THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 2 – 2007, ISSN 1453 – 083X

ELECTROMAGNETIC STRIP MILLS' DRIVING ROLLERS METALLISATION ADVANCED TECHNICS

Petra MOTOIU[1], Daniela DUMITRESCU[1], Cornel FRATILA[1], Dacia TRUSCA[2]
[1]*National R&D Institute for Nonfferrous and Rare Metals, IMNR. – Bucharest, Romania
[2]SC PLASMAJET SRL, Măgurele, Romania
email: petramototiu@yahoo.com

ABSTRACT

The continuous increase of the applications of thermal sprayed coatings together with the demand for layers having always more and more enhanced performances and properties stimulates the research activity toward the development of new coating materials and alloys.

To meet this goal, new complex alloys, based on the Fe, Si, B, Mo, Cu, W system, are here considered, through the development of new and innovative powders to be used, as powders directly or as a wire form, for thermal sprayed coatings to improve wear and corrosion resistance, as well as thermal fatigue properties of the electromagnetic strip mills' driving rollers, highlighting the materials performances and attaining economical and environmental advantages.

KEYWORDS: thermal spraying coating, plasma jet, hard facing, surface engineering

1. Introduction

The optimal performance of a component is to a great extent determined by the state of the surface, because every work piece is exposed to several strains, namely mechanical, thermal, chemical or electro-chemical, radiation stresses, which often have their maximum in the surface area. Owing to the presence of this complex strain most failures of machine components start within or close to the surface. The high importance of the surface in regard to the lifetime of a component justifies the term "surface engineering", which combines the knowledge of different scientific disciplines and deals with the design of a composite system which has properties, that cannot be achieved by either the surface layer or the bulk component alone [1].

Surface engineering can be seen as one of the key technologies of the present days, permitting to lengthen the lifetime of the products, simultaneously reducing costs and saving natural resources.

The surface of a component can be changed through a various amount of surface treatments.

2. Experimental researches and results

The processing powder experiments from the FeCrSiNiMnC system were realized using an atomization device of the metallic melt with water at high pressure.

The chemical composition of the obtained powders is presented in *Table 1*.

Table 1. *Chemical composition of powders*

Powder type	Chemical composition, %										
	Fe	Co	C	Cu	Al	Cr	Mn	B	Si	Sn	Zn	Ti
Charge I	base	0.012	0.026	0.38	0.082	0.92	1.20	1.12	2.00	0.034	0.042	<0.005
Charge II	base	0.018	0.65	0.09	<0.005	11.53	0.98	2.09	2.04	<0.005	0.016	0.012
Charge III	base	0.017	0.87	0.06	0.020	15.80	1.86	2.66	3.90	<0.005	0.016	0.040

The experimentations continued with the coating of an OL 37 metallic surface (unalloyed steel) by plasma spraying of the complex alloys, based on the Fe, Si, B, Mo, Cu, W system powder. The applied complex alloys coating will allow its usage into industrial processes where special materials are needed. [5,7].

The coating experimentations were made with the help of a METCO 7 M plasmatron, the obtained spraying parameters being presented in the *Table 2.*

Table 2. Optimum Coating Parameters

Argon and hydrogen flow [$m^3.h^{-1}$]	Power plasma flame [kW]	Spraying distance [mm]	Spraying speed [$m.s^{-1}$]	Temperature of base material [^oC]	Thickness of coating [mm]	Powder flow [$kg.h^{-1}$]
Ar+20 vol.%H_2 37	80	60, 80, 120	0,3	140 ± 5	0,5	0,7

The technological operations of the complex alloys, based on the Fe, Si, B, Mo, Cu, W system powder plasma spraying process underlines its main steps. It must be taken into consideration the fact that respecting the operational parameters is determining for suitable coatings.

The preliminary thermal plasma coating experimentations were made upon numerous probes, taking into account a lot of factors which influence the final structural and physical-mechanical characteristics of the experimental samples.

There are two coating aspects which must be taken into consideration:

- The contact with the metallic surface
- The internal interactions

Due to the fact that each separated particle strikes the surface and it is flattened by the powerful shock, the result is a local contraction of each particle which is somehow compensated by the material yield [1, 4, 5].

The correct choice of the plasma gas represents an important factor regarding the reactions type which can be generated at the metal-base interphase, finally a suitable surface resulting.

In order to achieve minimum expenses and a maximum heat transfer, argon is used with a 10 to 20 % H_2 addition, [7].

For pure theoretical operations, in order to avoid any possible reaction with the plasma gas, pure argon is used.

Generally, the process must take place so that the plasma gas shouldn't react with the metallic base which has to be coated.

Macro structural studies allow examining the obtained surfaces. Samples with special prepared surfaces are used, in order to underline the present phases and the metallographic constituents.

The sample was prepared with solution attack. A HNO_3 and CH_3COOH solution mixture was used. From metallographic analysis we can see a good density of the layer and a very good adherence to under layer.

Figure1 show the metallographic aspect of layer obtained through spraying method.

