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## **AUSTENITIZATION OF WELDING BEADS IN A S32750 MADE WITH ND:YAG PULSED LASER THROUGH HEAT TREATMENT**

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**Abstract.** Duplex and super duplex stainless steels, 50% austenite and 50% ferrite, combine the most desirable characteristics of ferritic and austenitic steels, have excellent mechanical and corrosion resistance for a wide variety of media with significant corrosion resistance in water of the sea and other environments containing chloride, due to its high level of chromium, molybdenum and nitrogen. When welded the region of the weld metal of these steels lose their characteristics of mechanical resistance and corrosion due to the imbalance of the ferrite and austenite phases. In the present research the effect of heat treatments after autogenous welding was investigated. Pulsed Nd: YAG to increase the amount of austenite in the weld bead in UNS S32750 super duplex stainless steel plates. A pulsed laser source Nd:YAG, United Winner 150A, was used with a maximum power of 150 W. The welding pulse energy was fixed at 30J, peak power of 2 kW and temporal width of 5 ms in wave form, and descent ramp varying from 20 ms with frequency variation and displacement speed. Pure argon with flow rate of 22 l / min was used as protection gas. The microstructural characterization was performed by optical microscopy applying Behara modified for surface attack. The results showed the obtaining of 30% of austenite.

**Keywords:** duplex, Nd:YAG, heat treatment, laser, austenite, ferrite

### **1. INTRODUCTION**

According to Ventrela an extremely important problem encountered in environments where materials are exposed to corrosive atmospheres is the selection of a resistant material. For this purpose, industrial parts and components are produced from stainless steel or even covered with thin sheets of the same or other materials resistant to corrosion, such as Ni alloys. Duplex and super duplex are types of stainless steels developed to have high mechanical strength and corrosion resistance in extremely aggressive environments (containing chlorides, acids, etc.). Its microstructure is divided between approximately 50% austenite and 50% ferrite. Elhoud explains that super duplex differs from duplex in its chemical composition (with increasing amount of molybdenum, nickel and chromium) and its mechanical properties (higher tensile strength and tensile strength). For Wainer welding is an area of knowledge of great technological importance, and can be defined as a process of joining two metal parts, using a heat source, applying pressure or not.

One of the most modern processes and the one of laser welding, that although they have a high cost in comparison to the conventional processes has a high rate of production and good quality of union where its cost is diluted in the greater quantity produced and it makes the process economically competitive. Among the welding processes, the Nd: YAG pulsed laser welding process has grown significantly in recent years. Machado points out that its flexibility and speed are very important factors taking into account the competitiveness of the market and the reduction of costs on a large scale (4). One of the problems of pulsed laser welding in an autogenous process in super duplex steels and phase imbalance, where the weld bead is practically ferrite with an average of 8% of austenite as seen by Franzini. The use of descent ramps does not have as much influence on austenitization, but avoid the appearance of voids in the beads with overlays of 50%, as demonstrated by Salgado Junior, so they were used. The present research investigated the effect of thermal treatments on welding 1.5 mm thick sheets of UNS S32750 super duplex stainless steel.

### **2. MATERIALS AND METHODS**

For the production of weld beads, we used a United Winners model UW 150A solid state laser Nd:YAG laser in the pulsed condition shown in Fig. 1



Figure 1. Laser source, in the background the cooling system.

The equipment also has a head with manual height displacement a table with automatic displacement with variable speed, a support with displacement transversal to the manual table and a camera to follow the positioning of the samples as shown in Fig. 2.



Figure 2. Assembly of the heads, tables and fixation of the test piece

The samples of UNS S32750 super duplex stainless steel were cut in a rectangular format in the approximate dimensions of 20mmx25mm and positioned so that weld beads are made in the direction of lamination of the plates.

The basic parameter was chosen from the work of Salgado Junior, in which there were no voids in the weld bead, where we have a peak power of 2 kW with a temporal width of 5 ms generating a rectangular wave, a descent slope of 20 ms, a frequency of 4.5 Hz and table speed of 2.5 mm/s as shown in Fig. 3.

