ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XIII, NR. 1, 2006, ISSN 1453 - 7394

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Laser Surface Thermal Treatment Applied to Stainless Steel X5 CrNi 18 10

The paper propose to mark out the influence of different control parameters of laser beam light over the entire surface thermal treatment applied and, also, the physical and technological proprieties of the stainless steel obtained layer.

1. Introduction

By elaborating the Plan of Experiences, together with the experimenting strategy, the used method being the method Taguchi, a numerical modulation method, often used in the quality management, it could be after woods very easy to study the influence of laser parameters who had been varied and also the influence of the interactions between these parameters over the entire process and over the obtained results. The researches that have been made focused on the depth of the treated layer and its hardness.

Despite the high costs of construction and sustenance of laser installations and of the restrain area of action of the laser beam, remain the substantial advantage to be able to be applied in difficult locations, fact impossible to accomplish by classical treatments and, also, the superior realizing speed of treatments. Another advantage would be the possibility of modifying the structure on controlled areas, without affecting the adjacent zones from the treated parts.

2. Analysis and Results

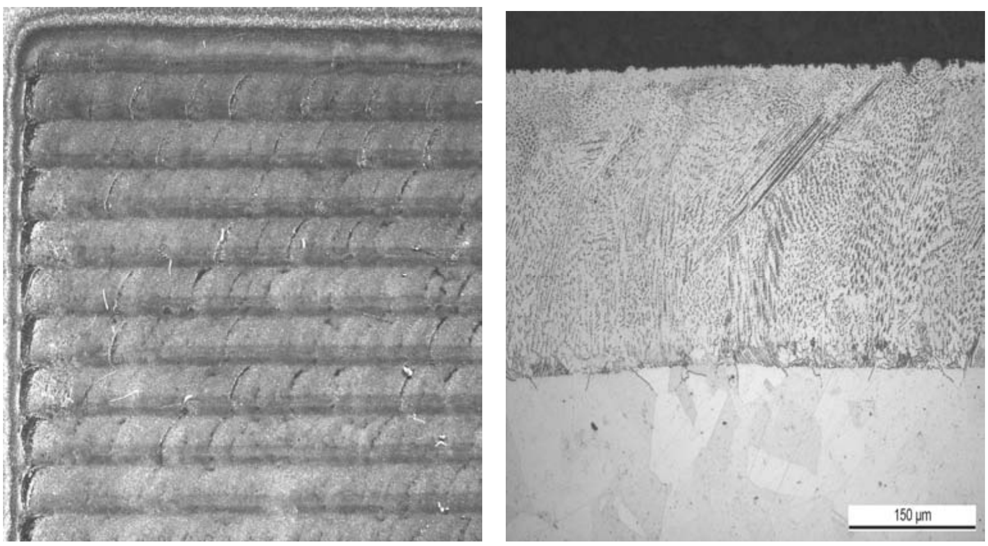
The classical thermal treatment for this type of stainless steel presume a 880^0 C austenitisation temperature and a martensite hardening at 20^0 C, using oil as cooling medium.

For the 8 tests considered for the experience plan, it has been used sheet metal of X5CrNi 18 10 stainles steel, using different values of the essential parameters of the laser (power, displacement speed and distance of focalisation). For each of these 3 factors had been utilised 2 diferrent values, presented in Table 1, toghether with the obtained values for the depth and the hardness of the treated layer.

Table 1.

Nr test	Energy [W]	Speed [mm/min]	Focalization point [mm]	Depth [µm]	Hardness [$HV_{0,2}$]
1	690	1000	10	90	308,3
2	690	1000	8	100	304,3
3	690	750	10	200	310
4	690	750	8	300	308,3
5	780	1000	10	250	310,6
6	780	1000	8	200	312
7	780	750	10	300	316
8	780	750	8	350	327,3

The purpose of the research was to obtain a layer with as high as possible depth and hardness.



a. surface b. section

Figure 1. The surface treated layer (optical microscope).

Due the carbon percentage (0,05% C) and the alloying elements percentages (18,2% Cr and 8,6% Ni), to the gas type used for the process (helium) and to the warming/cooling high speed (the high speed cooling being owed to a small dimensions area width and depth on one side, and blasting a great gas volume at high pressure), has been aquired hardnesses from 185,4 $HV_{0,2}$ (initial) up to 327 $HV_{0,2}$.

While the first four attempts were realized in solid state, the obtained treated layer containing crystalline grains with 5-6 synopses (test 1 and 2) and 6-7 synopses (test 3 and 4), the others four were realized in liquid state, in the solidification layer obtaining complex carbide precipitations with dendritically orientation, as shown in figure 2.

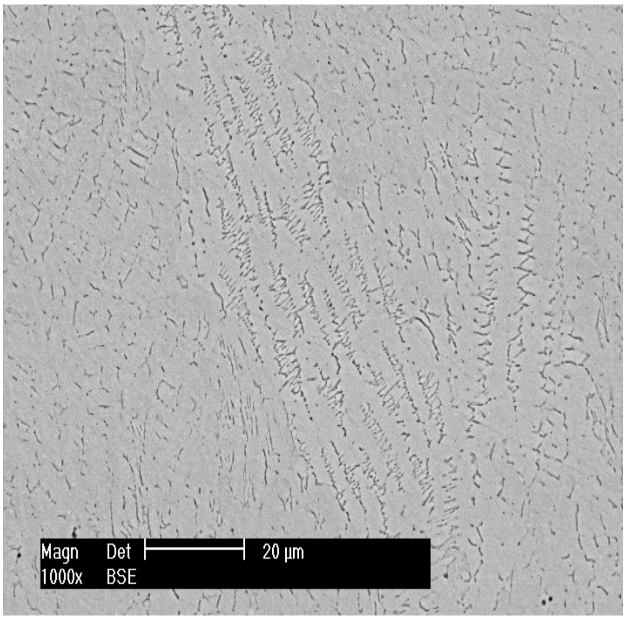


Figure 2. Dendritically structure in the treated layer (electronic microscope).

Because of the high percentage of Chrome, the treaded layer contains only some residual austenite, the hardness raising being due to the complex carbide precipitations. By the same process, it can be realized a superior hardness for the treated layer using a stainless steel only with a diminished percentage of Chrome (the most 16-17%). At this percentage, exist the possibility to obtain after the treatment a lot of martensite in the crystallized layer, fact that increase a lot the hardness.

As we can observe in table 1, the maximum depth and hardness was obtained in the test 8, having as values 350 [µm] and 327,3 [$HV_{0,2}$].

3. Conclusion

In conclusion, the installation power and the displacement speed of the laser beam are the most important factors influencing the depth and the hardness of the treated layer. Therewith, the interaction between these two hasn't the main influence over the process as the influence between each of them and the distance between of the focus point of the laser beam and the surface to be treat.

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