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Ferrite-pearlite Cast Iron Parts Restoring Using the Impulse Discharge Method

Manuela Cristina Perju, Dan-Gelu Galuşcă, Carmen Nejneru, Anca Elena Lărgeanu

Universitatea Tehnica „Gheorghe Asachi" din Iasi
e-mail: cryss_ela@yahoo.com

Abstract

This paper proposes an increase in wear resistance of sliding surfaces of frames lathes, as well as the pair of sleigh furniture surfaces.

Vibrating electrode method is a superficial deposition method mainly used for reconditioning parts that do not require a good surface quality in terms of roughness.

After the heat treatment of the parts, they have o high hardness and a great resistance to wear.

Key words: *impulse discharge, hardness, resistance to wear, resistance of sliding*

Introduction

Layer coating by welding (loading welding) is based on some basic welding methods like flame or electric discharge.

Loading welding is used to improve ware, corrosion and/or high temperatures resistance of mechanical parts or new tools as well as to recondition old tools. Coated materials by welding method are metals, alloys and composite materials with metallic matrix. This method is used to coat steel, cast-iron and nonferrous alloys.

One of the coating methods that use electric discharge is electric sparking superficial processing.

The electric discharge between deposited material (base material) and electrode (material added), through the concentrated heat generated ensures progressive melting of the added material as well al local melting of the base material.

In practice, tools and ware exposed tools electric spark hardening, is done using contact method with manual vibrator electrode. Between the fixed electrode and part sub-action of pulsating electrode takes place, a sparks discharge, which leads to transferring the material from the electrode to the cathode.

At the end of the discharge, at a low level of temperature, removing the anode from the cathode starts, action that is finished with the cut of electric circuit; then the process is restarted.

Following the material transfer and thermal modification from the discharge area, in the superficial discharge process of metallic materials using electric sparks the superficial layer of the cathode modifies its structure and chemical composition. The characteristics of this layer (fig.1) can vary between large limits depending on the electrode material, composition of the environment between the electrodes, impulse discharge parameters and other conditions of developing the layer on the cathode.

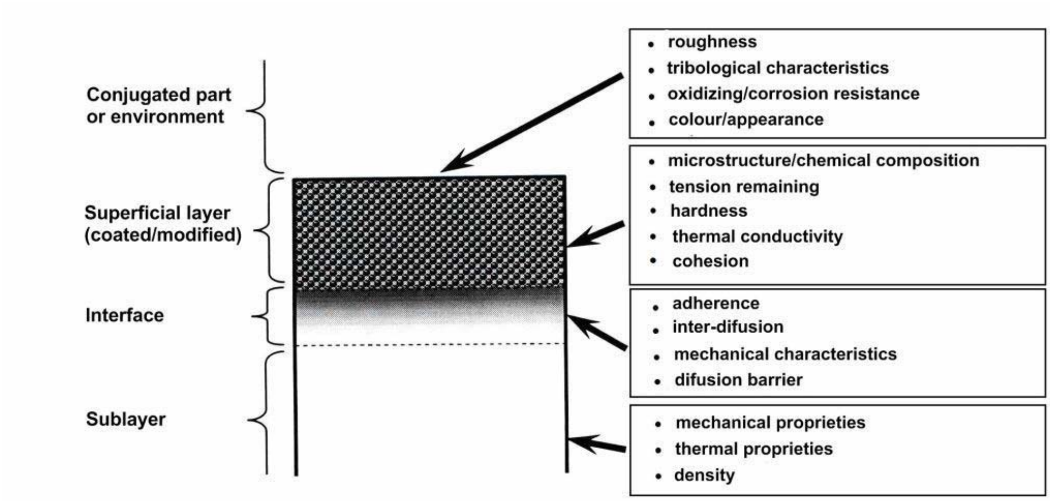


Fig. 1. Coating layer structure an proprieties

Methodology

Compared with other coating methods, superficial hardening using electric sparks reveals a series of advantages:

- metallic layer applied by electric spark method is forming a very high connection with the base material;
- the simplicity of the process and low consumption of energy;
- possibility to coat with any conductive material;
- no prior preparing of the coating surface is required;
- the method ensures the enrichment possibility of the superficial layer with Nitrogen, Carbon or partial alloying and also quenching during hardening, because this process comes with a very high heating inside the discharge channel; temperatures are reaching 10.000÷11.000ºC.

