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EFFECTS OF THE LASER POWER ON WOOD COLOURATION

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Abstract: *This paper present a study about influence of the laser power on wood colour change. An application of this study is artistic wood burning. The tests were made on beech wood. The results show that the laser power influence on wood is not linear. It found four variations areas defining this influence. It observed differences in colour uniformity between low and high laser power, also. In that way was defined the interval value limits in area in which the colour variation is large and uniformity is better.*

Keywords: *pyrography, wood burning, laser technology, beech*

1. INTRODUCTION

Laser radiation processing is gaining more and more followers because of the advantages which it has this technology. One of this is easy availability of equipment. One of the laser processing applications is the wood pyrography. Laser technology is well suited for high-volume automated manufacturing owing to the high processing speed, low waste, precision of operation, and high quality of engraved products [7].

Operational laser parameters that affect wood colour are: laser output power, feed speed, and scan gap. It keeps constant feed speed and scan gap for this study.

Dumitras proposed for permanent materials engraving the power of the CO_2 lasers less than 15 W [2]. These values depend on the other work parameters (especially speed), and on the material. The material to be processed is the most important influence factor.

Research on Moso bamboo wood showed that engraved surface darkens more and more with increasing laser power [7]. There have been other studies regarding the influence of laser power on wood colour, comparing several woody species [10].

2. OBJECTIVE

The aim of this study is to define the laser power variation range used for wood engraving. The study proposes itself to obtain more colour nuances between natural colour of the wood and black without pronounced degradation of the wood.

3. MATERIAL, METHOD, AND EQUIPMENT

The methodology consists in more tests about using more power values, and keep the others work parameters at the same values. For this study, it was used beech wood (*Fagus Sylvatica* L.) veneer. This wood is one of the most used species, recommended as support for pyrography by others authors [3,4,5,6,8,10]. Beech is a specie with light natural colour and an uniform structure. The

pale colour provides the possibility to obtain a large colour gradient by burning. The experiments were made on rectangular specimens with 105 mm wide and 225 mm depth (Fig. 1).

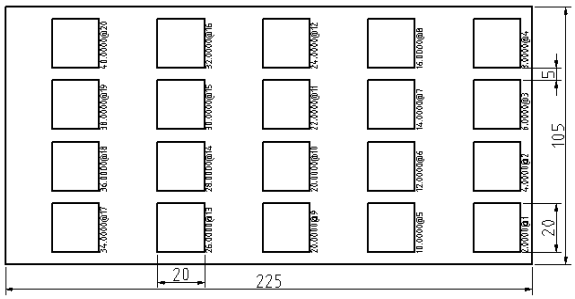

Fig. 1. Sample shape and size.

In order to analyse the wood colour, the radially section of samples were used. This section allowed the study of colour difference between early wood and late wood. These two areas of wood growth are distinguished by hardness.

The specimens was dried at 12% moisture content and conditioned at 20ºC temperature and 65% relative humidity [1]. Prior to manufacture, the wood specimens was sanded mechanical with 80 grained sand paper and then it sanded with 120 grained sand paper. The used equipment contains: Laser Engraving Machine 4030lsct equipment for laser processing, HP LaserJet 3055 all-in-one for image scanning, and PC for image processing and colour measurement. The specimens were burned by laser.

Original image is a linear draw processed by computer. This draw contains 20 squares. Each square was rasterised with different power value. The power values were chosen starting from minimum value of the engraving machine (2 W). Each square was burned at a range of powers from 2 to 40 W with incremental changes of 2 W (Fig. 1). A software application was developed for ease of data entry. This application helps to setting the process parameters.

The work parameters are:

- Focused distance: 73 mm;
- Scansion speed: 400 mm/s;
- Spot Size at working distance: 0.0254 mm;
- Laser Wavelength: 10.6 µm.

Engraved surface was scanned with HP LaserJet 3055 all-in-one printer, fax, copier, and scanner. The used parameters for this study are:

- Colour mode;
- Resolution 600 dpi;
- Bitmap image format;
- Scan scale 1:1.

The file with scanned image was transferred to a computer in order to analyse the image. Pyrographed image was converted to large-scale nuances in order to correlate the colour measured values.

The colour was measured using the digital colour analysis method [9]. The measured values were converted in to CIEL*a*b* system [11].

Each filled square was measured with a 100 pixels circular surface diameter. It resulted 7957 pixels for each square and 159140 measured pixels for each image using this parameter. It was calculated the average value for each measured round surface.

4. RESULTS AND DISCUSSION

In Fig. 2 are shown experimental research results. It observes that L* parameter is the most influenced by burning. A* and b* parameters define especially the natural colour of the wood. This is the reason why the values of these parameters have initial an upward trend, while L* decreases. This study analyses

L* parameter only. It observes several areas of change on its variation:

- Up to 4 W is the range in which the wood is not affected by laser radiation. It seems that under this power, the laser does not have energy to bring the temperature which burning the wood.
- Area between 4 and 10 W is the range in which we see great colour changes (darkening) of the surface. It seems that this is the recommended range for pyrography.
- Area between 10 and 24 W is the range in which the resulting colour variation is small, although the power increases mostly. This interval is not economical because it requires high energy consumption with a little colour effect.
- Area over 24 W is the range in which the brightness decreases significantly again. The wood is degrading strongly at these working parameters. It is not recommend to use these values for pyrography because burning wood is deep and it loses its mechanical properties. The colour varies randomly because the material becomes unstable and burned parts are removed from the surface by the cooling system.

Point where the trichromatic components meet is characteristic for grey colour. The black colour is represented in trichromatic components by 0 value for all components.

Another important aspect is related to how to the wood is coloured. At low power staining, the colour is uniform, with no major differences between early and late wood. With increasing laser output power, there appear differences between early and late wood. Late wood is denser and darker than early wood. Due to higher density, the late wood burns slower than early wood. Therefore, with the increasing laser output power, the burning

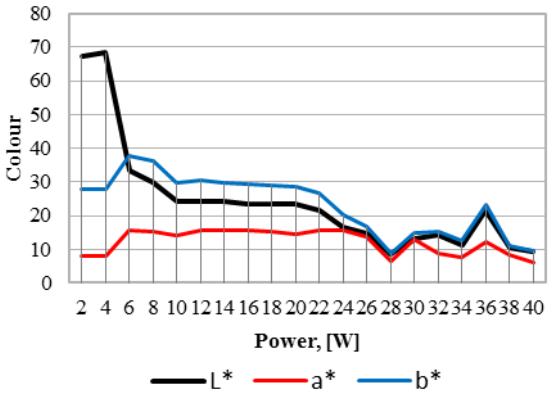

Fig. 2. Colour variation depending on laser power.

wood turns into a negative image of a natural design.

The laser power influences the wood temperature, because a higher power has a greater impact on processed wood. This impact is translating into higher impact forces which cause increasing processing temperature.

5. CONCLUSIONS & ACKNOWLEDGMENT

Because the pyrography represents a wood reaction under temperature influence, the work piece is very important for colour obtaining. It cannot obtain the black colour into strongly degrades wood phase by laser power variation only. This colour is important because it defines the number of nuances which it can be made by pyrography. The black is the limit of this interval.

It was defined the laser output power variation interval for pyrography. This is between 4 and 10 W. It was visually studied the surfaces aspect. The coloration is uniform in the mentioned range above.

The results can be used for mathematical modelling of the studied phenomenon. This

model will be used for work process optimising.

The colour modifications it obtains by varying the others working parameters (scan gap, feed speed), also.

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