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ANALYSIS OF TITANIUM INTERFACE AND TUNGSTEN EXTERIOR LAYER THICKNESS COATED BY VIBRATOR ELECTRODE METHOD

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ABSTRACT

The goal of this paper is to create metallic materials with superior functional performances. The layer obtained by electrode vibrator method must have a very good adherence on part surface and a high chemical and thermal compatibility with the substrate, as well as high ware and oxidation quality. So, in this paper Titan coating as interface and Wolfram as exterior layer were studied on ferito-perlitic cast-iron substrate. Pictures were taken with electronic scanning microscope.

KEYWORDS: electric spark alloying, layer thickness, metallic surface hardening, electronic scanning microscope

1. Introduction

Surface engineering does not refer to choosing and applying one of the many technologies available, for treating one part with a pre-established constructive shape, but in fact, surface engineering involves a new vision in fabricating and projecting activity.

Through this concept mechanical parts are treated as composite systems, superficial layer – sublayer. Specific technologies are applied for proprieties modification for each element, to obtain in the end the wanted functional performances of the part. The life time of a machine, tool or installation is determined by the wear of the parts. Wear, fatigue and corrosion are the most aggressive factors that destroy a part.

From all coating methods, metallic surfaces electro-spark alloying takes a good place because of the multitude of its advantages.

The advantages are high adherence of these coatings with the support, possibility to make the coating using all metallic materials with electro-conductive proprieties, the simplicity of the process and low energy costs. Electric-spark alloying is very simple, and the size of the needed machine is small and reliable.

The pollution effect is low using these unconventional technologies, and no toxic composites are used (like cyanide).

2. Methodology

Vibrated electrode method belongs to the same category of coatings that uses electric arc. Hardening with electric sparks principle consists in that in electric sparks discharge, with pulsating recovered current, polar transport of electrode material takes place (anode) on part surface (cathode). This material (electrode) alloys the part surface by chemical mixing with atomic nitrogen from the environment and the carbon from the part surface. A diffusion hardened layer is formed with high ware resistance. In the superficial layer, complex chemical compositions are formed: nitrides, carbon-nitrides, very stable carbides and quenched layers. Electric spark hardening of parts and tools submissive to wear, is done by contact, with manual vibrator. The process starts by approaching the anode with the cathode. After penetrating the space between the electrodes and the beginning of discharge channel (plasmatic stage of discharge), from the part surface vaporization and elimination of liquid stage begin. Under the electro ionic action of plasma and vapour currents and the liquid stage, on the electrodes, in the energetic discharge areas melted material micro-volumes are formed. As energetic discharge (electro-spark processing specific) develops a vapour splash and a liquid stage formed take place and lead to pressure increase between the electrodes.

The high temperature generated by the spark leads to partial melting and mixing of the electrode material with the surface material.

Between two sparks, the low quantity of melted metal solidifies, developing a protective layer.

3. Results and discussion

The paper, in this context, has the following general objectives:

- Titan coating study as interface wolfram as exterior layer;
- Layer thickness analysis;
- Coating layer crack analysis;

Hardening by impulse discharge can be used with benefice effect on pumps for desalinization of water, which are working in high ware conditions, for increasing their lifetime.

For the experiment was used grey ferito-perlitic cast-iron (fig. 1) whose chemical composition is presented in table 1. This composition is determined with Foundry Master Spectrometer machine.

Tests were made with Elitron 22 machine and titan electrode as interface with wolfram as exterior layer was used.

