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EXPERIMENTAL RESEARCHES REGARDING THE FUSION OF THE DEPOZIT LAYER BY METALLIZATION WITH FLAME AND POWDER USING WIG METHOD

PETRE, D[an]; IOVANAS, R[adu]; PETRE, I[oana] M[adalina]; ROATA, I[onut] C[laudiu]; PASCU, A[lexandru] & STANCIU, E[lena] - M[anuela]

Abstract: *The paper addressed the possibility of achieving fusion layer deposited by thermal spray using a current source used in WIG welding. This option was chosen because concentrated arc provided by these sources is being made a local heating. Another consideration is the protection against oxides created by used gas (Ar).*
Key words: *reconditioning, thermal spraying, powder*

1. INTRODUCTION

Lately, the thermal spray has underwent a great deal of progress, and has found applicability in almost all industrial domains such as aviation, navy, extracting industry, automobile and chemical industry, everywhere where the layers with special properties are needed.

The main thermal spray processes are: thermal spray with low-speed flame, high -speed thermal spray, through plasma, laser, induction, cold spray or detonation spray, where the add-on materials can be either powder or wire.

The coating is formed when millions of particles are deposited on top of each other. These particles are bonded by the substrate by either mechanical or metallurgical bonding.

The layers that are deposited by metallization with flame and powder at cold do not present dilution with the basic material and oxides appear in the contact zone between the basic material and the deposited one. In this paper it is presented some experimental researches regarding deposited layers using flame thermal spray for primary melting material and WIG source for fusion instead using classic oxyacetylene (mixture of oxygen and acetylene) procedure.

2. THERMAL SPRAY TECHNOLOGY WITH FLAME AND POWDER

The first step of any coating process is surface activation, the second step is to melt the material; this is done by introducing the feed stock material into the hot gas stream. , thirdly the particles are then accelerated to the substrate by the gas stream and deform on impact to form a coating (figure 1).

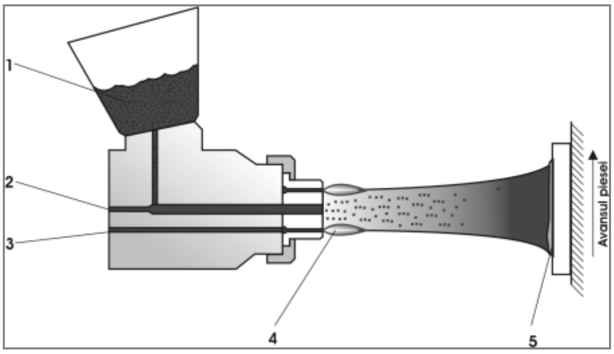


Fig.1. Schematic diagram of the flame thermal spray process and powder. 1-powder, 2-input powder, 3-gas mixture, 4-flame, 5-layer deposited by thermal spray. (Iovănaş, 2006)

Fig.2. Sample ready for metallization

Compared to traditional surface modification processes, thermal spraying offers greater thickness capability, no part size restrictions, it can be performed in situ, and it produces minimal noxious waste. High processing temperatures allow deposition of many high melting point materials onto a relatively cold substrate. A thermal spray coating must have a good bond with the base metal (substrate). In the "cold" spraying process, this is achieved mainly by mechanical bonding, with some micro welding. In the spraying and subsequent fusion process, any impurities (such as oxides) on the substrate may interfere with the metallurgical bonding process. It is therefore important to clean the substrate thoroughly.

The area to be coated should be machined to remove any fatigued metal and any unevenness induced by wear. Shafts should be chamfered. Various methods can be used to obtain a suitably rough surface for maximum bond strength (figure 2). After preparing the surface is recommend that the work piece be coated as soon as possible to avoid contamination.

3. FUSION OF THERMAL SPRAYED DEPOSIT

The Eutalloy RW process is carried out in two stages: spraying followed by fusion. Spraying alloys work pieces must be preheated to between 200 and 300°C and thermal spray parameters must be calculated for allowing about 25% shrinkage during the fusion process.

Fusion can be done in the classic method with CastoFuse handle with pressure adjusted for a slightly carburizing flame, heating the work piece evenly overall, to a temperature between 400 and 500°C then heating locally, 2-3 cm from the end/edge of the part. Fusion temperature is reached when the surface glows and then shines. (***,2010)

In our case for fusion it was used Origo™ Tig 3000i AC/DC welding power source produced by ESAB with argon protective gas. At cladding operations with WIG procedure it was used continuous current with inverted polarity CC+ where the thermal balance on the working piece is reduced. Hence the metal bath is larger and shallowed. The protective gas can be Argon or Helium. (Subu, Dumitrescu,1992)

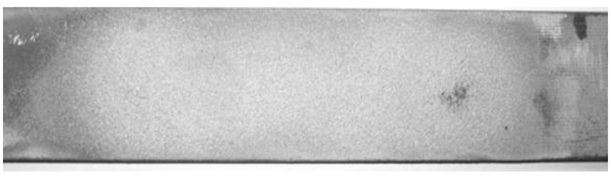


Fig.3. Thermal sprayed piece.

