AN ANALYSIS OF THE PROPERTIES OF CHROMIUM - BASED COATINGS DEPOSITED BY TIG WELDING

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Abstract

The paper deals with the investigations which consisted in conducting the process of hardfacing of steel sheets from X10CrMoNb9-1 steel. There were two different coatings marked to sheets through the TIG method. The material used on the weld overlay was as follows: W CrMo2Si, W CrMo91. After hardfacing of steel sheets, the examined samples have been cut from the sheets, from which the metallographic samples have been produced. In the paper, there were photographs of microstructures of metallographic samples attached, which were taken during the microscopic observations. The observations using optical microscope Nicon Eclipse MA 200 compared changes in surface microstructure and the effect of TIG welding. The process of hardfacing was conducted on the Electric Invertec V270 device - T pulse.

Keywords: Superficial layer**,** hardfacing, coating, TIG welding, microstructure

1. INTRODUCTION

Due to the present trend in constructing machines, alloys of high durability, wear resistance and corrosion are being sought. There are many of methods leads to surface quality improvement related to the modification of surface roughness properties [1,2], mechanical properties of surface, chemical composition surface layer [3-5], electrical discharge alloying method [6], welding processes, laser processes [7-9], microwelding or hybrid welding processes [10-13], thermal spraying [13] or detonation methods. An important issue is the machining of such materials, cutting such materials may prove difficult because most of them are hard to cut. In these circumstances it is advisable to use non-traditional processes such as non-traditional processes [14] or surface finishing process. In particular is difficult machining of metal matrix composite materials. In these cases is applying or hybrid machining. Nowadays, many research centers conducts investigations and the modelling of processes to improve its efficiency.

In spite of the constant development of modern construction materials as well as the technologies of processing it, the process of hardfacing is still aninseparable element of the production processes. The consumption of the machinery part is the damage of surface of the machine element - it is the reduction its functional properties of the working surface. It consists in a gradual loss of material from the surface of the “working” element which is caused by its move with regard to substance maching with it, or other element and with many physical and chemical processes which result mainly from its exploitation. This process is complex. Hardfacing is the way of regeneration of the machines parts and other devices which underwent partial wear and tear as a result of the usage.

The increase of the endurance and the possibility of conducting regenerating hardfacing allows to reduce the costs of the production and exploitation of the machines and devices used in many fields of our life, for example, in the teeth of excavators, mining drills, cast-iron pump pistons, lead coated walls of the containers used in the chemical industry.

2. HARDFACING

Hardfacing is the welding process consisting in the metallurgical melting of the hardfaced surface (weld overlay) and arranging it on the melted base. The fulfillment this condition is significant for getting the appropriate depth of blending which guaranteed the adhesion of the hardfaced surface with the material of base. The aim of this action is to set the hardfaced product the appropriate features such as: wear or corrosion resistance. It can be also used to regenerate an object by the improvement of its geometry or the supplementation of losses caused by its exaggerated. The participation of base surface in the weld overlay depends on many factors, for example, on the hardfacing method used by the operator or selected parameters. The key factor is blending depth and the degree of mixing material of base surface with weld overlay, which depend on the chemical composition and chosen hardfacing parameters. Depending on the physics of the process, applied factors subserving thawing and the realization of the process, one can distinguish many hardfacing methods. One of these methods is called the TIG method (Tungsten Inert Gas), which relies on arched hardfacing with the non-consumable electrode in the gas shield. In addition, the hardfacing material is being introduced into the area of the bow glowing between non- consumable solid tungsten electrode and hardfacing base.

3. THE RESEARCH OBJECT

The aim of this thesis was to analyse the hardfacing by the use of the TIG method and high-chromic electrode on the metal sheets from X10CrMoNb9-1 steel. Chemical composition of X10CrMoNb9-1 steel show in table (**Table 1**).

Table 1 Chemical composition (%) of X10CrMoNb9-1 steel

C	Si	Mn	Cr	Mo	Ni	V	Other
0.08-0.12	0.2-0.5	0.3-0.6	8-9.5	0.85-1.05	0.06-0.1	0.18-0.25	N=0.03-0.07

The material used on the weld overlay was as follows: W CrMo2Si, W CrMo91. After hardfacing the metallographic samples have been produced and subsequently, they were microscopic observed. The device which were used to apply the coatings by the TIG method was the Electric Invertec V270-T pulse. The machine is presented in the picture (**Figure 1**).

Figure 1 The Electric Invertec V270-T pulse

Chemical composition the deposited weld metal of W CrMo2Si show in table (**Table 2**) and W CrMo91 in (**Table 3**).

