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

K.M. Alex Raja, Faculty of Mechanical Engineering, VV College of Engineering, Tirunelveli, India

S. Vignesh, Faculty of Mechanical Engineering, Sir Issac Newton College of Engineering & Tech, Nagapattinam, India

**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.

|  |  |  |
| --- | --- | --- |
| Sample  No | Nano modifier | Quantity,  % |
| 1 | Reference electrode  E7018 | - |
| 2 | TiN | A |
| 3 | Al2 O3 | A |
| 4 | SiC | A |
| 5 | TiCN+C (coated  with carbon) | A |
| 6 | TiN+Cr (coated  with chromium) | A |
| 7 | TiN | A/2 |
| 8 | TiCN | A/2 |
| 9 | Al2O3 | A/2 |
| 10 | SiC | A/2 |

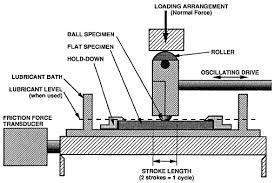
**EXPERIMENTAL TEST OF HARDNESS OF THE WELD OVERLAYED METAL**

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 electrode  E7018 | 328.4 |
| TiN | 486.1 |
| Al2 O3 | 436.3 |
| SiC | 404.9 |
| TiCN+C (coated  with carbon) | 374.2 |
| TiN+Cr (coated  with 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 electrode  E7018 | 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 (coated  with carbon) | 131 | 0.37.106 |
| TiN+Cr (coated  with 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.

**References**

1. R. S. Abdel Hameed, Abd-Alhakeem H. Abu-Nawwasb, H. A. Shehataa, Nano-composite

as corrosion inhibitors for steel alloys in different corrosive media, Pelagia Research Library,

Advances in Applied Science Research, 2013, 4(3):126-129

2. H.A. Jehn, Improvement of corrosion resistance of PVD hard coating substrates, Surface

and Coatings Technology 125 (2000) 212-217.

3. A.J. Novinrooz, H. Seyedi, M.M. Larigani, Microhardness study of Ti(C,N) films by

Hallow Cathode Discharge Gun, Journal of Achievements in Materials and Manufacturing

Engineering 14 (2006) 59-63.

4. M.I. Jones, I.R. McColl, Effect of substrate preparation condition of TiN coating by RF

sputtering, Surface and Coatings Technology 132 (2000) 143-151

5. A.J. Novinrooz\*, N. Afshari, H. Seyedi, Improvement of hardness and corrosion resistance

of SS-420 by Cr+TiN coatings, Journal of Achievment in Materials and Manufacturing

Engineering, Volume 23, Issue 1, July 2007,

6. V. Dyakova, Yo. Kostova, Comparative Study on the Corrosion Resistance of Specimens

from Non-Modified and Nano-Modified Steel GX120Mn12, Engineering Sciences, Book

1/2018, Year LV., DOI:10.7546/EngSci.LV.18.01.05

7. T. Simeonova, M. Tongov and G. Avdeev, Microstructure and properties of NiCrBSiC

overlay coatings deposited by plasma scanning process, WIT Transactions on the Built

Environment Volume 137, 2014, Pages 553-564 International Conference on High

Performance and Optimum Design of Structures and Materials, HPSM/OPTI 2014; Ostend;

Belgium; 9 June 2014 through 11 June 2014; Code 105905 , ISSN: 1743-3509, DOI

10.2495/HPSM140511

8. Tashev P., Kondov H., Lukarski Y., Tasheva E., Development of nanomodified electrodes

for manual arc welding, hardness of the overlay layer, Engineering Sciences, year LII, 2015,

№ 3, Scientific journal "Engineering sciences", Bulgarian Academy of Sciences, p. 71, ISSN

1312-5702. (in Bulgarian)

10

9. Tashev P., Kondov H., Tasev A., "Technological properties of nano-modified electrodes

for manual arc welding", ISSN 1313-8308, Collection of Papers, pp. 75-79 Fourth National

Conference with International Participation "Metal Science, Hydro- and Aerodynamics ,

National Security '2014', 23 - 24 October 2014, Sofia. (in Bulgarian)

10. Tashev P., Kondov H., Tasheva E., Kandeva M., Study on hardness and wear resistance of

layersoverlayed using electrodes with nano-modified coating, International Journal of

Engineering and Applied Sciences (EAAS); pp 01 - 06 Vol 06. No. 04, 2015; Islamabad,

Pakistan, ISSN 2305-8269.

11. Tachev P., Kondov H., Kandeva М.,.Tasheva E., Wear-resistance study of nano-modified

coatings by tig surfacing process, SERBIATRIB ’15, 14th International Conference on

Tribology, Belgrade, Serbia, 13 – 15 May 2015, ISBN: 978-86-7083-857-442.

12. Tashev P., Kondov H., Tasheva E., Tasev A., Durability of nano-modified layers

produced by manual arc overlay welding, The 3rd Organizers South-East European Welding

Congress, “Welding and Joining Technologies for a Sustainable Development and

Environment”, , June 3-5, 2015, Timişoara, Romania, pp 267-271, ISBN 978-606-554-955-5.

13. Tashev P., Kondov H., Lazarova R., Dimitrova R., Research on Nanomodified Layers

obtained in Manual Arc Welding, Collection of Reports, 28th International Scientific

Conference of the Faculty of Mechanical and Manufacturing Technology of the Technical

University of Sofia "70 Years of MTF" 11 - 13 September 2015, Sozopol, p.197-205, ISSN

978-619-167-178-6. (in Bulgarian)

14. Tashev P., H. Kondov, S. Valkanov, E. Tasheva, Scanning electron microscope

examination of layers weld overlaid with nano-modified electrodes, Academic journal

“Mechanics Transport Communications”, volume 15, issue 3/1, 2016, article No 1331, ISSN

1312-3823 (print), ISSN 2367-6620 (online).

15. Kolarov, P. Tashev, Ultrasonic comparative assessment of internal incompleteness in

welded nanomodified layers, ISSN 1312-4897, Acoustics, year XVI, issue 16, 2014, National

Scientific and Technical Conference "Acoustics" 2014, 28-29.11.2014, TU Sofia, pp. 48-53.

(in Bulgarian)

16. Mara Kandeva, Boryana Ivanova, Abrasive Wear And Wear-Resistance Of High Strength

Cast Iron Containing Sn Microalloy International Journal of The Balkan Tribological

Association, 4, Vol. 4, 2013, pp 559-547

17. Ilyan Peichev Il., Mara Kandeva, Emilia Assenova, Vyara. Pojidaeva, About the

Deposition of Superilloys by Means of Supersonic HVOF Process, Journal of the Balkan

Tribological Association, № 3, Vol.17 , 2011 pp 380-386.