Table 1. *Basic material chemical composition, %*

C	Si	Mn	P	S	Cr	Ni	Cu	Mo
3.97	2.87	0.25	0.06	0.07	0.28	0.126	0.17	0.03

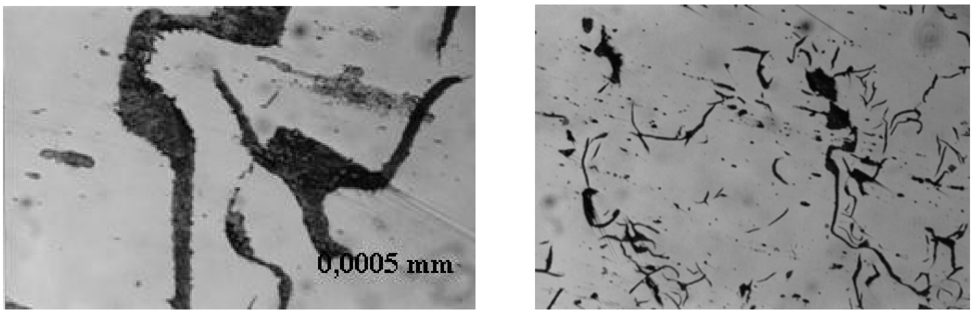
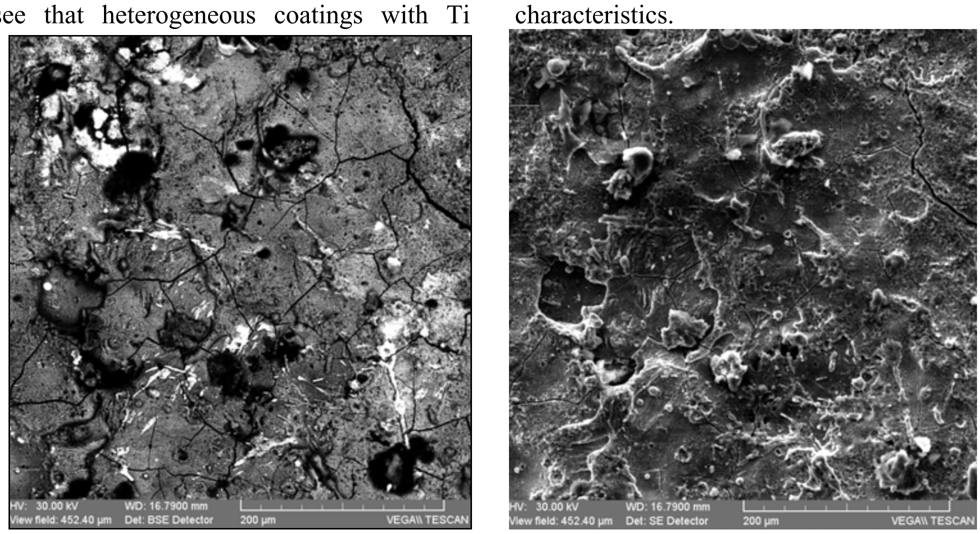


Fig. 1. *Basic material microstructure*

Ti as interface and W exterior layer coatings are good from metallurgic point of view, and have high accuracy.

In fig. 2 taken with electronic scanning method, we can see that heterogeneous coatings with Ti interface and W exterior layer. These have a soft look, with few asperity and bumps, with small melted material drops welded to the exterior. These are the wolfram electro erosion micro alloying characteristics.



a) b)

Fig. 2. *a), b) BSE pictures (back scattered electron) and SE (scanning electron) for Ti interface and W exterior layer coating on ferito-perlitic cast-iron.*

Exterior layer is showing soft cracks and small adherence areas. Titan was used as transition layer between ferrito-perlitic support and the wolfram layer.

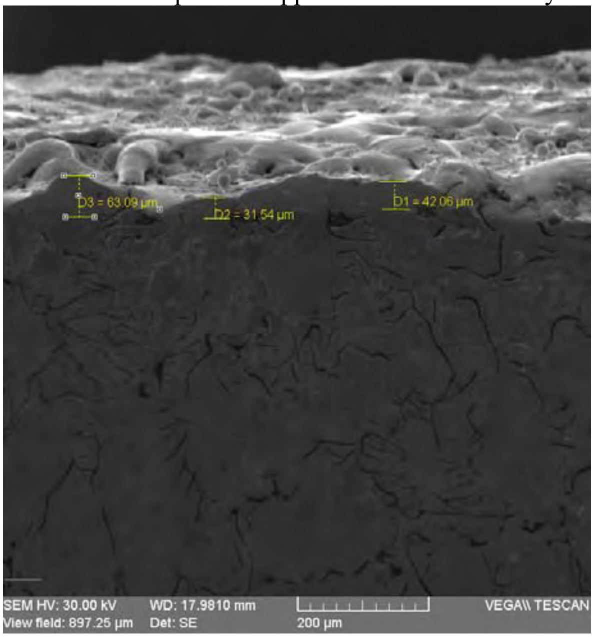


Fig. 3. *Layer thickness*

The intermediary layer levels the coating because of a good adherence and a constant thickness and a good plasticity at high temperatures. At the second layer deposition a low roughness exterior is formed (fig. 3).