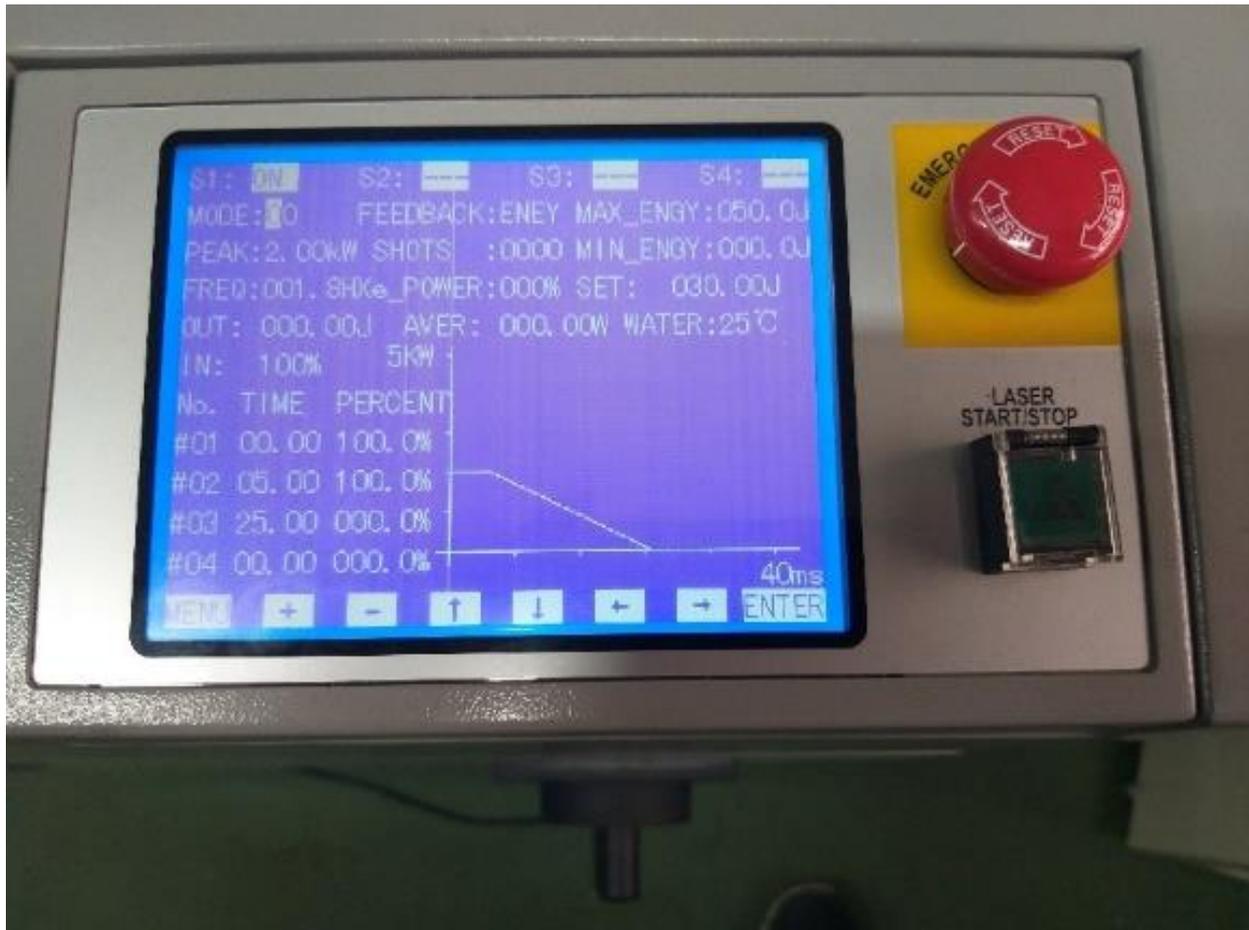


Figure 3. Laser source panel with one of the parameters set.

In Fig. 4 we can see one of the specimens with the strands, these specimens were divided into two parts so that we could obtain samples without treatment and heated in a muffle oven at 400°C for one hour.



Figure 4. Weld beads.

After the heat treatment the specimens were divided in the middle in the transverse direction to the beads by doubling the amount of samples, embedded in bakelite, a test specimen of a non-welded region was also produced for comparison of microstructure, then sanded with grana 220, 340, 400, 600 and 1200, polished in flocked felt with alumina in suspension of 1  $\mu\text{m}$  size and attacked with the modified Behara reagent: 20 ml of HCl, 80 ml of distilled water, 1.0 g of potassium metabisulfite, plus 2.0 g of ammonium bifluoride.

Then the specimens were taken to the optical microscope to be photographed the strings and an analysis was done through austenite quantity measurement software.

### 3. RESULTS AND DISCUSSION

Fig. 5 to 7 show the samples with the strands and the micrographs where we can see the phases ferrite, austenite.

