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Treatment of commercial aluminum by Nd:YAG laser

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Abstract

In this work, two types of commercial aluminum alloys (industrial and recovered aluminum) are studied. The surface is irradiated by Nd: Yag laser (λ = 532 nm, with a pulse duration of 15 ns and an energy of 50 mJ). The experimental results show that the hardness profile can be divided into three regions. The melted area is the hardest region, Then, the hardness decreases sharply in the interface region between the melted area and the heat-affected zone.

***Keywords:** Laser treatment, aluminum alloys, Hardness,*

1. Introduction

Even though over 30% of the aluminum produced worldwide now comes from secondary sources (recycled material), the collecting, sorting, and separating of scrap aluminum as well as the processing and upgrading equipment used to convert scrap aluminum and its alloys into new aluminum products and mixtures are studied[1]. The recycled aluminum alloys provides a benchmark in assessing a sustainable vision for positive economic and environmental progress, and it can serve as great reference for educating the next generation of engineers on the demands of sustainable development and the application of life-cycle assessment by industry [2].The Nd:Yag laser radiation is used to improve several material surface hardness, like aluminum, titanium, nickel, cooper and kind of steel (21CrMoV57 and 40C130) targets [3], CdZnTe crystal[4]. The same radiation source is also used to treat some biomaterials[5,6].

In this paper, two comercial aluminum alloys (industrial and recuperated aluminum) are studied. Each alloy contains several chemical elements and it is composed of more than six elements[7]. Although it is a complex material, but we can studied the effect of laser radiation on the surface hardness.

The samples studied are two materials, industrial and recuperated aluminum alloys. They were polished mechanically and cleaned. The chemical composition of each type is obtained by X-ray analysis[4]. The chemical composition of recycled aluminum alloy is Al(72.02 wt %), Si(13.05 wt %), Zn(6.34 wt %), O(4.28 wt %), Mg(2.08 wt %), Cu(1.75 wt %), and Ni(0.48 wt %). The chemical composition of industrial aluminum alloy is Al(83.10 wt %), Cu(5.47 wt %), Fe(4.12 wt %), O(2.71 wt %), Mn(1.74 wt %), Si(1.66 wt %), and Mg(1.20 wt %)[7]. A nanosecond pulsed laser (Nd:Yag) is used to irradiate an aluminum alloy sample (figure 1). The instrument used in this experiment is the Spectrum laser system. The laser used is a Q-Switch Nd: YAG Brilliant (Quantel). The Bar is pumped by flash lamps, and delivers 300 mJ per pulse at λ = 1064 μ m. The dubbing is often made with a crystal KDP output of the laser, and allows for 160 mJ per pulse at λ = 532 nm. A diachronic mirror, positioned behind the crystal doubler, cannot recover the beam at λ = 532 nm.

The measures of the micro-hardness were taken by a semi-automatic micro-durometer, type ZWICK with Vickers penetration

, under a load of. 100 g and connected to a micro-computer that allows the automatic footprint through an appropriate software.

The properties of material studied are reported in the table 1.

2. Experimental

Table1: Main properties of the two alloys studied (compared with pure Aluminum)

	recuperated aluminum	industrial aluminum	pure Aluminum
Density (Kg.m^3)	2816	2614	2700
Microhardness (kg F/mm^2)	118	125	2.75
Thermal conductivity (W/m.K)	128	160	237

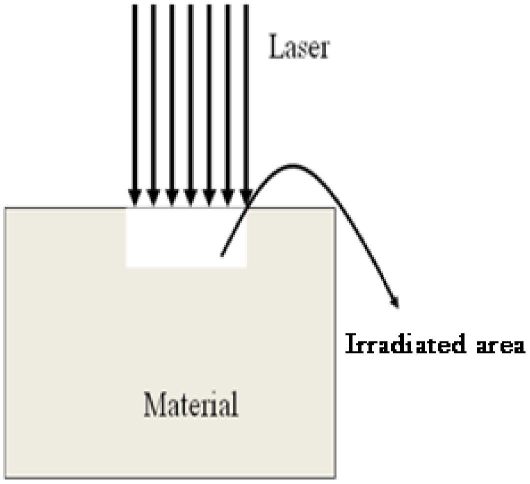

Figure1: Schematic representation of material surface irradiation process.

