramics, polymers and natural materials such as wood and rubber can all be cut using CO_2 lasers. For steels the dominant process utilises an oxygen assist gas, which provides exothermic energy to the cutting process. As a result, thick sections (up to 20 - 25mm with the most advanced equipment) can be cut commercially and the cut quality and speed are generally considered high when compared with other thermal cutting processes. Laser cutting is also generally regarded as a 'low distortion' process, compared with other

thermal cutting options. Stainless steel, aluminium and titanium are also cut using CO_2 lasers, this time using a high pressure (up to 15 bars) inert assist gas to aid the process and blow material from the cut kerf. Less cutting of thermoplastic materials is performed currently because of the nature of the fume generated when some plastics are vaporised.
First applications of lasers in production confirmed possibilities of the technology as well as help to improve first laser devices, find and eliminate their defects. Real breakage in world distribution of lasers was in 1985. Manufacturing devices was more expensive than research itself. Since then there is 25% growth and over the 1000 lasers get to the production sphere in one year.

2. USE AND PRINCIPLES OF LASER

Nowadays the laser is multifunctional tool used in most of industries. With laser ray you can cut or weld the material, mark the surface or modify it – local hardening, surface alloying etc.

It is used for machining plane work pieces, rounded or angular pipes and profiles from various materials, mainly constructional steel, stainless steel, aluminium and aluminium alloys. It is dominating in machine engineering for cutting the sheets and other semi-products of various thickness.

In comparison with usual cutting methods laser enables serious increase of production flexibility – adaptation to miscellaneous cutting shapes just by changing the control program. Example can be taken from electromotor production. If customer asks for three pieces, usual methods are inefficient.

Manufacturing of expensive drivers for sheets of stator and rotor would increase production costs and the price of whole product while simultaneously extending final time. Laser production is in some cases more effective and economic.

2.1 Principle of laser cutting

The word laser actually is a shortcut created from firs letters of the expression Light Amplification by Stimulated Emission of Radiation. Laser ray rises by stimulated emission in resonator of laser aggregate as followed: laser gas is electrically activated and received energy in order of 105 kW/cm^2 is given as laser radiation with wawe-length of 10,6 μm.

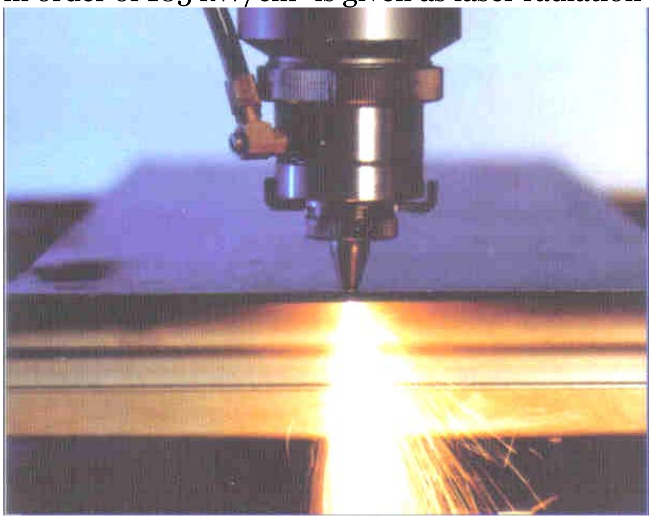
FIGURE 2. Laser Cutting

Laser ray with the direction parallel with the centre line of resonator is led from laser aggregate to the work piece exactly through the system of mirrors and lenses. The ray is usually led in the system of protecting pipes. At the end of laser ray line there is a cutting torch in which the ray is focused using the lens. Through the cutting torch and nozzle the ray and the cutting gas are led directly to work piece. Highly concentrated light energy strikes into the work piece cutting zone, where it changes to thermal one which causes material heating-up. Heat created in this zone melts the material and steams it off. Material is then blown off by cutting gas. That should be chosen according to treated material and quality demands of machined product. Laser output and cutting speed should be adapted to the material type and thickness. Wide usage of lasers in various fields of science and technical praxis results from their unique attributes in comparison with classic sources of light.

