ELECTROSLAG SURFACING OF PARTS, MADE OF HIGH-CHROME CAST IRON, USING CAST IRON SHOT

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A lot of parts, used in machine building, metallurgy, mining and other industry branches and subjected to different types of wear in service, are manufactured of high-chrome cast irons. After base service the worn-out parts of this type are not subjected to restoration in practice by the known methods of arc surfacing. The present work deals with the possibility of restoration of worn-out parts, manufactured of high-chrome cast iron, using the technology of electroslag surfacing, developed at the E.O. Paton Electric Welding Institute. The peculiar feature of this technology is the application of a special device in surfacing, namely a current-carrying mould, allowing surfacing using a discrete filler material (shot). Here, the capability of «soft» and uniform heating of surface and layer being deposited by a slag, typical of various known methods of electroslag surfacing, the present technology provides a feasibility to produce a fine-grain deposited metal. This contributes to restoration of parts providing high service characteristics. Using the present technology, the experimental restoration electroslag surfacing of high-chrome cast iron layer on worn-out zones of plates of chamber of shotblast unit of «Bduhuis» company and blades of shotblast unit of «Carlo Banfi» company, made of high-chrome cast iron, were carried out. As a surfacing filler material the shot was used of the following chemical composition, wt.%: 2.5 C, 26.2 Cr, 0.7 Si, 0.7 Mn, 1.3 Ni, 0.9 Mo. It was found that the technology of electroslag surfacing using discrete surfacing materials in the form of shot of high-chrome cast iron allows manufacturing quality bimetal products with an optimum combination of deposited metal of high-hard carbides and ductile matrix in the structure. 5 Ref., 5 Figures.

Keywords: *high-chrome cast iron, electroslag surfacing, surfacing shot, deposited metal*

As to their structure the high-chrome cast-irons (15–30 % Cr) are the materials with an increased resistance to different kinds of wear [1–3]. As the abrasive-resistant materials they found the widest spreading in the machine building, metallurgy, mining industry, in particular at ore-dressing factories.

The advantage of these materials, due to the presence of a large amount of high-hard chromium carbides ($HV \approx 14.5$–16.0 GPa) in the structure, is also a serious drawback at the same time. The latter is connected with the fact that it is almost impossible to repair the products, manufactured of high-chrome cast irons, after their coming out of service. In particular, the known method of repair of parts using arc surfacing is not acceptable in this case, because it is necessary to apply a complicated technology for its realization (heating above 600–700 °C, strict keeping of rate of temperatures decreasing both in surfacing and also in next cooling of the deposited product), nevertheless not guaranteeing the prevention of crack initiation both during surfacing and also after it. As a result, these non-repairable products, in spite of their high cost, had to be sent to remelting in the form of production wastes.

The present work considers the method of restoration of this type of parts using the technology of electroslag surfacing (ESS). The main distinguishing feature of this technology from the arc technology is the absence of a local heating of surface being deposited. Therefore, no high gradients of temperature are occurred in different zones of the deposited metal and, respectively, high thermal stresses, connected with them, leading to the appearance of cracks both in base and also in deposited metals. The another feature of the technology considered is the application of discrete surfacing material, namely a shot. As the experience of application of high-chrome cast iron shot showed, the present technology in ESS of mill rolls, made of low-alloy white cast irons or high-strength ones allows producing the quality products of a high serviceability [4]. The cause of producing of deposited metal with high service characteristics (strength, wear resistance, shock-resistance, resistance to crack initiation both at normal and also increased temperatures, and also

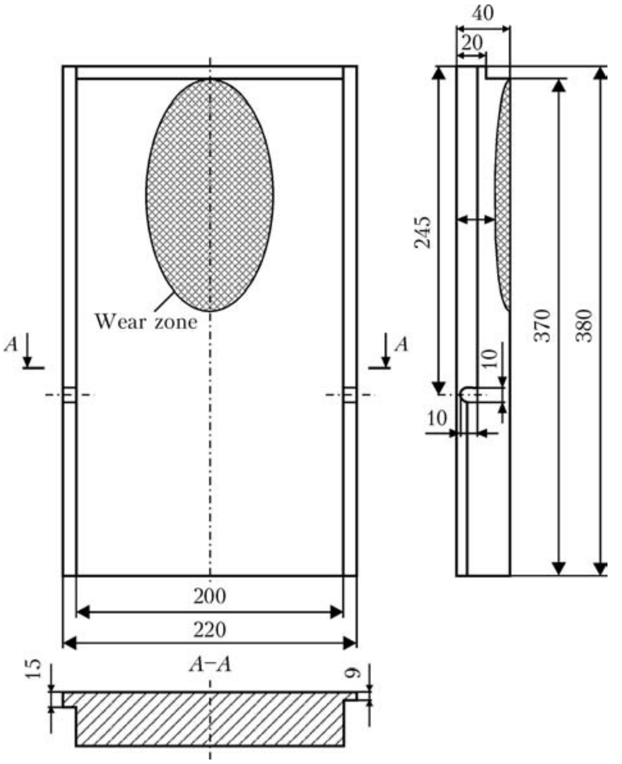

Figure 1. Scheme of upper plate of chamber of shotblast unit of «Bduhuis» company with a zone of abrasive wear

