LASER BEAM CLADDING WITH WIRE FILLER MATERIAL

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Abstract

The article summarily represents the results of surface layer creation with using the laser beam. This research was realized within diploma work "creating of the coatings by laser" in the laboratory of PZ, a.s. Bratislava. The aim of my graduation theses is to familiarize myself with the laser weld deposits creation and to study properties of these deposits. The coatings were created by the laser beam used the metal wire with the defocused laser and with slanting wire feeding to the coating processes. Created coatings at the appropriate coating parameters had a smooth surface, good cohesiveness with the basic material, very narrow transitional field to the basic material from the soft steel, hardness and structure is equal to the used wire.

Key words

CO_2 *laser, weld deposit/ weld deposition of coatings, wire*

Introduction

There is a plenty of technologies for coating creation and modification used world-wide during the production and renovation of machine parts. Conventional methods of flame cladding and electric arc are used to renewal of damaged components, but these methods are usually destructive and may cause low mechanical properties, cracks, porosity, deformation, wide thermal affected zone and very short component life.

Modern „surface engineering" is currently utilizing new energy resources and technologies. These considerably eliminate mentioned disadvantages. One of them is the technology of laser cladding which enables creation of thin layers within the material with specific properties on materials of ordinary quality.

Experiment

CO_2 laser device Feranti Photonics type AF8, with performance 8 kW and wavelength 10.6 μm was used to create the layers by laser beam (Fig.1).

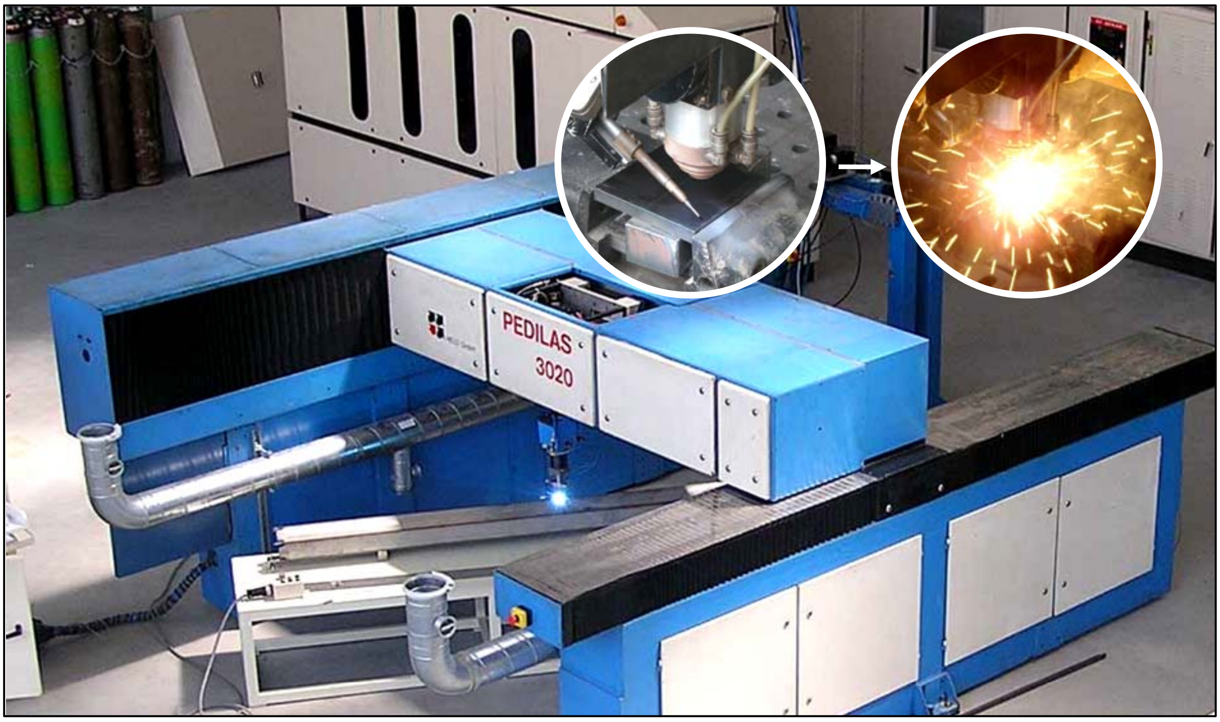

Fig. 1. *CO_2 laser device Feranti Photonics type AF8*

Steel S 235 JR G1 in the form of board with parameters 100 x 100 x 10 mm was used as the basic material for laser beam cladding. Its surface had been cleaned before cladding by sharpening; it had been defatted and sprayed with black opaque color as well. The chemical composition and mechanical properties of the used steel are given in Table 1.

CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES
OF THE USED STEEL - S 235 JR G1 Table 1

Steel	***Chemical composition (%)***					
	C	*N*	*P*	*S*		
S 235 JR G1	max. 0.170	max. 0.007	max. 0.045	max. 0.045		
(11 373)	***Mechanical properties***					
	R_e [MPa]	*R_m [MPa]*	*A_5 [%]*	*KV [J]*	*E [GPa]*	*Hardness [HB]*
	225 - 235	340 - 470	24	27	206	200 - 233

On this prepared surface we were gradually cladding the filer material in the form of wire with MEGAFIL A 760 B marking. We were cladding two times and produced individual samples for suggested testing. The chemical composition of the used wire is given in Table 2.

CHEMICAL COMPOSITION OF THE USED
FILER MATERIAL - A 760 B   Table 2

Wire	Chemical composition (%)				
MEGAFIL A 760 B	C	Mn	Si	Cr	Mo
	0,5	1,5	0,6	6	0,5

The coatings were created by the laser beam used the metal wire with the defocused laser and with slanting wire feeding to the coating processes (Fig.2). Produced clad was separated so it could be evaluated. For sample separation we used the technology of water beam separation. The sample has been sliced up to four parts. We realized following tests with them:

- three parts were in the shape of cylinder with parameters Ø10 x 10 + clad mm and they were used to test the abrasive wear resistance,
- the last part was used to metallographic and micro hardness testing.