3. QUALITY OF LASER CUT SURFACE

Material: ARMOX 500 T, **Thickness**: 6 mm, **Speed of cutting**: 2,700 m.min^{-1}

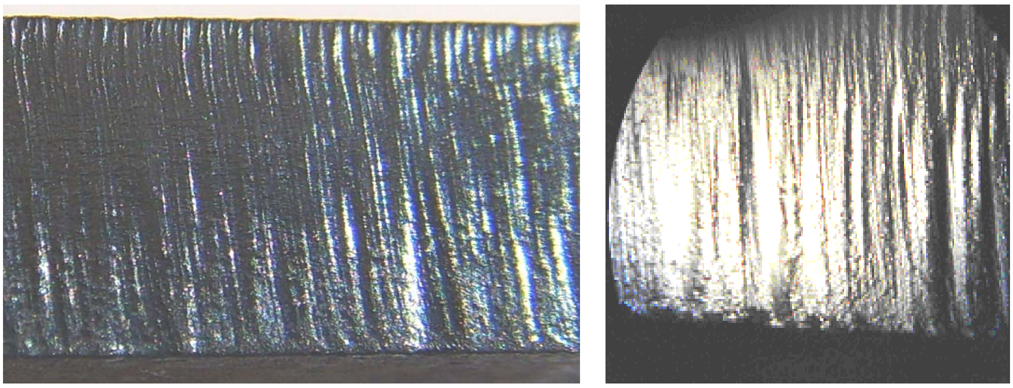

FIGURE 3. THE CUT SURFACE OF MATERIAL **ARMOX 500 T** (zoom 8x)

TABLE 1. MEASUREMENTS OF THE ROUGNESS OF THE CUT SURFACE: ARMOX 500 T

ARMOX 500 T	Measurements						Arithmetic Ra (μm)
	1.	2.	3.	4.	5.	6.	
Roughness of surface Ra (μm)	2,60	2,89	3,57	3,96	2,56	2,50	**3,01**

Material: **Steel 12 040, Thickness**: 6 mm, **Speed of cutting**: 2,300 m,min^{-1}

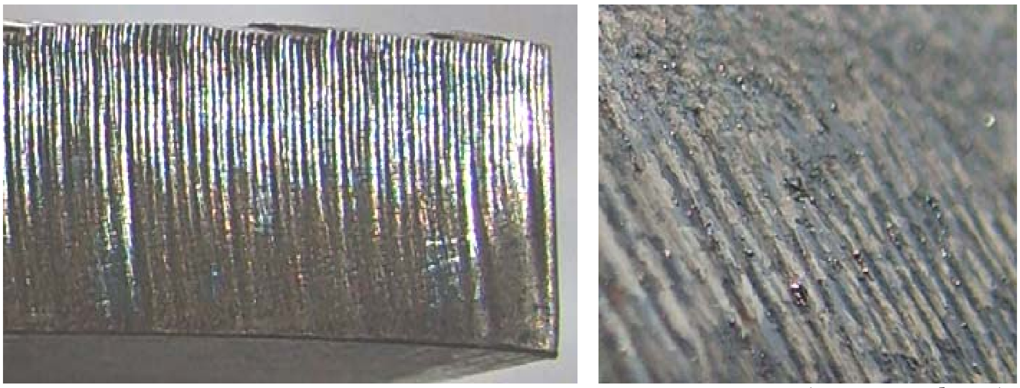

FIGURE 4. THE CUT SURFACE OF MATERIAL **STEEL 12 040** (zoom 7 and 20x)

TABLE 2. MEASUREMENTS OF THE ROUGNESS OF THE CUT SURFACE: STEEL 12 040

Steel 12 040	Measurements						Arithmetic Ra (μm)
	1.	2.	3.	4.	5.	6.	
Roughness of surface Ra (μm)	3,15	2,55	1,6	2,2	1,59	2.50	**2,26**

Material: Steel 17 243**, Thickness**: 6 mm, **Speed of cutting**: 1,700 m.min^{-1}