Titanium is an important presence not only in the interface but on the exterior thanks to metal bath dynamics made at double coating, demonstrated by the appearance of areas with titanium mainly at coating edge drops. Studying the elements distribution, a smooth and uniform distribution is observed of titanium and wolfram elements, mentioning that wolfram agglomerations atoms are found mainly in the middle of the drop and on micro-adherence like plucks, of electrode micro-cracks partially melted and welded on the exterior layer.

From the coating layer thickness point of view it is quite important to be between 42,06 – 63,09 µm.

Because wolfram gives more good results, it burns the part surface producing grooves in the material (material loss by vaporization), oxides and adherences, observing an irregular surface with high roughness and uneven layer. To avoid this inconvenience an intermediary titan coating layer on grey cast iron matrix, then the wolfram layer which doesn't coat but strongly melts the exterior layer. Only accidentally small particles from the wolfram electrode lands on the part surface because dynamics. Titanium's main effect is decrease of layer roughness and increase surface quality by obtaining the layer with few cracks, oxides and bumps.

Studying the pictures with in line analysis we observe titanium presence as a relatively compact layer covered with a dispersion of the wolfram layer (fig. 4).

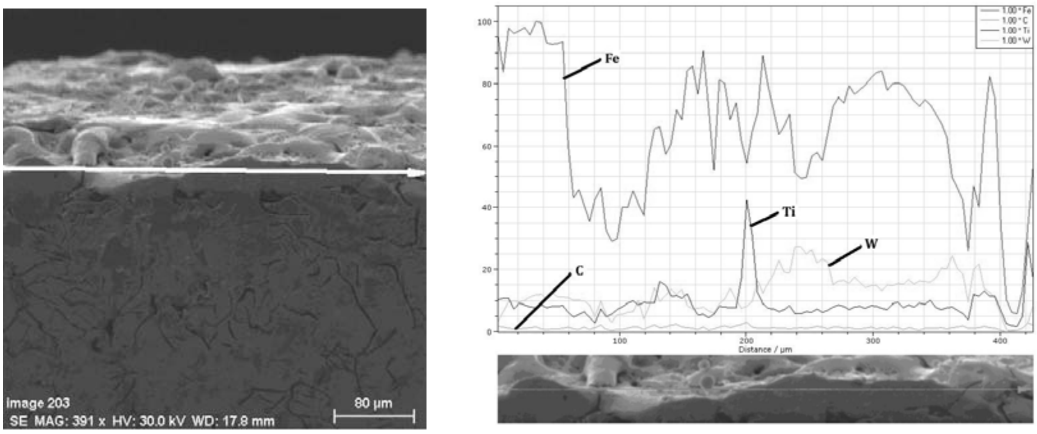


Fig. 4. *In line analysis of Ti interface coating, and W exterior layer*

Inside the fracture the part presents a compact layer, adherent and with a basic material compatibility, evident by the presence of similarities such as fibres and composition between coating and ferito-perlitic matrix.

Titanium presents a good distribution on all coating area, evident at in line analysis, when titanium percent, on section coating, varies between 15 - 100% through the whole layer thickness which varies between 30 - 40 µm.