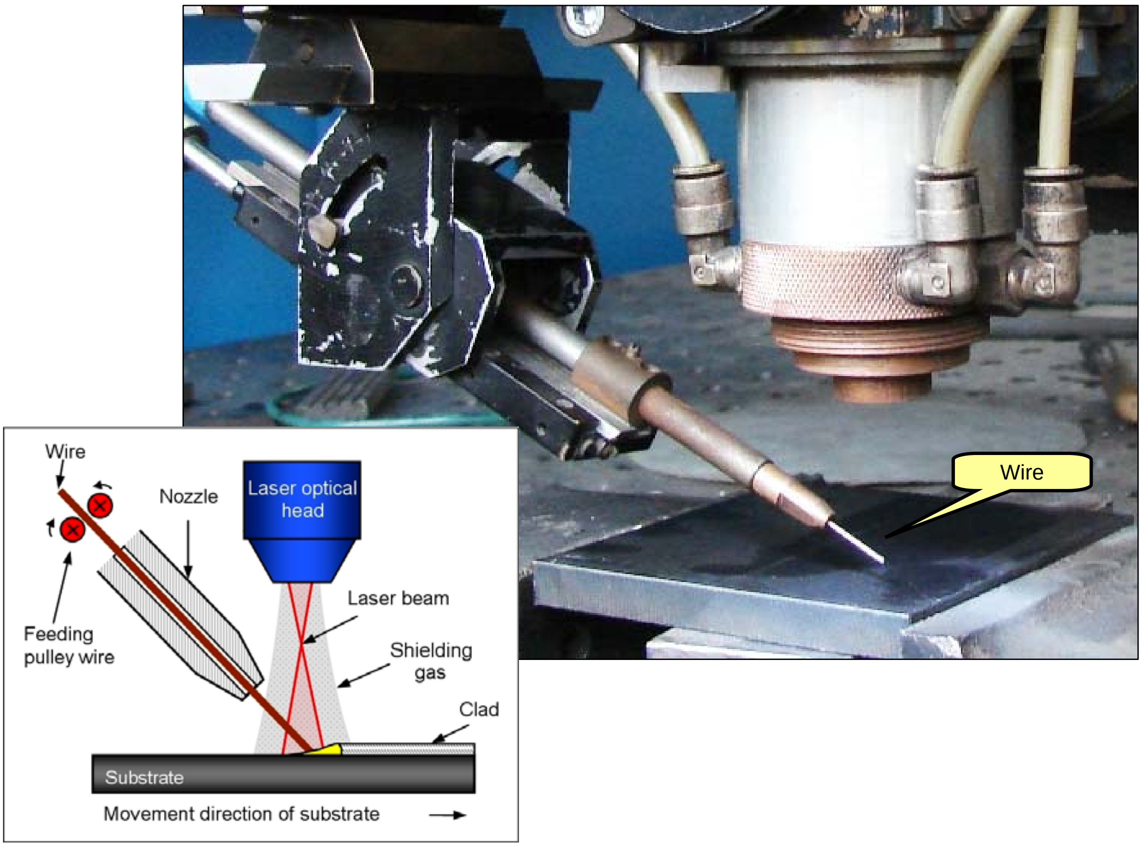

Fig. 2. *Principle of laser beam cladding with wire*

Parameters of cladding are given in Table 3.

PARAMETERS OF CLADDING Table 3

Parameters		Accessory material MEGAFIL A 760 B
Output	*[kW]*	4
Speed of cladding	*[mm/s]*	3
Flow rate of shielding gas	*[l/min]*	16 -17
Speed of feeding of wire	*[m/min]*	0,8
Inclination angle of nozzle	*[°]*	30
Defocusing	*[mm]*	22

Attained results

In the Fig. 3, we can see a cross-section of the cladding layer made by wire at the tenfold magnification. The layers of clad are perfectly lapped and coupled. The layer of clad is uniform all over the cross-section. There are no non-integrity signs like cracks or poruses in the clad that would be visible to the naked eye. Further, we can observe a clearly recognizable heat affected zone that is constant through all over the cross-section. Crossing edge between the layer and the basic material is sharp, without any area mixing, coherent, relatively flat and without the non-integrity signs, what points to the perfect metallurgic weld of the clad and the basic material.

According to done snap-shots of macrostructure analysis, we found out that we can gain ideal superimpose and melted clad layers connected to background material with minimal interfusion. All this we can achieve by laser beam cladding with wire.

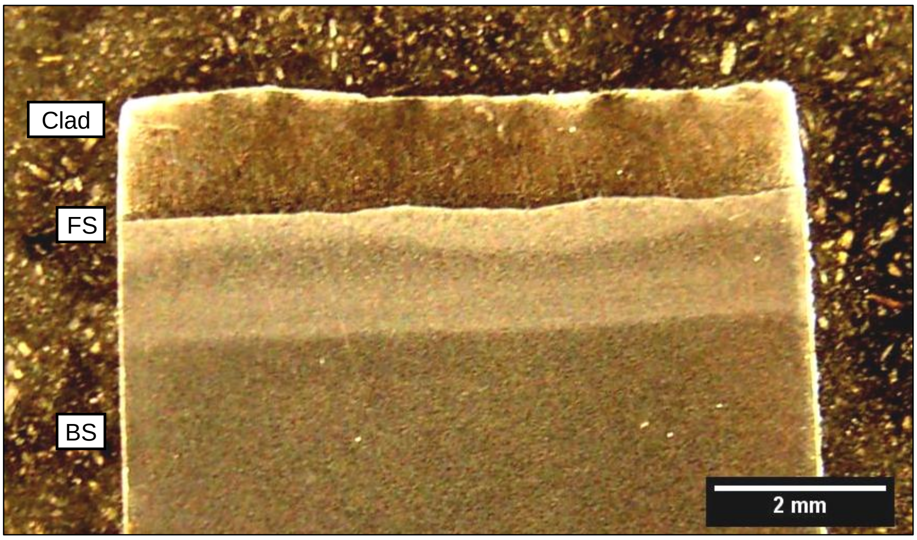

Fig. 3. *Macrostructure of clad*

Snap-shots in the Fig. 4a) to e) show the microstructure of the sample No. A 760 B. In the Fig.4a), there is a microstructure of the clad that has a dendrite character with eutectic secreted in the inter-dendrite area. Following the hardness, we can suppose that it is a martensite. In the picture a), we can see the non-integrity signs like poruses of a small size (up to 15 µm). In the Fig.4b-c), there is an interface of clad and basic material that is sharp without any signs of mixing, but metallurgical concerted. Structure high heat affected zone is formed by acicular and polyedric ferrite where we did not notice any distinctive coarsening of the primary austenitic grain. There was a grain refinement at the interface heat affected zone - basic material and we could observe the structure of the basic material formed by ferrite and perlite (Fig.4d-e).