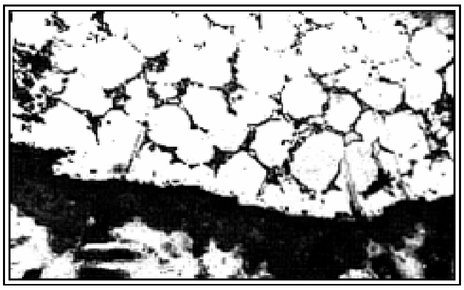

Fig.1. *Metallographic of the new coat (x500).*

Also we can see the beginning of diffusion phenomenon at the interface layer/under layer.

From place to place there are mini-hollows in the mass of the new layer, [7].

The structure, density and composition of the layers have been modified in order to be able to give the wished technological function to the new layers.

Among all these, the modification of the density of the new formed layer is the main use of these operations.

Warming and melting of the coverings have been used throughout heat application, after covering, using lasers, electrons flows, heating through induction, plasma jets or flames.

The existing barriers in using these technologies include the processing supplementary costs, the control of the thermal tensions which appear during remitting and solidification and ultimately the apparition of new unwanted phases in the fusion zones.

The melting may occur on the surface, in the middle or deep inside the contact zone with the under layer.

It is necessary that the used powders should have an extremely fine granular structure, the porosity being maintained at a 0.5 % maximum. A low porosity has positive consequences upon the final layer, increasing adherence between the particles and the traction strength of the layer itself.

Most of the industrial applications need very thin layers. As a consequence it is important as the adherence between the cover layer and the base one should be obtained without a middle coating layer.

First of all the nature of the adherence is due to: the high temperatures of the materials used, the fine structure of the particles and the very high speed of spraying in oxygen or helium atmosphere, the result being an extremely high resistance of the layer adherence, [2, 3].

From the details presented above about the powder fineness of grain and density it is obvious that the sprayed industrial coatings can endure the most complicated finishing techniques in order to obtain a perfect smooth surface.

The processing of the new formed layer after coating is used in certain applications in order to modify and improve the coating characteristics.

Sub missed to ultra – finishing techniques, the layers obtained by plasma spraying (industrial coatings) may reach a 2 – 5 RMS finishing degree, which represents a very satisfactory value even for the most pretentious industries, [8].

The advantages of a chosen bulk-surface system can be related to reduced production costs, failure of the part without damaging the whole machine or even risking human lives, possibility of local repair of damaged machine parts, minimal variation of the original design, energy and resource saving as well as environmental protection.

In this contest the perspective of the coating industry is a very good one. Besides the combination of new or known processes, coating engineering gains interest towards multi-layer coating. The internal layer is responsible for a good adhesion to the substrate, there is a gradually change of the properties with each additional layer so that the outer layers have the optimal properties to fulfil the functions they are designated for.

3. Conclusions

The data from this paper confirm the fact that the powder obtained by high pressure water atomisation of studying alloy has a good behaviour when flame sprayed.

The properties of the surface of a component greatly influence its performance and lifetime, among the numerous and different surface treatments useful to improve the properties of a surface, thermal spray processes gained great interest and allow many advantages, being able to produce large assortment of wear and corrosion resistant protective layers.

Moreover, the presence of porosity may constitute an optimal base, providing adhesion between substrate and applied coating, without the requirement of additional operations, like grit blasting, to roughen the substrate surface.

The contact between the implicated components in the thermal spraying process presents rugose surfaces; there are large contact surfaces between the coated layer matrix powder based on Fe and the basic layer.

We have to underline that an important contribution in achieving this goal is due to this kind of powder, which responds to the required conditions by this kind of coating during the exploitation time of the electromagnetic strip mills' driving rollers.

References

[1]. D. Ugues, M. Rosso, M. Albertinazzi, F. Raimondi, A. Silipigni, Proc. 2nd Int. Conf. High Tech Die Casting, Brescia, Italy (2004), p. 155.

[2]. D. Ugues, M. Rosso, M. Albertinazzi, Metall. Sci. and Tech., 22 No.1, (2004), Teksid, Carmagnola (I), p. 22.

[3]. A. Chowdhury, D. Cameron, M. Hashmi, Surf. and Coat. Tech., 116-119, (1999), 46.

[4]. T. Michler, M. Grischke, K. Bewilogua, A. Hieke, Surf. and Coat. Tech., 111, (1999), p. 41

[5]. H. Prengel, W. Pfouts, A. Santhanam, Surf. and Coat. Tech., 102, (1998), p. 183-190

[6]. D. Heim a, F. Holler, C. Mitterer, Surf. and Coat. Tech., 116-119, (1999), p.530-536

[7]. P. Moţoiu, G. Popescu, P. Moldovan, “*Influence of NiSiB/WC-Co components ratio on the tribologic properties of thermal spraying NiSiB/WC-Co type powder layer*”, EURO PM 2006, Congress&Exhibition –23-25 october 2006, Ghent, Belgium, Proceedings Volume 1, Hard Materials, pg. 247-252

[8]. P. Motoiu, D. Dumitrescu, G. Popescu , H. Binchiciu , C. Munteanu, *„Study of composite material for hardfacing to counteract the tooling damage”*, Bulletin of the Polytechnic Institute of Iaşi, Tomul LIII, (LVII), Fascicola 1, Iaşi 2007, ISSN 1453-1690, pag.105-112.