**ANALYSIS THE HARDNESS AND WEAR RESISTANCE ON MATERIAL OF ELECTRODE WITH NANO COATING**

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**ABSTRACT**

The aim of this paper is developing of manufacturing for electrodes with the suitable nano coating method. The importance of nano composite coating materials are TiN, Al2O3, SiC, TiCN+C, TiN+Cr, and TiCN used to give overlay for improve hardness and wear resistance of electrode materials. The importance of the test like viker hardness, surface hardness and wear resistance are analysis after the fulfillment of Nano Composite coating over that electrode material. The main importance of nano coating electrodes is used in industries is like Automobile and Production to prevent the corrosive resistance.

Keywords: electrode, manual arc welding, nano-coating, weld overlayed layer, Vickers hardness, wears resistance

**INTRODUCTION**

Arc welding is a process suitable to increase the hardness wear resistance of surfaces of parts and tools. So the weld overlay can be purposed for prevention or repair. The process is especially efficient when more different modifying additives are introduced in the weld overlay metal. The additives can be introduced through the coating of the welding electrodes. The study area presents innovative techniques for manufacture of electrodes for arc manual welding containing different types of nano-particles (modifiers) in the coating. Herein are also presented the results from the testing of hardness and wear resistance of claddings over layer using nano-coating electrodes.

The first review of the reference literature available reveals numerous studies on the effect of titanium-containing nano-particles on the technical characteristics of the metal after weld overlay. Most area of studies use titanium dioxide, titanium, titanium carbonitride [1],and silicon carbide [2] as nano-modifiers. It is found that the increased. The quantities of titanium-containing inclusions lead to changes in the micro-structure of the metal thus improving its mechanical properties (hardness, wear resistance) [3]. The increased concentration of titanium in the weld overlayed metal increases the concentration of titanium in these inclusions too. [4]. The examined is the effect of titanium [5] on the properties of the weld overlayed metal at 1.4% and 2% levels of manganese. Next the mechanical properties of the weld overlayed metal are improved [6-10], largely at medium concentrations of nano-particles, which is explained with the increased level of acicular ferrite and the finer microstructure. The significantly improved mechanical properties, such as high hardness and toughness, are probably due to the fine grain microstructure and redistribution of internal stresses resulting from the added substances in the form of nano- powders with predominant particle size distribution measuring several tens of nanometers [11,12].

**MANUFACTURE OF NANO COATING ELECTRODE**

The nano-coating electrodes for weld overlay are developed based on electrode type Е7018. It belongs to the group of electrodes for weld overlay of layers with higher requirements for wear resistance. [13].Materials for the coating of the electrodes delivered is graded according to the technical requirements for each of them individually. Preliminary chemical analysis and granulometric analyses are carried out. Used is potassium water glass with content as per the requirements of the technical specification. Selected is electrode wire with diameter Ø4 and length 450mm.

The materials are dosed in accordance with the formulation for manufacture of electrodes type Е7018. Nano-materials are input at a certain point in the implementation of the technology, taking into account the specific particle size of material.The dry homogenization is carried out manually with a blender. The nano-materials for each sample are added immediately before blending. The wet homogenization is carried out in "S" blender with volume up 2,5 kg.

Then, the sample coating is dry blended, and then water glass is added in trickle. The coating thus prepared is poured into a suitable container and fed to the extrusion process.



The extrusion press (Fig.1) is set for electrodes with dimensions Ø4/450 mm.

The extruded electrodes are passed through the trimming device. The concentricity of the coating is completely checked using a tool that is calibrated for the particular diameter. The first and the last electrode are removed because since their coating is usually incomplete or uneven stage.