at thermal cycling) is the formation of a fine-grain metal in crystallization [5], having the matrix of increased ductility alongside with hard components (carbides). In other words, the present technology of surfacing allows producing a working layer in the form of a natural composite metal.

ESS was made of worn-out zones of plates of a chamber of shotblast unit of «Bduhuis» company (Figure 1) and blades of shotblast unit of «Carlo Banfi» company, manufactured of the high-chrome cast iron. As a surfacing filler material, the shot of OJSC «Torezhardalloy» was used, having the following chemical composition, wt.%: 2.5 C, 26.2 Cr, 0.7 Si, 0.7 Mn, 1.3 Ni, 0.9 Mo.

Specimens were cut out from deposited parts to evaluate the quality of deposited metal and carry out the metallographic examinations. It was found as a result of examinations of macrosections, that there were no pores, cracks and other defects in the deposited metal (layer thickness was 15–20 mm).

Metallographic examinations were made using microscope «Neophot-32». The digital image of microstructures was obtained by photocamera «Olympus C 5050» Hardness by Vickers was measured in microhardness meter M-400 of LECO company at 100 g load.

Microstructure of the deposited metal in surface layer of the specimen consists of chromium

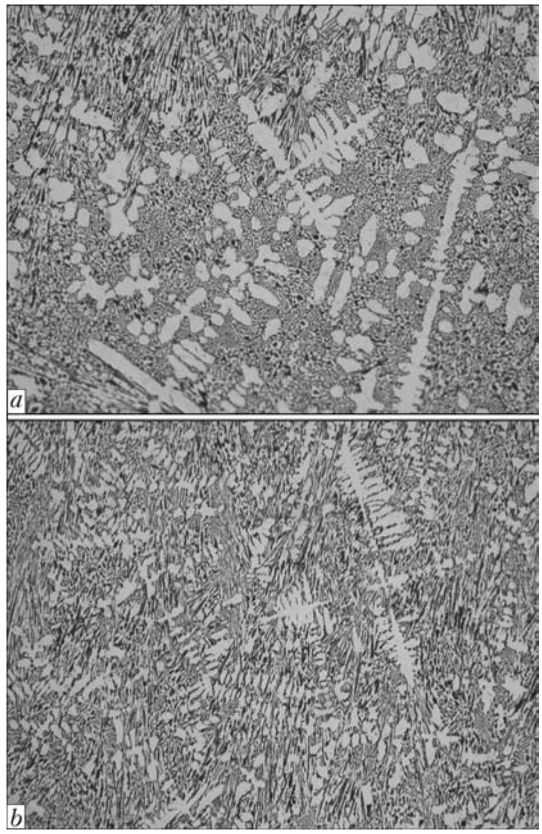

Figure 2. Microstructure (×125) of deposited high-chrome cast iron in a specimen surface layer (*a*) and in the middle part of deposited layer (*b*)

carbides arranged fan-like in the form of plates of a lancet shape and carbides, having hexagonal faceting with a distinct boundary of mating with a matrix, as well as a carbide eutectics and austenite in the form of dendrites (Figure 2, *a*). Microhardness of austenite in this zone $HV1$ is 2850–3090 MPa.

Metal in the middle part in height of the deposited metal is characterized by the presence of fine-dispersed carbides. In this zone the size of austenite dendrites is decreased, and the degree of their branching is increased (Figure 2, *b*). Microhardness of austenite zone $HV1$ is also in-

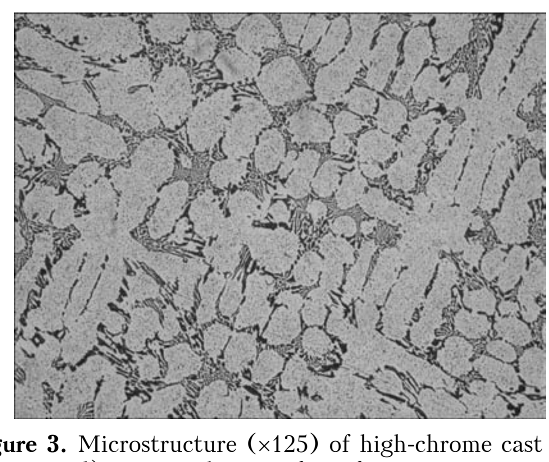

Figure 3. Microstructure (×125) of high-chrome cast iron (base metal) at some distance from fusion zone