The process starts with approaching the anode and cathode. After penetrating the space between the electrodes and the start of the discharge channel (plasmatic stage of discharge), from the surface of the electrodes the evaporation and the elimination of the liquid stage starts. Under the action of the electronic component of plasma and the current from the vapors and liquid stage, on the electrodes, in the area of the energetic discharge micro-volumes of melted material are formed.

As the impulse energetic discharge (specific surface sparking discharge machining) a vapor and liquid phase splash takes place; this leads to pressure increasing in the space between the electrodes. High temperature generated by the spark leads to melting and partial mixing of the electrode material with the surface material. In time between two sparks the low quantity of melted material solidifies creating a protection coating layer.

Results and Discussion

The paper proposed in this context, pursuits the following general objectives:

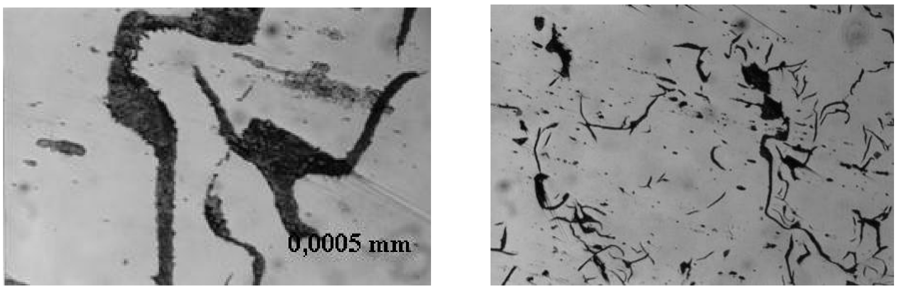
- Study of double layer titan double layer coating (with two successive passes);
- Analysis of layer thickness;
- Hardness analysis.

Hardening using impulse discharge method can have benefic effect on the sliding surfaces of the cradle of turning machines, as well as pare surfaces from the mobile sliding sledge.

For the experiment grey ferrite-perlitic cast-iron (fig.2 a), b)), vas used witch chemical composition is displayed in table 1, witch was discovered with the help of Foundry Master Spectrometer.

Table 1. Chemical composition of ferrite-perlitic cast-iron material, %

Element	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

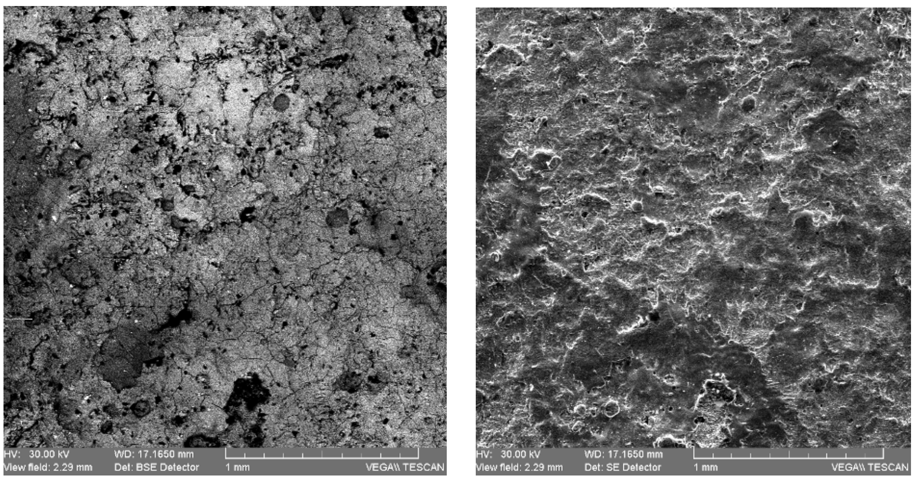


a) b)

Fig. 2. Basic material microstructure (ferrite-perlitic cast-iron); a) zoom 400 µm; b) zoom 200 µm

Trials have been made with Elitron 22 machine; coating material was and titan (electrode) with two passes.