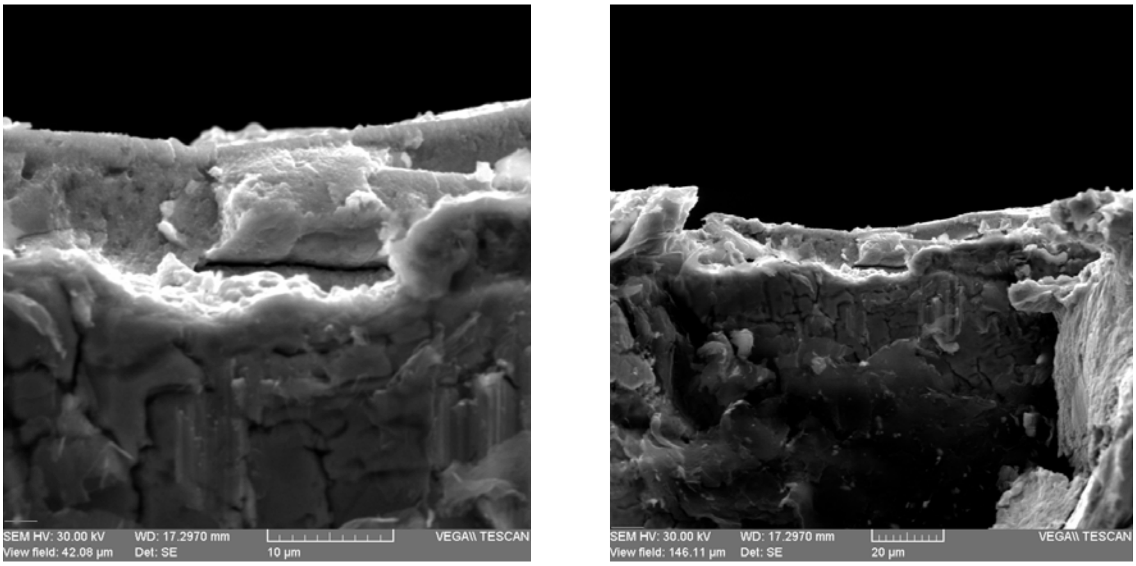


Fig. 5. *Coating layer cracked areas highlighted in pictures taken through electronic scanning microscope*

Wolfram has a very low percent in section (8 – 12%) and distributed in the middle area, that is justified by the high temperature used for its melting, that means it is absent from the alloying bath but as accidentally extracted particles from the top of the electrode, because of thermo-electrical flux dynamics. The same thing is checked by point EDX analysis in the coating material, when analyzed areas present a titan concentricity of 24.47%, 24.46% and wolfram 9.91%, 21% (in the measured points).

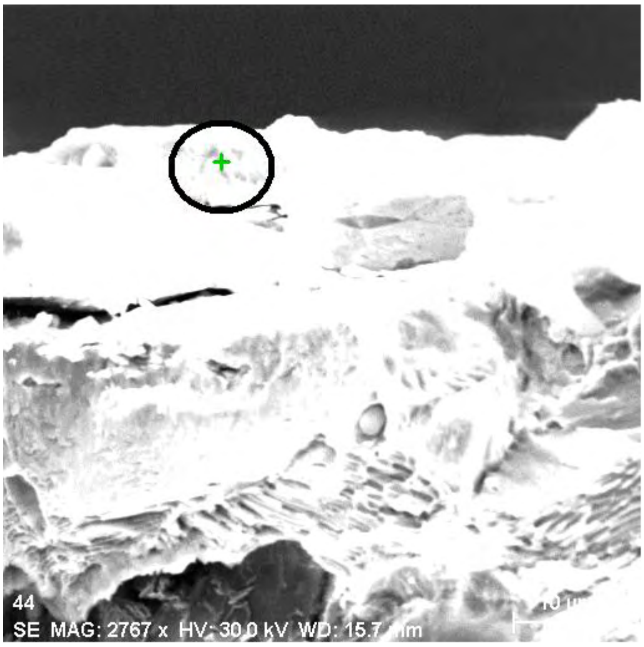


Fig. 6. *Coating layer crack point analysis.*

Table 2. *Point analysis of chemical composition inside Crack area, %*

Element	AN	Net	[wt.%]	[norm. wt.%]	[norm. at.%]	Error in %
Oxygen	8	2523	39.50027	36.58712	62.08326	64.40004
Titanium	22	67228	26.42008	24.47159	13.8758	0.757145
Iron	26	44113	25.37151	23.50035	11.42417	0.678102
Tungsten	74	9297	10.70124	9.912021	1.463688	0.311983
Nitrogen	7	1265	4.505784	4.173481	8.089333	7.442224
Carbon	6	2040	1.46337	1.355446	3.063748	0.300936

4. Conclusions

1. Ferrito-perlitic cast-iron hardening, with titan electrode as interface and W as exterior layer using vibrator electrode method, is done, mainly, because of hard white cast-iron layer developing, superficial quenching specific.

2. Hardened layer thickness, by Ti interface and W exterior layer coating, has a thickness between 31 μm and 63 μm.

3. Inside the fracture we observe that the hardened layer has a good coherence with basic matrix. This thing leads to exfoliation absence.

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