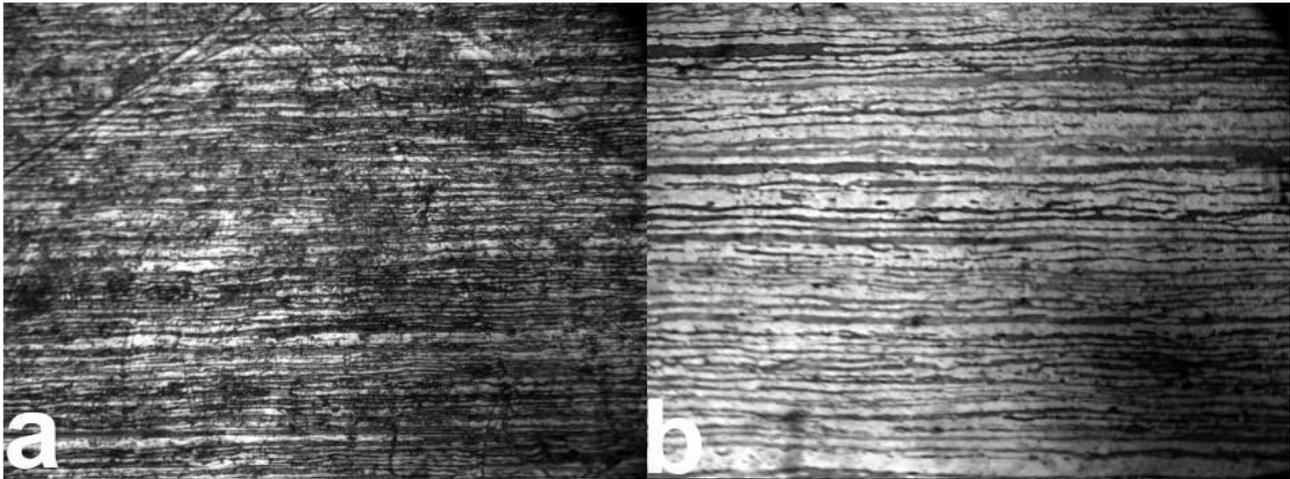


Figure 5. Base metal (a) without treatment, (b) at 400 ° C. Dark region ferrite, austenite light region.

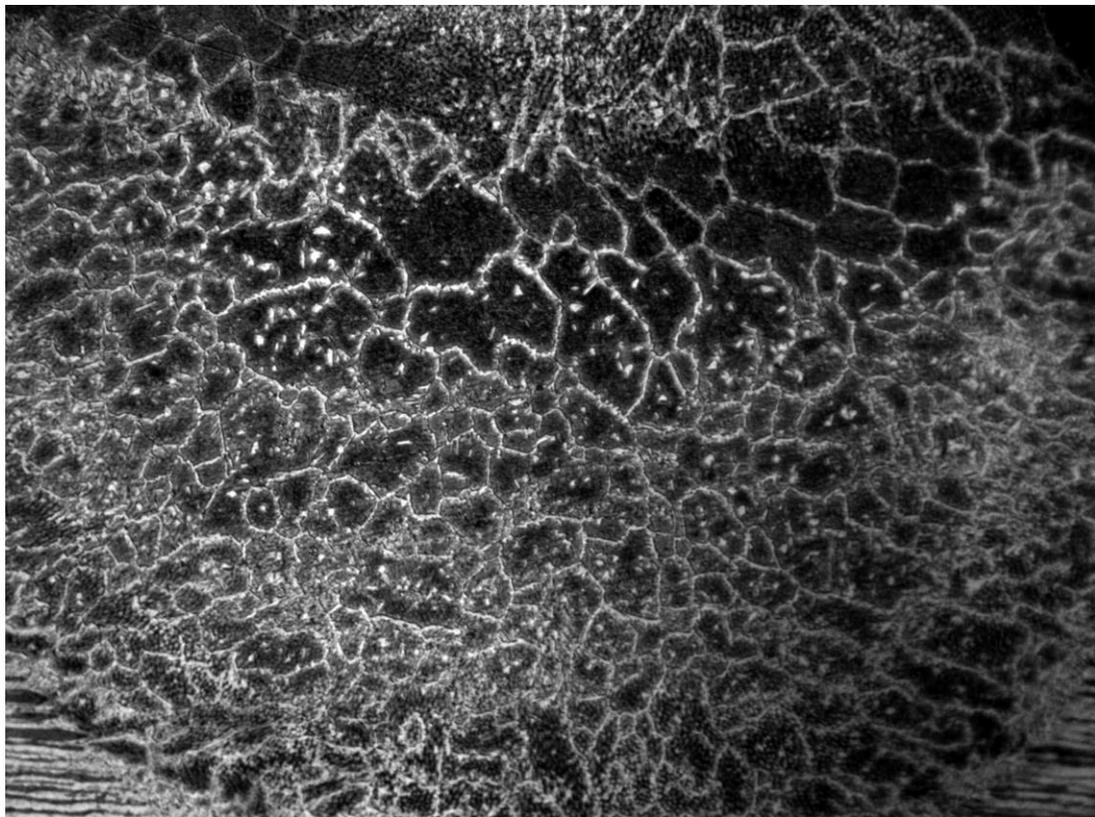


Figure 6. Lower part of weld bead treated at 400 °C for 1 hour, the austenite clear part.

It can be seen in Fig. 5 that the base metal both at 400 ° C maintained the same characteristics of the material as received.

In Fig. 6 we see that the treated beads have more defined austenite contours and in greater quantity than those seen by Franzini.

The phase counting is shown in Table 1. When compared to Franzini's dissertation which obtained on average 8% austenite in the bead, the heat treatment resulted in an average of 30% austenite in the lower section of the weld bead.

Table 1. Phase count in the samples.

Sample	Austenite	Ferrite
1	30.53%	69.47%
2	30.20%	69.80%
3	31.99%	68.01%
Mean	30.91%	69.09%
Standard Deviation	0.95%	0.95%

#### 4. CONCLUSIONS

We observed in this study that have appreciable heat treated beads improvement in swing phase winding in the lower section thereof.

#### 5. ACKNOWLEDGEMENTS

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