To study the microstructure electronic scanning microscope was used (SEM model VEGA II LSH). SEM is an instrument that reveals an image with a very high zoom using electrons and not light to form an image.



a) b)

Fig. 3. a) BSE microstructures for titan with two passes coating, zoom 1 mm;
b) SE microstructures Ti with two passes coating, zoom 1 mm.

For coating titan two passes (fig. 3 a, b) we observe a uniformity of the layer because of the remelting the superficial layer and the Ti coating, and also on the graphite lamellas not meeting the situation with only one passes. Some micro-cracks are revealed that is due to increasing the superficial layer thickness and to the fact that the sub-layer is colder than in case of first coating, so the cracks are smaller, but it is possible that the micro-cracks are only on the first coating layer and not in the second.

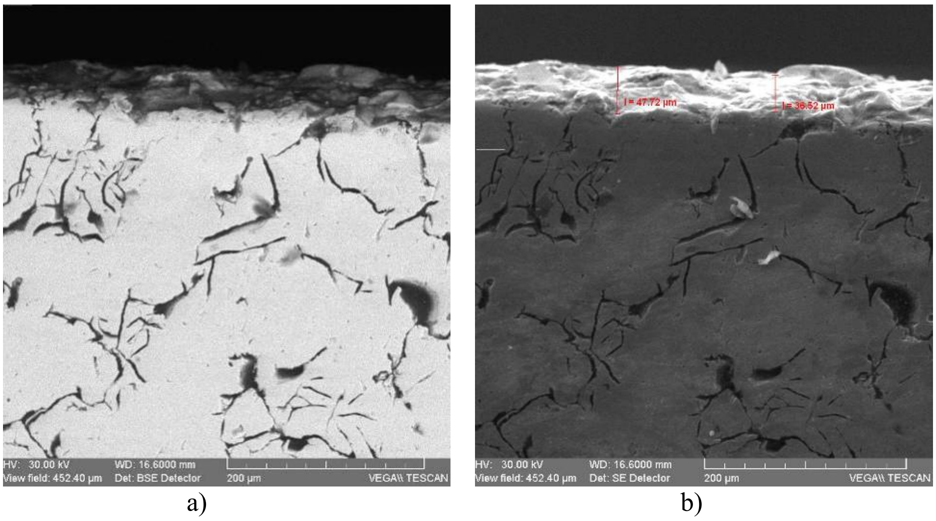
Titan coats the part without pronounced material drops like in one layer coating, but with some porosity at the exterior, areas that are overlap some points that are indicating the presence of the oxygen, so they will represent some porosity with some gaseous oxides.

Element repartition reveals common areas Fe, C and Ti what means that inside the alloying bath of inter-metallic compounds, and also Ti carbide and small areas with cementite appeared due to the energy intake of the thermal flux, and high cooling temperature gradient because the exterior layer is cooling very fast, because of the contact with the environment and also low coating layer thickness (tens of microns). Table 2 present the chemical composition after deposition of Ti layer with two passes.

Table 2. Chemical composition of Ti double layer, %

Element	**%**
Iron	58.82282
Carbon	35.59981
Titanium	3.581229
Silicium	1.996136

In the layer thickness analysis, we can observe, on the pictures made with electronic scanning, that Ti outside, with two passes is forming same smooth surface finish.



a) b)

Fig.4. a), b) BSE pictures and SE, zoom 200 µm

From the pictures (fig. 4 a, b) observed, beside high coating layer thickness and a high alloying degree, Ti and Fe intercourse is done with a higher depth; coating area compactness is occasionally sliced by graphite lamellas not dissolved in metallic bath.

Ti double layer thickness varies between 36.52 – 47.72 µm.

Studying the in-line analysis (fig. 5) we can observe the penetrating depth and Ti repartition in layer, obtaining at the exterior a Ti percentage between 10 – 50%, and Fe between 10 – 60 % C is existing in the metallic block under 1% concentrated in the lamellar area.

