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Structural Changes in the Base-Material under Coating by the Laser Surfacing Method

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Abstract.

The article is devoted to disclosure of the coating effect on structural changes of the base- material, deposited by the laser surfacing method. The chemical analysis of the studied materials was carried out and the obtained data were compared with GOST. The thermal influence zone and its dependence on a grade of the base- material and modes of coating are investigated. The microhardness of the coatings, thermal influence zones and base- material are determined.

Keywords: engineering, laser surfacing, microhardness, thermal influence zone.

INTRODUCTION.

The practice has shown that the sustainable development of all industry and economy sectors in general, largely depends on the engineering development level. This industry provides all manufacturing by the machinery and the required equipment. Moreover, machine building affects on the most important indicators of GDP, such as the material consumption, the energy consumption. And it is directly related with the defense capability of the state and the level of environmental safety production.

Unfortunately, it should be noted that nowdays domestic engineering is much yielded to demand of the elaboration level to the most developed and even developing countries. The situation in the industry is not saved by the successful introduction of new technologies and borrowing the experience of foreign countries. One of the problems is the restoration of the equipment and assemblies parts surfaces. The suggested way to solve this problem is to apply protective coatings using the method of laser surfacing.

Two steel grades were chosen as a base material: St3 and U8A. The chemical composition of the studied steels and the requirements of GOST are presented in table 1 and 2.

Table 1: Chemical composition of steel (%) St3

C	**Si**	**Mn**	**S**	**P**	**Cr**	**Ni**	**Cu**
Content of elements in research material							
0,18	0,04	0,47	0,031	0,026	0,03	0,03	0,04
GOST requisition 308-2005 for steel St3							
0,14 – 0,22	≤ 0,05	0,30 – 0,60	≤ 0,050	≤ 0,040	≤ 0,30	≤ 0,30	≤ 0,30

Table 2: Chemical composition of steel (%) U8A

C	**Si**	**Mn**	**S**	**P**	**Cr**	**Ni**	**Cu**
Content of elements in research material							
0,79	0,40	0,27	0,016	0,021	0,18	0,10	0,17
GOST requisition 1435-99 for steel U8A							
0,75 – 0,84	0,17 – 0,33	0,17 – 0,28	≤ 0,018	≤ 0,025	≤ 0,20	≤ 0,25	≤ 0,25

The samples were coated by the method of laser surfacing. The powder Plakart-03.98.-P was used as surfacing material. It is used for surfacing: bearings, valves of the diesel engine , fan blades, agricultural tools and mixer blades. This powder is designed for the protective coatings creation , which have a high resistance to abrasive wear, durability against corrosion and oxidation. The chemical composition of the powder is shown in table 3.

Table 3: Chemical powder composition Plakart-03.98

Name of the element	C	Cr	Si	W	Fe	Co	Ni	B	S	P
Amount, %	0,81	17,26	4,49	-	4,18	-	69,78	3,48	-	0,1

Firstly, the selected materials with the powders application and the base- material microstructure with the release of the thermal influence zone were studied. The results of the microstructures study are presented in figures 1-3.

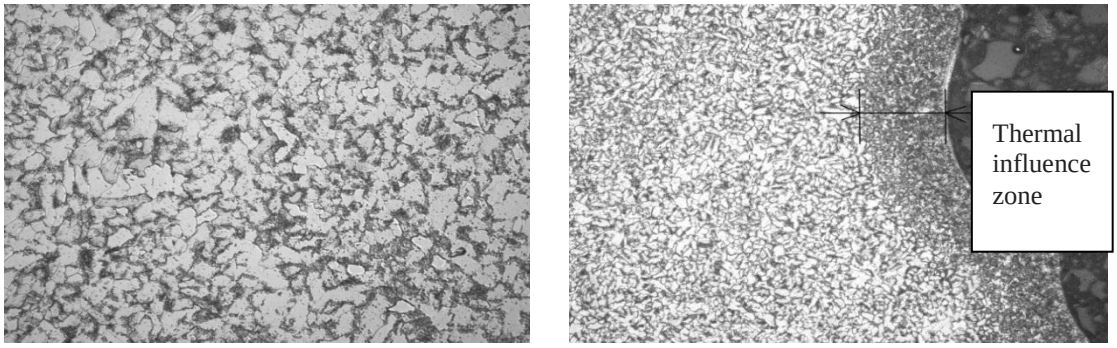


Figure 1: The microstructure of St3: a-before coating, X500; b-after coating, X200

A

Figure 1b shows the steel microstructure St3 after laser surfacing, on which we can observe thermal influence zone. Its average depth is 90 mkm (about 0.1 mm).

For a more detailed study of the thermal influence zone, phase description and structural changes concerning the initial state, the photomicrographs of steel St3 were made ith an increase of 500 - figure 2.