According to the micro structural analysis, we can say that from original ferritic-perlitic structure of the basic material we can gain different martensite-based structures of dendrites character.

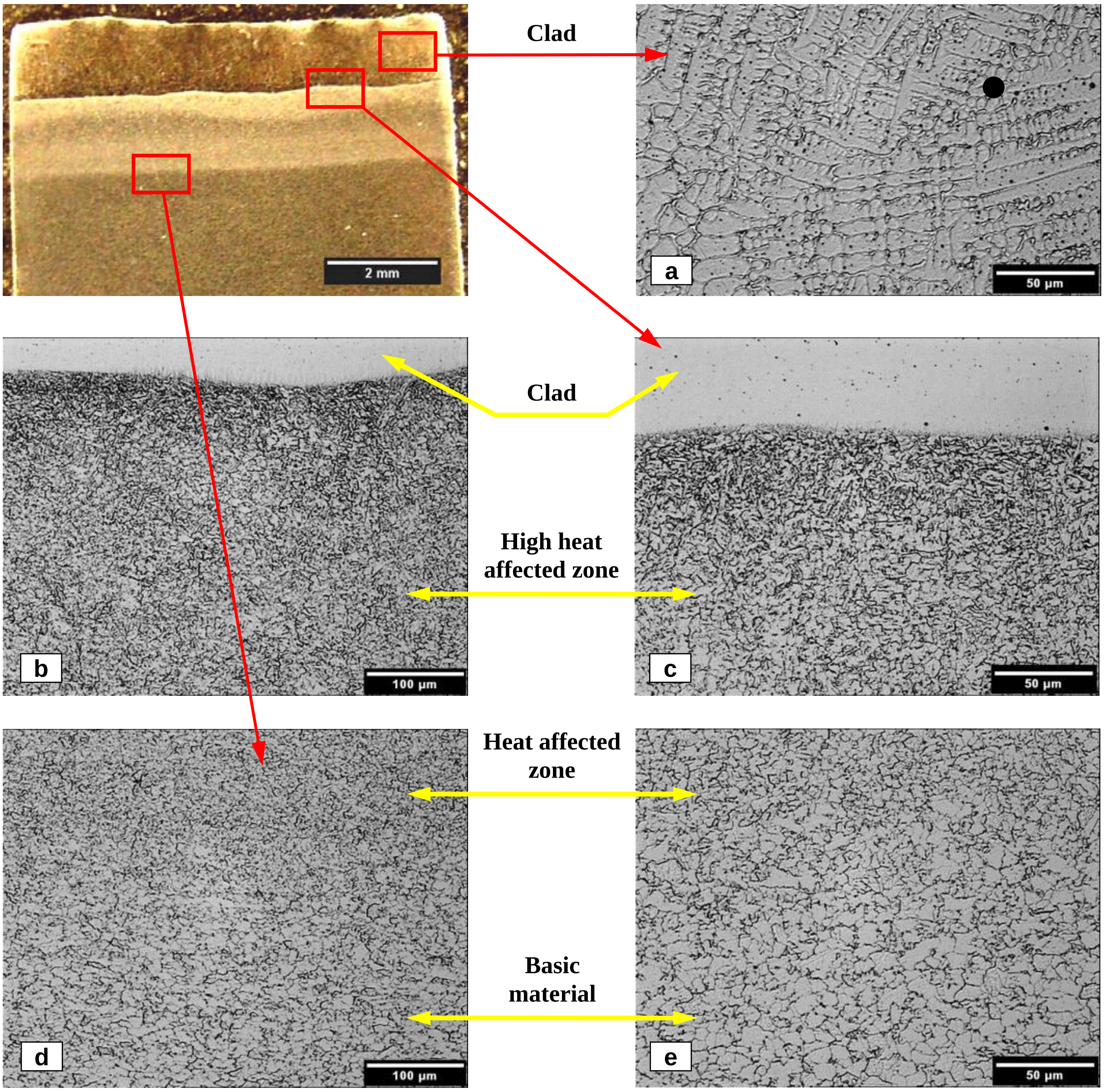

Fig. 4. Microstructure of clad

Microhardness was measured in the cross-cuts of each sample in the distance of 0.1 millimetres in the clad, heat affected zone and in the basic material. The initial point, marked as number 1, was just below the cladding surface and we gradually measured towards the basic material. The measuring was finished by minimum of three stamps in the basic material as it is schematically shown in the Fig. 5.