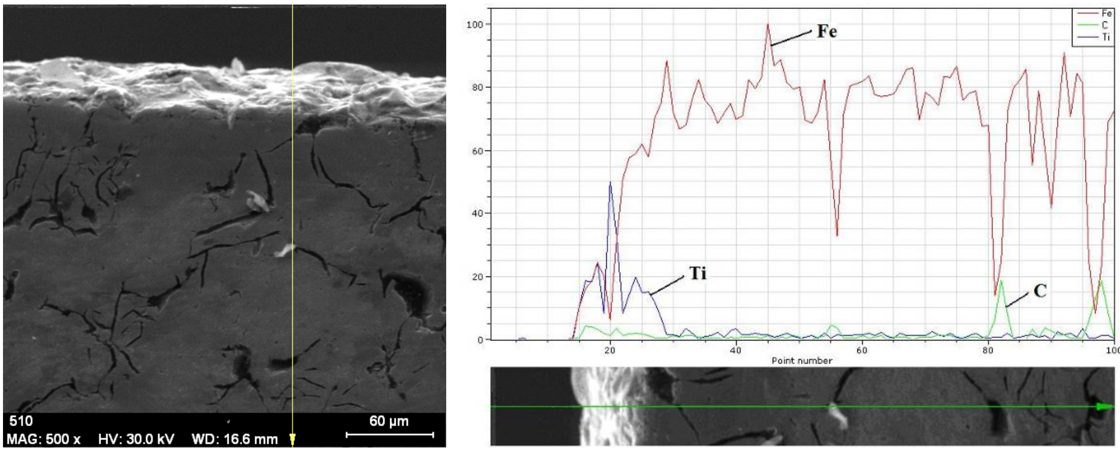


Fig.5. In line Ti double coating layer analysis

To measure the micro-hardness (fig. 6) Micro Vickers Hardness Tester machine was used. Diamond penetrator weight was 50g (HV50).

Table 3. Micro-hardness variation for superficial layers processed with sparking method HV 50

Base material (ferrite-perlitic cast-iron)	400
Ti coating double layer	786.53

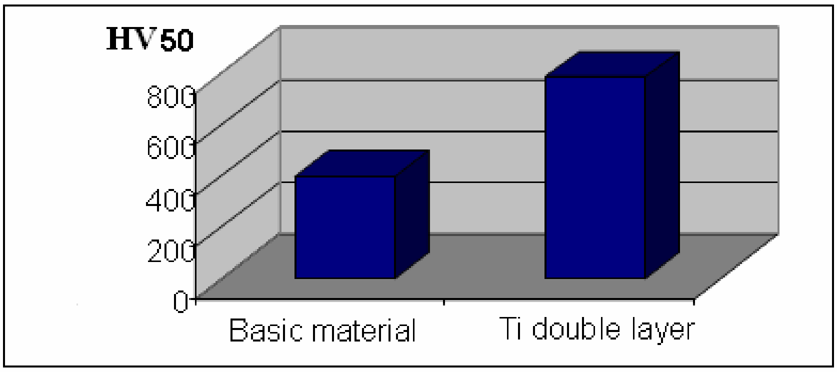


Fig.6. Micro-hardness variation chart for coating using vibrator electrode method

Conclusions

1) By using a deposition pulse discharge method and by choosing the appropriate basic material (generally, steels and irons) and process parameters, layers with very fine grain and high hardness can be processed.

2) The process has the advantage that heating request of the part is very low, maintaining chemical composition and properties.

3) Hardening of ferrite-perlitic cast-iron, using Ti electrode and vibrating electrode method is achieved mainly, due to the formation of a hard layer of white cast-iron specific superficial quenching.

4) The thickness of Ti by depositing the two passages is consistent and varies between 36.52 – 47.72 µm.

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Recondiționarea pieselor din fontă ferito-perlitică utilizând metoda descărcării în impuls

Rezumat

Lucrarea propune o creştere a rezistenţei la uzură a suprafeţelor de alunecare a batiurilor strungurilor, precum şi la suprafeţele pereche de la sania mobilă.

Metoda de depunere cu electrod vibrator este o metodă de depunere superficială folosită în special la recondiţionări ale pieselor care nu necesită o calitate de suprafaţă foarte bună din punct de vedere a rugozităţii.

În urma tratării piesele au duritate mare şi o deosebită rezistenţă la uzură.