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Characterization of the Co-base layers obtained by laser cladding technique

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Abstract: The exhaust valves laser cladded with two Co-base powdres were investigated. The microstructure of created layers close to the surface and to the melting line was examined. The distribution of elements within the clad layers was checked. Both microstructure and chemical composition of clad layers was similar for two applied powders.

Keywords: Co-base alloys; Laser cladding; Exhaust valves;

1. INTRODUCTION

Among materials, which can improve surface properties, there are cobalt-base alloys, which offer excellent high temperature corrosion resistance and attractive mechanical properties at work temperature. The coatings are, among others, obtained by laser cladding which provides solid fine layers, well adjacent to the base after surface melting. The high solidification rate may induce small grain microstructure. Various studies [1-7] have been performed on the most commonly used hard facing materials, namely stellites. The objective of this work has been to compare the morphology of microstructure of coatings created by laser cladding with an usage of two different powder materials.

2. EXPERIMENTAL

The substrate was the exhaust valve made of the A-R-H10S2M steel forging of chemical composition: 0.374%C, 9.34%Mn, 0.344%Ni, 2.46%Si, 0.822%Mn, 0.0162%P, 0.001%S.

The valve face was treated by the high 2.3 kW power diode laser HDPL ROFIN SINAR DL 020. The powder was delivered straight to the melting pool. The parameters of the process were: laser input 1.0-1.2 kW, scan rate 0.2 m/min., powder feeding rate 5 g/min., track thickness 1.0-1.5 mm, track width 5.5-6.5 mm.

Two new experimental cobalt base powders were delivered by CASTOLIN. The EUTROLOY 16012 composed of: 1.55%C, 1.21%Si, 29.7%Cr, 9.0%W, 2.0%Ni, 0.01%Mo, 1.7%Fe and Co as balance. The PG5218 powder contained: 1.32%C, 1.25%Si, 29.0%Cr, 5.3%W, 2.1%Ni, <0.01%Mo, 1.9%Fe and Co as balance.

The morphology of microstructures was determined by scanning electron microscope (SEM) equipped with the EDAX instrument to analyse chemical composition.

3. RESULTS

The details of microstructure close to the melting line are illustrated in Figs. 1 and 2. As a result of examinations of clad layers, the small grain, dendritic and directional sub-eutectic structures formed the weldments were observed. In melting line of the padding weld the grain size was differentiated as an effect of thermal processes of mixing of elements of the base exhaust valve with those of melted powders.

a) b)

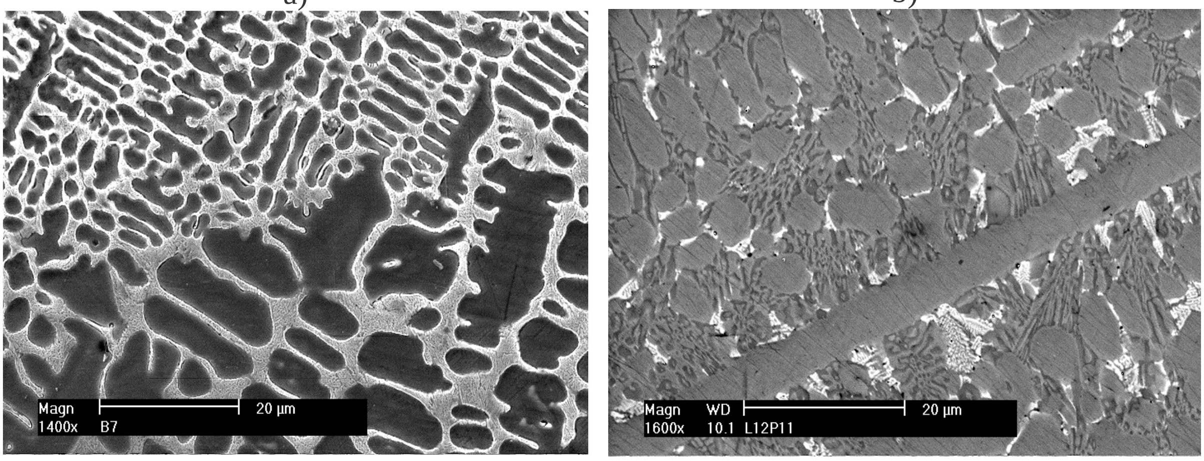


Figure 1. Microstructure of layers close to the surface: a) PG5218, b) EuTroLoy 16012

a) b)

