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INVESTIGATION OF HEAT TREATED TI-6AL-4V PLATE WITH DIFFERENT POWER BY LASER

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Abstract
In this study, titanium plate surface was applied heat treatment in different powers and different cycle. The microstructure and micro hardness values of the markes formed on the surface of titantum plate were taken. The effects of hardness change on the surface of the material depending on laser power on production parameters were investigated.

Keywords: Titanium, laser marking, hardness, microstructure.

INTRODUCTION

Titanium is at the center of the recent technical developments because of its physical and mechanical properties. Its ability to work in special harmony with human tissue, plays an important role in its use as a prosthesis. Furthermore, corrosive materials are more advantageous than other materials because they do not react with another materials [1-5].
When weight and mechanical properties are compared, we can see Titanium materials provide more advantages over conventional materials. Many fields, especially aerospace industry used this material for its advantages. For this reason Titanium materials were focused by academicians and industries. Pure Ti and its alloys used in many researches. One of this alloy is Ti6Al4V [6-10].

Ti6Al4V materials are important engineering alloy which has been frequently used for like power generation, marine industry, aerospace. Ti6Al4V materials mechanical properties and hardness of surfaces can be changed by heat treatment [11,12]. Laser treatment is one of the mostly utilized method in titanium materials' surface modification. In the literature, surface texture with controllable high frequency light is widely studied [13].

In addition to surface texturing, surface coating can be performed via materials that are similar to the main material with the help of laser surface treatment. Remodification of surface is important for the materials that are in physical contact because of friction effect. Moreover, it is important in medical implant applications on bone structures.

Quin Wang. Et. al. studied the effect of color surface change on Ti6Al4V material hardness by exposing the material to a surface texture that has 2 μm grain size in various frequencies

Andrzej Grabowski Et. al. performed surface texture with laser on Ti6Al4V, stainless steel, aluminum silicon alloy and determined that surface's optic reflections are linked with the production method [14].

C.G.Moura Et. al. investigated oxidation surface of texture area and electrical properties of Ti6Al4V using nanosecond laser [15].

In this study, surface texture is conducted on Ti6Al4V with laser marking for various frequencies then material microstructure and micro hardness are investigated.

EXPOSITION

Laserisse laser marking machine is used in the study. Laser machine's technical properties are provided in Table1.

Table. 1. Technical properties of Laser Marking Machine

Laser Source	Fiber - SPI
Average Power	100W
Beam Quality M^2	< 1,6
Max Peak Power (kW)	>10
Max Pulse Energy (mJ)	>1
Pulse Repetation Frequency Range	1-1000
PulseTune Waveforms	32
Pulse Duration Range(ns)	12-500
Output Power Stability %p-p	<5
Wavelength	1060 nm
Marking Field*	120 mm x 120 mm
Working Distance	163 mm +/-2 mm

Chemical composition of Ti6Al4V plate is given in Table 2.

Table. 2. Chemical Composition of Ti6Al4V

Chemical Composition							
Fe	C	N	O	H	Al	V	Ti
<0,01	<0,01	0,01	0,12	0,004	6,2	4,1	Remainder

Ti6Al4V plate is processed with different frequencies and cycles by laser marking machine. Process conditions and cycles are presented in Table 3.

Table. 3. Technical Data of Process Conditions and Cycles

100 W Constant Power				
Velocity; 2000mm/sn	**Exp. 1**	100 kHz / 1 Cycle	**Exp. 6**	100 kHz / 5 Cycle
Power; %100 (100W)	**Exp. 2**	150 kHz / 1 Cycle	**Exp. 7**	150 kHz / 5 Cycle
Fill Frequency; 0.05	**Exp. 3**	200 kHz / 1 Cycle	**Exp. 8**	200 kHz / 5 Cycle
Filling Count; 3	**Exp. 4**	300 kHz / 1 Cycle	**Exp. 9**	300 kHz / 5 Cycle
Set Angle; 60°	**Exp. 5**	75 kHz / 1 Cycle	**Exp. 10**	75 kHz / 5 Cycle

The texture formed on the material surface as a result of laser marking process is shown in Figure 1.

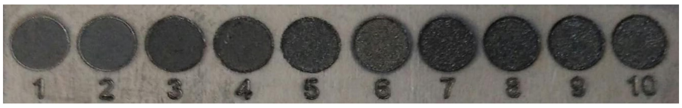

***Fig. 1.** Marked Ti6Al4V material*

Obtained microstructures of material's textured surface using inverted microscope is demonstrated in Figure 2.

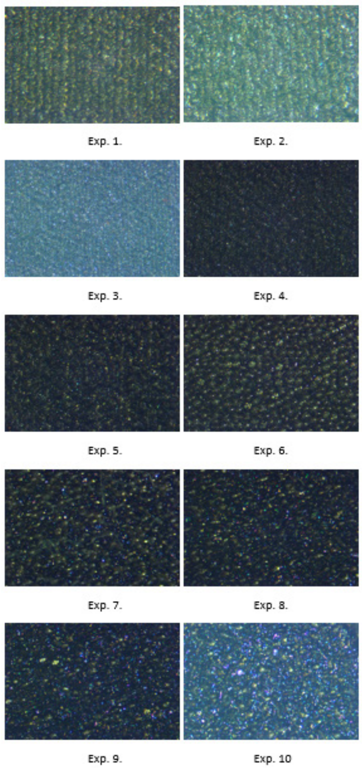

***Fig. 2.** Microstructure of Textured Materials*

Micro hardness tests are applied 200gf load. Tests are applied three times at various locations and the averaged values of all results are shown in table 4.

Table. 4. *Results of Micro Hardness Test*

Vickers Micro Hardness Measurements	
Specimen	**HV value**
Original Ti6Al4V	**410**
1	520
2	575
3	586
4	620
5	486
6	610
7	632
8	637
9	670
10	527

CONCLUSION

When micro structure analyses of Ti6Al4V is investigated it is observed that surface quality is influenced by laser marking frequencies and cycle variations. Moreover, it is found that laser beam depth is also increased.

When experimental results are compared with each other, it is observed that increase in frequency does not have any affect in beam depth for initial cycles. On the other hand, significant increase in beam depth is noticed in 5th cycles. This can be explained with the formation of cooling surfaces because of increase in beam depth.

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