Composition and mechanical proprieties						
Material	Form	Element (wt. %)				
		C	Mn	Cr	Ni	Mo
AISI 4340	Plate	0,39	0,70	0,84	1,78	0,30
Yield Point	66 kg/mm2 (Min 655 N/mm2)					
Tensile Strength	76 kg/mm2 (Min 758 N/mm2)					
Elongation	18%					
Equivalent	AISI 4340, JIS SNCM439, BE EN24					

Tab. 1. Chemical composition and mechanical proprieties of AISI 4340

Argon is preferred (99,9% purity, 0,03% humidity) for its advantages: limited electric arc burning, easier arc ignition, lower ionization voltage at the same length of welding arc and welding current, efficient cleaning of oxide film because of the heavy Argon ions and cheaper than Helium.

Used base material is High Tensile Steel AISI 4340 – EN24 having the chemical composition from table 1.

AISI 4340 is a heat treatable, low alloy steel containing nickel, chromium and molybdenum. It is known for its toughness and capability of developing high strength in the heat treated condition while retaining good fatigue strength. Typical applications are for structural use, such as aircraft landing gear, power transmission gears and shafts and other structural parts AISI 4340 is considered to be a "through hardening" steel such that large section sizes can still be heat treated to high strength

The used powder for this application is: Eutalloy RW 12112 which is alloy powder for anti-wear protective coating. Applications include mixers, press plungers, press screws, and wear rings on pumps. (***,1995).

Technical data of powder used:

Hardness (matrix): 60-65 HRC; Hardness (hard phases): 1500 HV; Service temperature (max): ~700°C

• Very strong resistance to abrasion and erosion
• Resistance to high temperatures
• Applicable on steels, stainless steels, cast-iron, nickel alloys
• Applied by spraying with subsequent fusion-process, using CDS 8000 torch(***,2009).

For spraying it was used CastoDyn DS 8000, an advanced modular oxy-acetylene thermal spray system, designed to spray a wide range of alloys and other materials for many different applications, from anti-abrasion coatings to thermal shielding. Thermal spray parameters are presented in table 2.

Powder	Flame	Compressed air [Bar]	Oxygen [Bar]	Acetylene [Bar]	Spraying distance [mm]
Eutalloy 12112	neutral	1	4	0,7	190

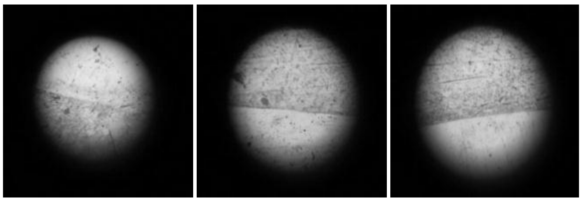
Tab. 2. Process parameters

4. PARAMETERS USED FOR FUSIONING THERMAL SPRAYED MATERIAL

Parameters used for fusioning the thermal sprayed material with flame and powders are presented in the following table:

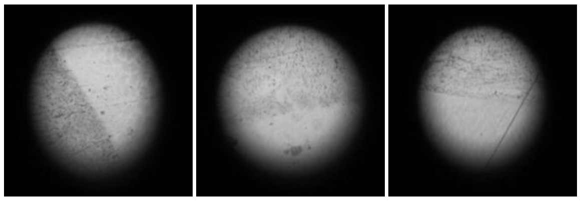
Sample nr	**DL [mm]**	**MB [mm]**	**Ia (A)**	**Rod dia. [mm]**	**Argon flow L/min**
P1	0,8	3,0	50	1,6	5
P2	0,8	3,0	60	1,6	5
P3	0,8	3,0	70	1,6	5
P4	0,8	3,0	80	1,6	5
P5	0,8	3,0	90	1,6	5
P6	0,8	3,0	100	1,6	5

Tab. 3. Technological parameters



a b c

Fig. 4. a) P1. Is = 50 [A]; b) P2. Is = 60 [A]; c) P3. Is = 70 [A]



a b c

Fig. 5. a) P4. Is = 80 [A]; b) P5. Is = 90 [A]; c) P6. Is = 100 [A]

Samples taken in the experiments are presented in Fig. 4. a, b, c and Fig. 5. a, b, c. Basic metal structure is a pearlitic-ferrite and can also be seen a transition zone discontinuities rare type of pores and inclusions. After microscopic analysis of the material was observed by dilution of the material, if the sample no.P5 with the following parameters: Is = 90 [A]; Q_{gas} = 5 [l/min], $d_{electrode}$ = 1,6 [mm]

5. CONCLUSION

➢ It was presented a new concept of merging the layer deposited by thermal spraying using a W.I.G. power source instead of traditional oxy-fuel burner.

➢ The fusion solution is adopted, using a WIG source to the detriment of the classic oxide – gas burner, due to the reduction of the number of oxides that appear in the deposit layers by using the protection gas. The metal bath that was formed is permanently maintained in protective gas jet.

➢ The electrode is shelled with electrons which yield their energy and heat the electrode. That is the reason for the utilization of higher electrode diameter or obligatory water cooling. Argon ions are heavy and at the impact with the working piece surface they broke the oxide film which is superseded by the protective gas jet. This phenomenon is called electric blasting and is very favourable at pieces covered with difficultly fusible oxides (Al, Hg).

➢ Following research were obtained best results with the following parameters technology: Is =90 [A]; Q_{gas}=5 [l/min], $d_{electrode}$=1,6 [mm]

➢ The following researches will study the fusion parameters optimization using the WIG method for a larger range of materials.

6. REFERENCES

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