The types of nano-coating electrodes according to the amount and the type of nano-modifier is shown in below Table.

|  |  |  |
| --- | --- | --- |
| SampleNo | Nano modifier | Quantity,% |
| 1 | Reference electrodeE7018 | - |
| 2 | TiN | A |
| 3 | Al2 O3 | A |
| 4 | SiC | A |
| 5 | TiCN+C (coatedwith carbon) | A |
| 6 | TiN+Cr (coatedwith chromium) | A |
| 7 | TiN | A/2 |
| 8 | TiCN | A/2 |
| 9 | Al2O3 | A/2 |
| 10 | SiC | A/2 |

**EXPERIMENTAL TEST OF HARDNESS OF THE WELD OVERLAYED METAL**

The final weld overlay, half of the overlapped surface is polished, as is shown in Figure. And The hardness measurements are carried out according to Vickers hardness test in eight points as per the regular procedure.

|  |  |
| --- | --- |
| Nano Modifier | Average value of HV |
| Reference electrodeE7018 | 328.4 |
| TiN | 486.1 |
| Al2 O3 | 436.3 |
| SiC | 404.9 |
| TiCN+C (coatedwith carbon) | 374.2 |
| TiN+Cr (coatedwith chromium) | 642.4 |
| TiN | 462.3 |
| TiCN | 422.5 |
| Al2O3 | 441.2 |
| SiC | 571.0 |

The overall estimated is the value change of hardness of each sample related to the basic Sample No 1. The highest value 642.4 is achieved in Sample No 6 where the nano-coating introduced with the coating of the electrode is titanium nitride coated with chromium. The most of materials most samples with nano-modified overlayed surface also exhibit increased hardness in the range from 400 to 600 ranges.

**TRIBOLOGICAL METHOD WEAR RESISTANCE TEST**



The two authors assess the wear resistance of claddings using our own methodology described in [16, 17]. It consists in measurement of the mass wear of samples after that a number of wear cycles and estimation of wear intensity and wear resistance for the travelled path of friction. The comparison upon the parameter wear resistance is made under invariable test conditions.

The methodology for testing of wear resistance is based on measuring the integral (total) loss of mass of the test sample at exactly the same conditions of contact interaction of the sample with the abrasive surface: normal loading, sliding speed, contact area, road of friction, dimension and hardness of abrasive particles. By measuring the mass wear using the developed methodology are estimated the rate of mass wear and the intensity of mass wear resistance.

The samples for the testing of wear resistance are cylindrical with diameter 8mm and length equal to the thickness of the cladded plate. The cylinders are cut out using water jet abrasive technology in order to avoid any possible deformations and stresses from undesired heating. The method for testing is implemented using the device shown in Fig. 8, which operate under kinematic scheme "finger-disc" [23].

The below table shown the overall wear resistance values by using the Tribotester.

|  |  |  |
| --- | --- | --- |
| Nano Modifier | Wear m, mg | Wear resistance *Ih* |
| Reference electrodeE7018 |  110.7 |  0.44.106 |
| TiN | 146.4 | 0.33.106 |
| Al2 O3 | 112.7 | 0.43.106 |
| SiC | 139.5 | 0.35.106 |
| TiCN+C (coatedwith carbon) | 131 | 0.37.106 |
| TiN+Cr (coatedwith chromium) | 78.6 | 0.35.106 |
| TiN | 97.9 | 0.49.106 |
| TiCN | 92.2 | 0.52.106 |
| Al2O3 | 125 | 0.40.106 |
| SiC | 94.4 | 0.51.106 |

The results from the testing for wear resistance are shown in above Table. As is seen, the best results are achieved in Sample 6 where the increased hardness

**CONCLUSION**

Developed is innovative technology for manufacture of nano-modified electrodes for manual arc welding belonging to the group of electrodes for weld overlay of wear resistant surface layers, and trial amounts thereof are manufactured in experimental conditions. A significant increase of hardness, correspondingly with 56% and 38%, is observed in Samples No 11 and No 10, compared to the reference sample. The overlayed metal in Sample No 11 is nano-modified with titanium nitride coated with chrome, and that of Sample No 10 is nano-modified with silicon carbide. Comparative study of samples for wear resistance is carried out using the method of accelerated surface wear with fixed abrasive. The highest wear resistance (70% higher than that of the reference sample) is achieved in the layer overlayed using electrode Sample No 11.There are certain deviations in hardness and wear resistance that are possibly due to the presence of some sub-surface imperfections revealed through ultrasound non-destructive testing. The nano-modification of surfaces through weld overlay with electrodes for manual arc welding results in considerable increase of hardness and wear resistance of the overlayed layers modified with nano sized particles of TiN coated with Cr.

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