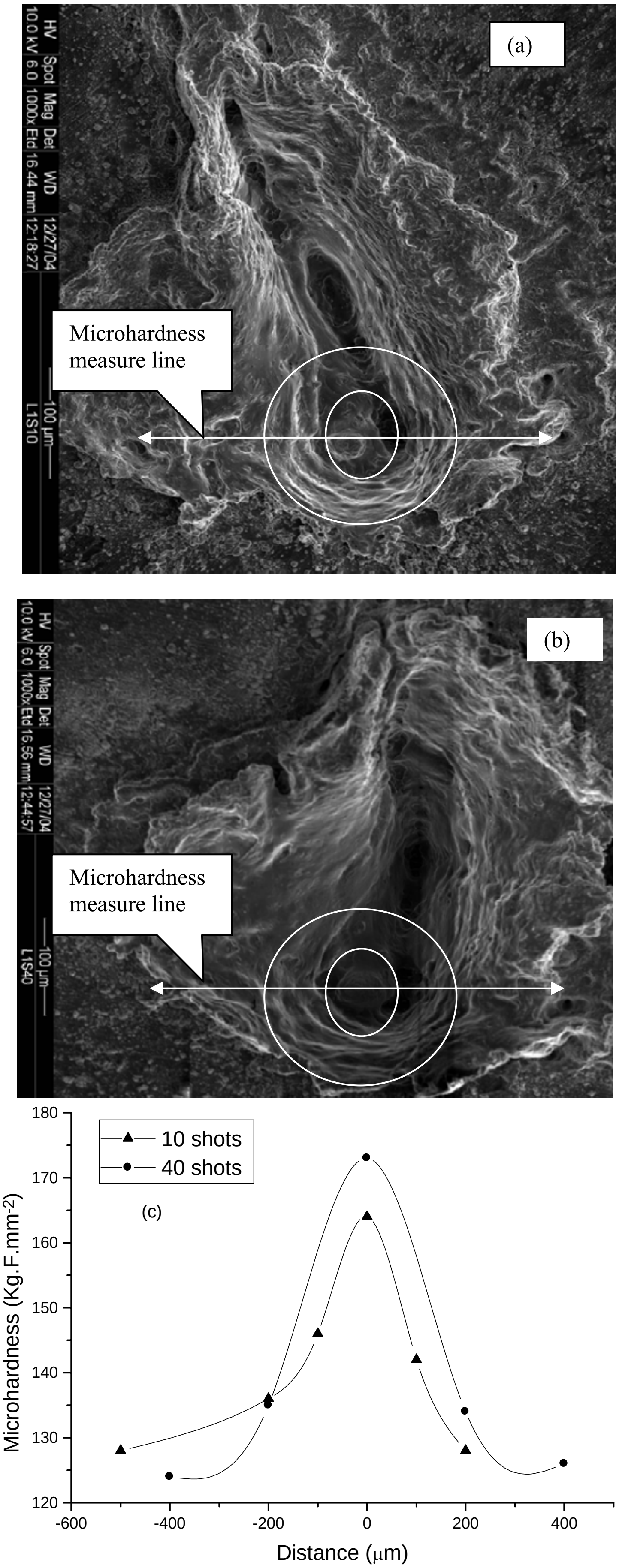

Figure2 : Dependence of the microhardness on the distance from the center to the boundaries of laser spot.

(a) SEM images of irradiated area with 10 shots of pulsed laser
(b) SEM images of irradiated area with 40 shots of pulsed laser
(c) Curves of the microhardnes as a function of distance for both 10 and 40 shots cases according to the two previous images(a and b)

3. Results and discussion

Figure 2 (a and b) shows a Scanning Electron Microscope images of irradiated area, the line indicates the track of the hardness measures, whereas the circles show the three zones. Figure 2(c) represents the hardness curves depending on the distance along the irradiated zone for both 10 and 40 shots of laser pulses. The hardness profile can be divided into three regions:

1. The melted area is the hardest region because the hardness can reach 164 Kg.F.mm^{-2} (for 10 shots) and 173 Kg.F.mm^{-2} (for 40 shots)
2. Then, the hardness decreases sharply in the interface region between the melted area and the heat-affected zone.
3. The hardness gradually decreases from 152 to 130 Kg F/mm2 in the heat-affected-zone

The hardness remains unchanged in the area unaffected, the value of 125 Kg F.mm^{-2} is the same of that of untreated aluminum (see table 1).

On the other hand, the figure 2(c) shows that the microhardness increases with increasing of number of shots; the curve for 40 shots is above that for 10 shots. These results confirm that obtained by other researchers [3].

4. Conclusion

According to this brief study, the microhardness of aluminum alloys (including the commercial aluminum) depends on the spatial distribution of laser energy whatever the form of laser spot. The microhardness takes a maximum value at the center, and then decreases when one goes to the boundaries.

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References

[1] Mark E. Schlesinger, O. J. Ilegbusi, Manabu Iguchi, Walter Wahnsiedler, Aluminum recycling, Ed. CRC/Taylor & Francis, 2000

[2] John A. S. Green, Aluminum recycling and processing for energy conservation and sustainability, Ed. ASM International, 2007

[3] C. Oros, J. Optoelectronics and Advanced Materials, 6, 1, (2004) 325 - 328

[4] A. Medvid, A. Mychko, E. Dauksta, Y. Naseka, J. Crocco, E. Dieguez, doi:10.1088/1748-0221/6/11/C11010, Journal of instrumentation(Jinst), (2011)

[5] B. S. Lee , C. P. Lin , F. H. Lin , U. M. Li , W. H. Lan , J Clin Laser Med Surg. 21(1), (2003)41

[6] J. Tavakoli, M. E. Khosroshahi and M. Mahmoodi, IJE Transactions B: Applications, 20, 1, (2007)1-11

[7] L. Baziz, A. Nouiri, and Y. A. Youcef, J. Laser Physics, 16, 12, (2006)1643.