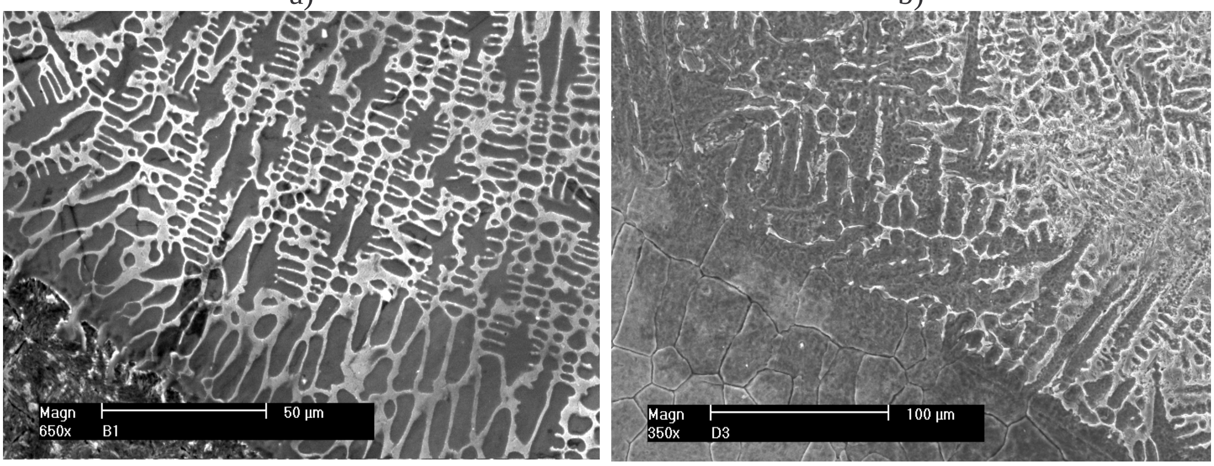
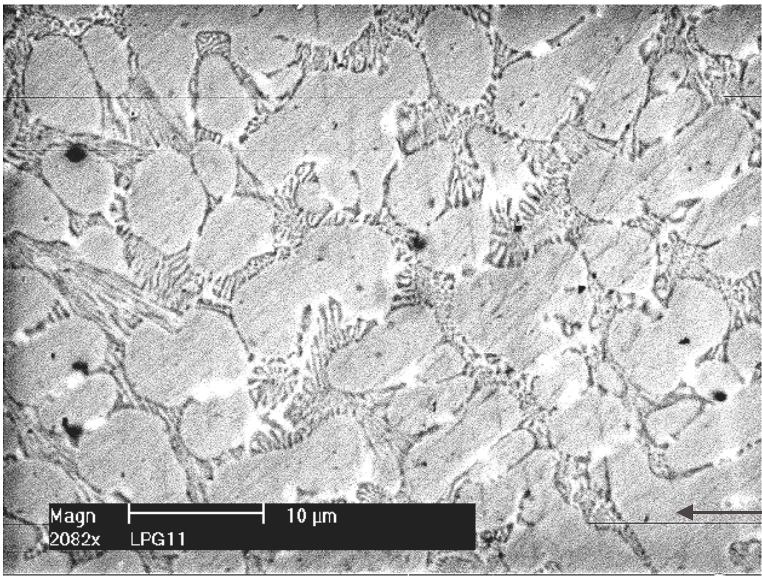