Table 2 Chemical composition (%) the deposited weld metal of W CrMo2Si [15]

C	Mn	Si	Cr	Mo	P	As	Sb	Sn
0.08	0.90	0.60	2.50	1.00	≤0.01	≤0.01	≤0.005	≤0.006

Table 3 Chemical composition (%) the deposited weld metal of W CrMo91 [15]

C	Mn	Si	Cr	Mo	Ni	Nb	V
0.1	0.3	0.5	9.0	0.9	0.5	0.06	0.2

4. THE RESEARCH

In the process of hardfacing there was argon used as a protective gas. The volume flow rate of protective gas amounted about 10 dm3 per minute. The current amounted 180 A. After the hardfacing process, there were the metallographic samples produced, which were observed by the inverted metallographic microscope Nicon Eclipse MA 200, which is presented in the picture (**Figure 2**).

Figure 2 The inverted metallographic microscope Nicon Eclipse MA 200

The macroscopic analysis of cut elements showed that the weld overlay is combined to the surface material. In addition, one can observe the transitional layer which is typical for hardfacing coatings. In the picture (**Figure 3**) there is presented the microphotography of joining the hardfaced object with the deposited weld metal W CrMo2Si. The surface layer of the base consists of one coat, the second layer is formed by hardfacing coating. Between coating and base, there is a layer which has got indirect properties and the heat- affected zone. In the picture (**Figure 4**) there is presented the microphotography of joining the hardfaced object with the deposited weld metal W CrMo91.

Figure 3 Microphotography of X10CrMoNb9-1 steel with the deposited weld electrode alloy W CrMo2Si by TIG welding

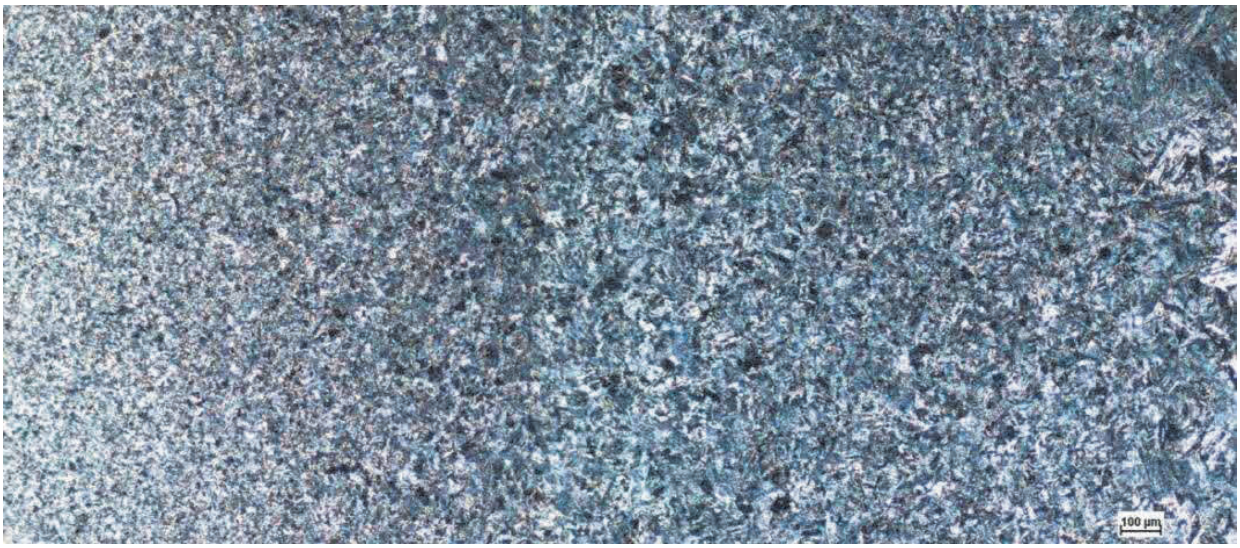

Figure 4 Microphotography of X10CrMoNb9-1 steel with the deposited weld electrode alloy W CrMo91 by TIG welding

The microhardness measurement was conducted on the NEXUS 4303. The averaged result of microhardness measurement by Vickers method show in table (**Table 4**) and table (**Table 5**).

Table 4 The averaged result of microhardness measurement (W CrMo2Si)

C	Microhardness $HV_{0,5}$
Coating	425
Transitional layer	440
Base material	419

Table 5 The averaged result of microhardness measurement (W CrMo91)

C	Microhardness $HV_{0,5}$
Coating	459
Transitional layer	451
Base materaial	424

4. CONCLUSIONS

The technology of hardfacing is characterized by the accurate metallurgical fusion of weld overlay with melted surface material. As a result of the TIG method hardfacing, weld overlay is characterized by an excellent connection with metal surface which comes directly from rendering down hardfacing material with the original material. The microstructure of the layer hardfacing by the TIG method is characterized by 4 layers, such as: weld overlay, the transition layer, heat-affected zone and the original material. If the process of hardfacing is conducted properly, the coating does not include any pores or other faults. The participation of the surface in a weld overlay is dependent on many factors, for example, on the hardfacing method used by the operator or applied parameters and hardfacing conditions. The composition and the features of hardfacing layer and the one of the original material, due to rendering of the base material down, the layers are changing the direction from the external layer of weld overlay, all the way to original material.

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