On the graph (Fig. 6), hardness figures are measured and processed for the purposes of the sample made by laser cladding.

Microhardness of clad metal is relatively equal and it was moving at average at 723 $HV_{0,1}$ level which was up to the used wire.

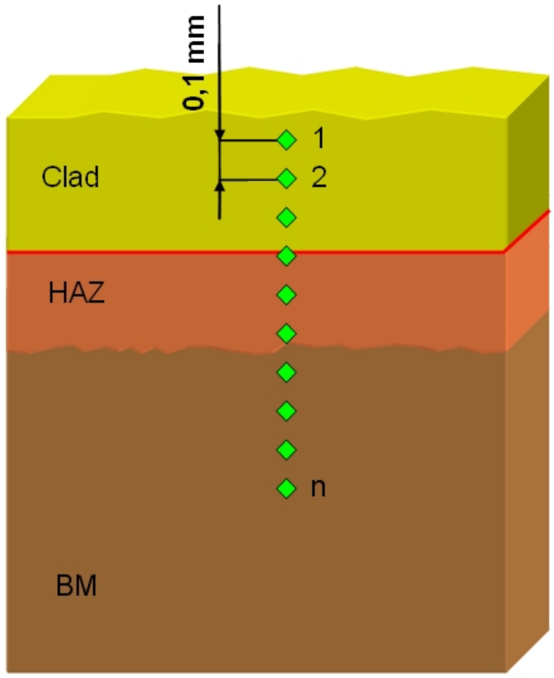

Fig. 5. Measuring microhardness

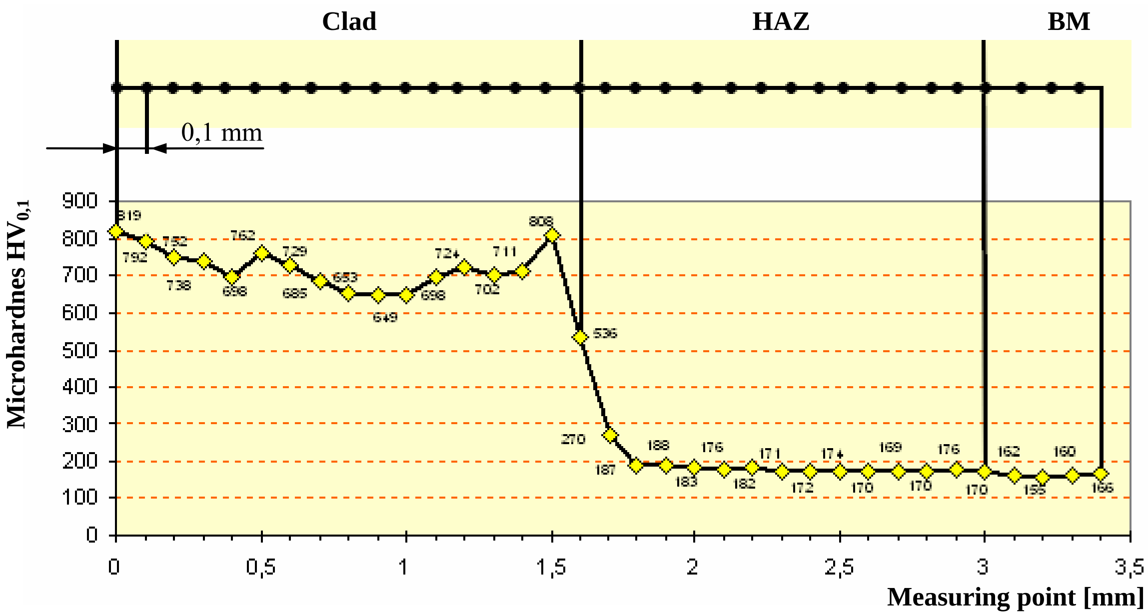

Fig. 6. *Course of microhardnes*

Conclusion

On the ground of suggested and realized experimental program and its valorization, we can say that the problem being solved – problem of coating creating - under convenient cladding parameters and convenient progress enables to create, effectively and in quite economic way, relatively thin layers of excellent quality without any quality reduction of used cladding materials, substrate and its boundary line with clad. Its properties increase utility possibilities of created layers.

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