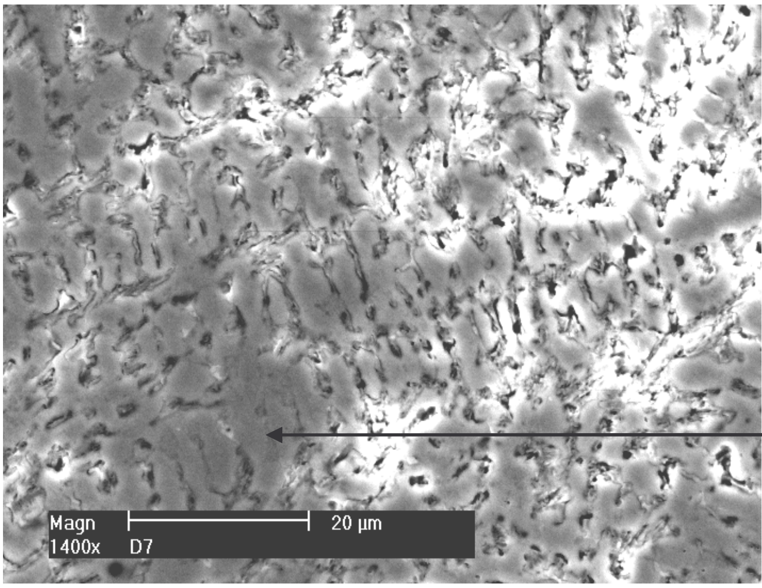
Figure 2. Microstructure of layers close to the melting line: a) PG5218, b) EuTroLoy 16012

Figs. 3 and 4 illustrate microstructure and chemical composition of austenitic matrix after cladding with two different powders. As seen, difference is relatively small.



Element	Wt %	At %
SiK	1.13	2.34
CrK	22.73	25.51
FeK	5.92	6.18
CoK	63.86	63.22
NiK	1.08	1.07
W L	5.29	1.68
Total	100.00	100.00

Figure 3. Microstructure and chemical composition of austenitic matrix within the padding weld made by PG5218 powder



Element	Wt %	At %
SiK	2.09	4.38
CrK	29.75	33.71
FeK	4.91	5.18
CoK	52.47	52.47
NiK	1.17	1.17
W L	9.61	3.08
Total	100.00	100.00

Figure 4. Microstructure and chemical composition of austenitic matrix within the padding weld made by EuTroLoy 16012 powder

The examinations of microstructure and composition within the clad layers and austenitic matrix show that no substantial difference occurs between technologies utilizing two different powders. This evidence may result from similar chemical composition of applied powders and the same parameters of cladding technology. Thus, there is no advantage of any powder and therefore the final choice of powder for laser treatment should be made upon the base of investigations of degradation of the clad leyers at high temperature in atmosphere of exhaust gases, currently in progress.

4. CONCLUSIONS

The microstructure of layers is composed of small grain, directional dendrites of subeutectic structure.

Within the subeutectic alloy constituting the padding weld, the austenite grains with Co, Cr and Ni as main elements are observed, rounded by eutectics composed mainly of W, Si and Cr.

The chemical compositon of clad layers is very similar to the chemical composition of applied powders.

The practical application of both powders should be verified by tests made at high temperature in atmosphere of exhaust gases, simulating operating conditions.

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REFERENCES

1. J.L.De Mol Van Otterloo and J.Th.M. De Hosson, Microstructural features and mechanical properties of cobalt-based laser coating, Acta Materialia, Vol. 45, pp. 1225-1236, 1997
2. A.S.C. d`Oliveira, R. Vilar and C.G. Feder, High temperature behaviour of plasma transferred arc and laser Co-based alloy coatings, Applied Surface Science, Vol. 201, pp. 154-160, 2002
3. A.S.C. d`Oliveira, P.S.C.P. da Silva and R.M.C. Vilar, Microstructural features of consecutive layers of Stellite 6 deposited by laser cladding, Surface and Coatings Technology, Vol. 153, pp. 203-209, 2002
4. Y. Yang and H.C. Man, Microstructure evolution of laser clad layers of W-C-Co alloy powders, Surface and Coatings Technology, Vol. 132, pp.130-136, 2000
5. Y. Yang, Microstructure and properties of laser-clad high temperature wear-resistant alloys, Applied Surface Science, Vol. 140, pp. 19-23, 1999
6. M. Zhong, W. Liu, K. Yao, J.-C. Goussain, C. Mayer an A. Becker, Microstructural evolution in high power laser cladding of Stellite 6+WC layers, Surface and Coatings Technology, Vol. 157, pp. 128-137, 2002
7. M. Riabkina-Fishman and J. Zahavi, Laser alloying and cladding for improving surface properties, Applied Surface Science, Vol. 106, pp. 263-267, 1996