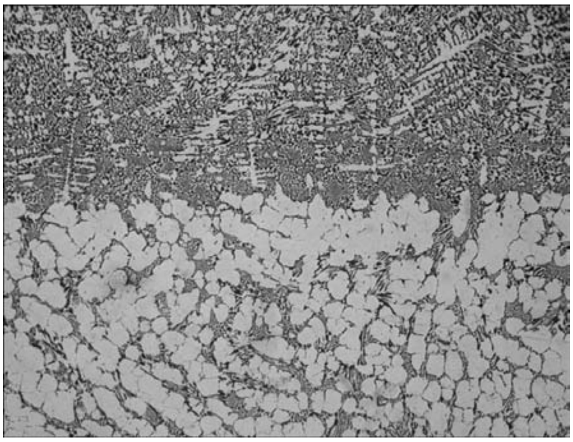

Figure 4. Microstructure (×100) of fusion zone of high-chrome-cast irons

creased to 3830 MPa. The deposited metal has a typical fine-grained structure (Figure 2, *b*) as the application of filler particles in surfacing promotes the formation of local zones of crystallization in a molten metal.

The structure of base metal near the fusion zone is differed from the structure of the deposited metal. First of all it is cellular and consists of an austenitic matrix of hardness *HV*1, equal to 3510–3830 MPa and precipitations of carbide eutectics along the boundaries of cells. The mean diameter of the cells is 25–44 μm. Fine-dispersed precipitations of carbides are observed in the austenitic matrix (Figure 3). Microhardness *HV*1 of austenite with fine-dispersed precipitations of carbides is 6060–6420 MPa. Ratio of sizes of structure components in the deposited and base metal are well seen in Figure 4, where their fusion zone is presented. The width of this zone is rather large, i.e. 1400–1800 μm.

One of the indices, characterizing the metal resistance against the abrasive wear, is its hardness. Therefore, hardness (*HRC*) of the deposited specimen was measured in its height: from the base metal up to the deposited layer surface (Figure 5).

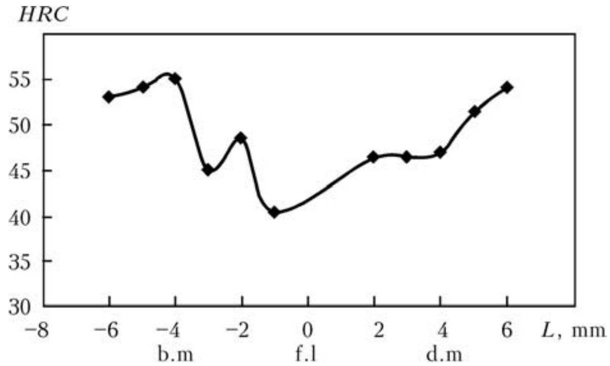

Figure 5. Hardness of specimen, deposited by ESS using shot of high-chrome cast iron (b.m — base metal, f.l — fusion line, d.m — deposited metal)

Maximum hardness of the deposited metal almost corresponds to the base metal hardness. In both cast irons the hardness reduction is observed when approaching the zone of their fusion: by 6–8 in deposited metal and by 13–15 units in the base metal. It should be noted that the lower hardness in the base metal is observed on the product working surface. This is due to the peculiarities of product casting, for example, its non-working side could, probably, be cooled at higher rates. It can be concluded from the abovementioned that under the real service conditions the as-repaired product should possess a wear resistance of not less than by 20 % exceeding that of the new product (coming only from the hardness values).

Conclusions

1. Restoration of worn-out products, made of high-chrome cast irons, by ESS using cast iron shot, also containing the increased amount of chromium, allows manufacturing quality surfaced products.

2. Applying the offered surfacing with use of a water-cooled mould and discrete filler, it is possible to provide the optimum conditions of crystallization of molten metal (metal pool) with obtaining of fine-dispersed structure and increased service characteristics.

3. Application of ESS for some products as a technology of repair can increase their service life not only due to extension of this life, but also by imparting the higher service properties to the working surface.

4. Full-scale tests of restored different-purpose products by the offered method of ESS will allow defining the optimal fields of application of the offered technology and specifying of its advantages.

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