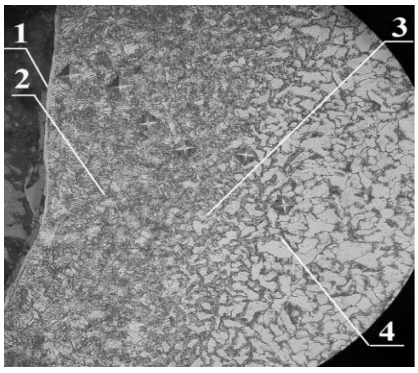
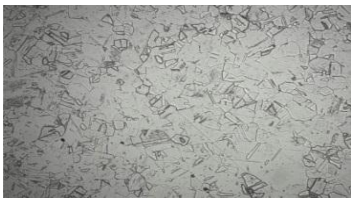
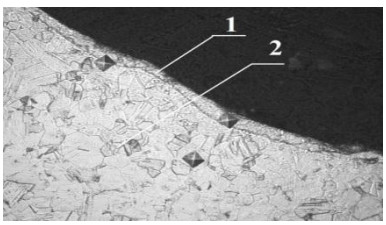


Figure 2: Microstructure St3, X500: 1-oxidized (decarburized) layer; 2- martensite zone; 3- transitional zone (zone of thermal influence); 4- base metal.

B



A



B

Figure 3: U8A Microstructure: a-before coating application, X500; b-after coating, X500: 1 oxidized layer; 2-base metal.

The metals samples interface is clearly visible, the thermal influence zone is sufficiently wide that indicates overheating of the material during the application of a protective coating by laser surfacing and it does not depend on the base material. The figures show that the grain in the thermal

influence zone is larger than the base- metal grain.

The main parameters for laser fusion are: the laser power and the speed of relative laser head movement.

Laser tests melting was carried out by changing the main parameters. Two specific values were chosen for each parameter. The tests of the selected melting regimes on different base materials varying the parameters according to table 4 were made.

Table 4: Variable parameters of laser dilution

№ Test	Parameter value		
	Laser power,Vt	Speed of laser head movement, mm/s	Steel grade
1	1800	10	St3
2	1200	10	St3
3	1800	5	St3
4	1200	5	St3
5	1800	10	U8A
6	1200	10	U8A
7	1800	5	U8A
8	1200	5	U8A

The microhardness of the coating, the thermal influence zones and base- metal were determinded. The results are shown in table 5.

Table 5: The obtained values of microhardness

Sample number	Microhardness, MP							
	Melted layer			Thermal influence zone				Base metal
1	3386	3474	3362	1981	1571	1458	1339	1257
2	7064	5722	3886	2019	1868	1833	1599	1201
3	4326	3662	2919	1613	1585	1361	1346	1194
4	3415	3444	3328	1967	1723	1575	1462	1257
5	3139	2828	3014	2235	2381	2159	2116	1886
6	5029	4826	4926	3761	3385	3273	3192	2189
7	5506	5536	4875	2487	2433	2282	2159	1766
8	3063	2991	2664	2434	2453	2433	2298	1904

For evaluating the dependence of microhardness on laser reflow modes, the results of the measurements are presented in the form of a diagram l .

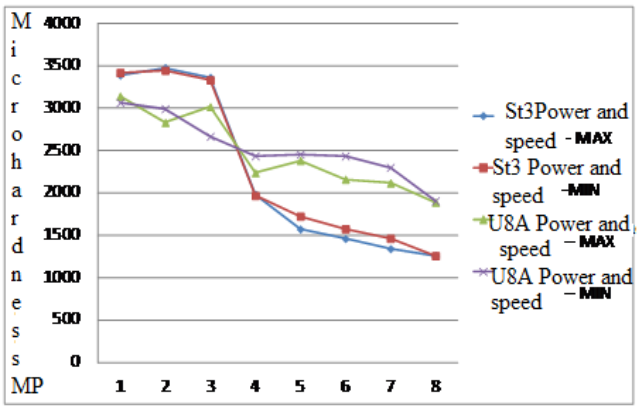


Diagram 1: Dependence of microhardness on laser reflow regimes.

CONCLUSION

The following conclusions can be drawn as a result of the study:

1. The difference in structure and size of the thermal influence zone and the base metal make up a voltage concentrator, the presence of which is reflected on the mechanical characteristics of the base- material.
2. For reducing effect on the mechanical characteristics of the base- material, it is necessary to conduct medium temperature tempering (400- 500 C).
3. The change in the modes of laser surfacing has not practically affected on the microhardness of the samples made of St3.
4. The preferred mode of the coating application is found as the minimum speed and power value for steel U8A, according to diagram 1.
5. The base- material is not affected on the microhardness of the applied coatings.