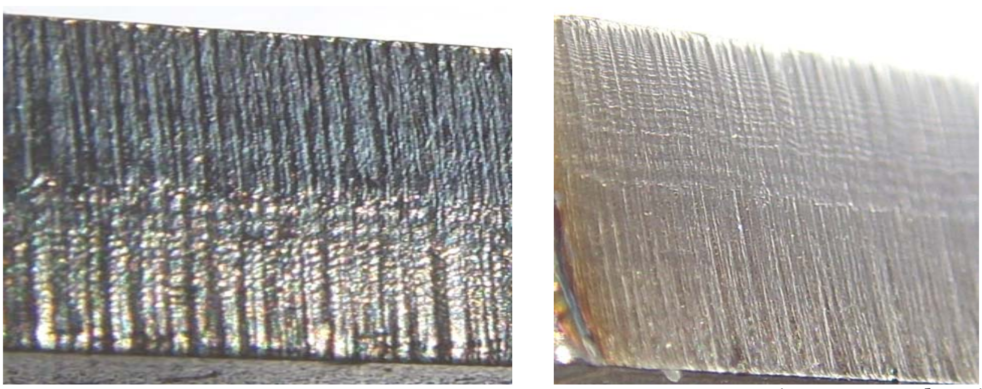

FIGURE 5. THE CUT SURFACE OF MATERIAL **STEEL 17 241** (zoom 10 and 12x)

TABLE 3. MEASUREMENTS OF THE ROUGNESS OF THE CUT SURFACE: STEEL 17 241

Steel 17 143	Measurements						Arithmetic Ra (μm)
	1.	2.	3.	4.	5.	6.	
Roughness of surface Ra (μm)	2,23	3,02	1,97	2,53	2,46	2,55	**2,46**

Material: **alloy AlMg3, Thickness**: 6 mm, **Speed of cutting:** 1,100 m,min^{-1}

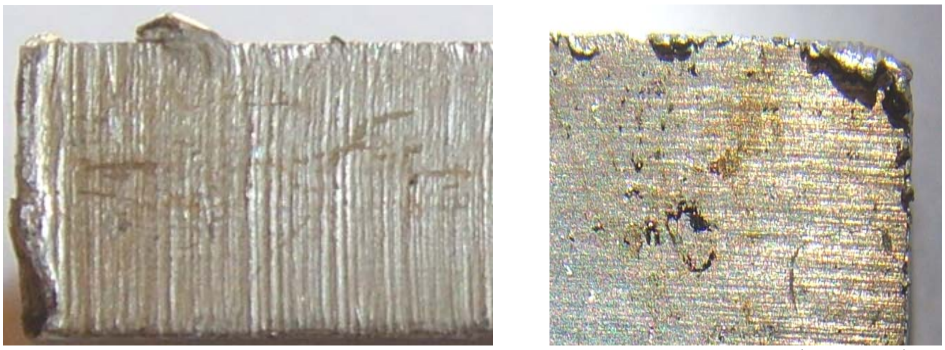

FIGURE 6. THE CUT SURFACE OF MATERIAL **alloy AlMg3** (zoom 9x)

TABLE 4. MEASUREMENTS OF THE ROUGNESS OF THE CUT SURFACE: alloy AlMg3

Zliatina AlMg3	Measurements						Arithmetic Ra (μm)
	1.	2.	3.	4.	5.	6.	
Roughness of surface Ra (μm)	6,86	6,10	6,13	7,67	7,15	6,50	**6,73**

4. CONCLUSION

Rising requirements of high productivity together with demand of high quality parts production enforce the request of finding the suitable variants of manufacturing processes, where maximum production volume would be achieved by minimum production costs while keeping required quality parameters. These current demands to industrial production are presented also in plants where laser cutting is used as one of the methods of material treatment.

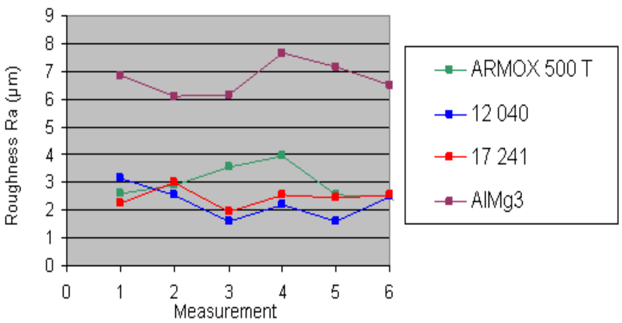

FIGURE 7. THE GRAPH OF THE ROUGHNESS OF THE CUT SURFACES OF ALL EXPERIMENTAL MATERIALS

Laser technology permits production of parts, which couldn't be manufactured using conventional methods. Indeed they take skilled attendance. Laser finds its application in various operations types (cutting, welding, drilling, thermal surface treatment, ...). The variation of these operations is simply possible by changing working parameters of laser device. One of the most important indicators of thermal cutting quality is roughness of cut surface on the manufactured components.

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