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Development of Technology to Increase the Brittleness of Cast Parts Made of Alloyed White Cast Iron

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Abstract— *Development of the chemical composition of the charge on the basis of alloying elements for the production of stable structural white cast iron, and CEMCO and BARMAK the issues of casting rotors of crushers operating under high friction conditions are considered. The analysis showed that in order to increase the service life of products obtained by casting in the conditions of the Navoi Metallurgical Plant of Navoi Mining and Metallurgical Enterprise, they were offered to use special heat treatment methods.*

Keywords— brittleness, grinder, rotor, pump, friction, heat treatment, chrome, alloyed white cast iron, phase, carbide, cementite, shale, alloy.

1. INTRODUCTION

The high-chromium white irons have excellent abrasion resistance and are used effectively in slurry pumps, coal-grinding mills, shot-blasting equipment, and components for quarrying, hard-rock mining, and milling. In some applications they must also be able to withstand heavy impact loading. These alloyed white irons are recognized as providing the best combination of toughness and abrasion resistance attainable among the white cast irons.

In the high-chromium irons, as with most abrasion-resistant materials, there is a trade-off between wear resistance and toughness. By varying composition and heat treatment, these properties can be adjusted to meet the needs of most abrasive applications.

Specification **300X32N2M2TL** covers the compositions and hard nesses of two general classes of the high-chromium irons. The chromium-nickel irons (contain 30 to 32 % Cr and up to 2 % Ni and can be supplied either as-cast with an austenitic or austenitic-martensitic matrix, or heat-treated with a martensitic matrix microstructure for maximum abrasion resistance and toughness. They are usually considered the hardest of all grades of white cast irons. Compared to the lower-alloy nickel-chromium white irons, the eutectic carbides are harder and can be heat-treated to achieve castings of higher hardness. Molybdenum, as well as nickel and copper when needed, is added to prevent pearlite and to ensure maximum hardness.

The high-chromium irons **280X29NL** represent the oldest grade of high-chromium irons. These general-purpose irons, also called 28 % Cr and 30 % Cr irons, contain 25 to 30 % Cr with up to 1 % Mo. To prevent pearlite and attain maximum hardness, molybdenum is added in all but the lightest-cast sections. Alloying with nickel 2 % and copper 0,2 % is also practiced. Although the maximum attainable hardness is not as high as in the class 280X29NL chromium-molybdenum white irons, these alloys are selected when resistance to corrosion is also desired.

MATERIALS AND METHODS

Today, centrifugal crushers are widely used in metallurgical plants operating in the Republic of Uzbekistan, including the state enterprise "Navoi Mining and Metallurgical Combine", JSC "Almalyk Mining and Metallurgy" and JSC "Uzmetkombinat". Changes in the technological route of flexible rotor parts and crusher rotors, ie the possibility of corrosion of CEMCO and Finger crushers based on centrifugal force and corrosion-resistant pump parts made of alloyed white cast iron. Extensive research is being conducted on the chemical composition of the cast material, the development of enrichment with alloying elements and the use of modern, efficient methods of heat treatment in the production of castings and their high-friction rotors. The developed technologies are being implemented in metallurgical plants, including the state enterprise "Navoi Mining and Metallurgical Combine", "Almalyk Mining and Metallurgy" and "Uzmetkombinat" operating in the country.

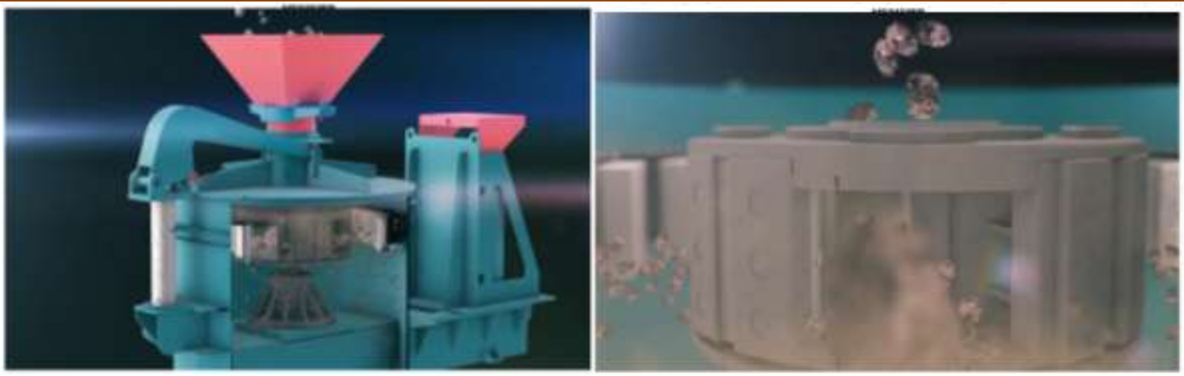


Figure 1. CEMCO is the operation of the rotor of a crusher operating under the influence of centrifugal force

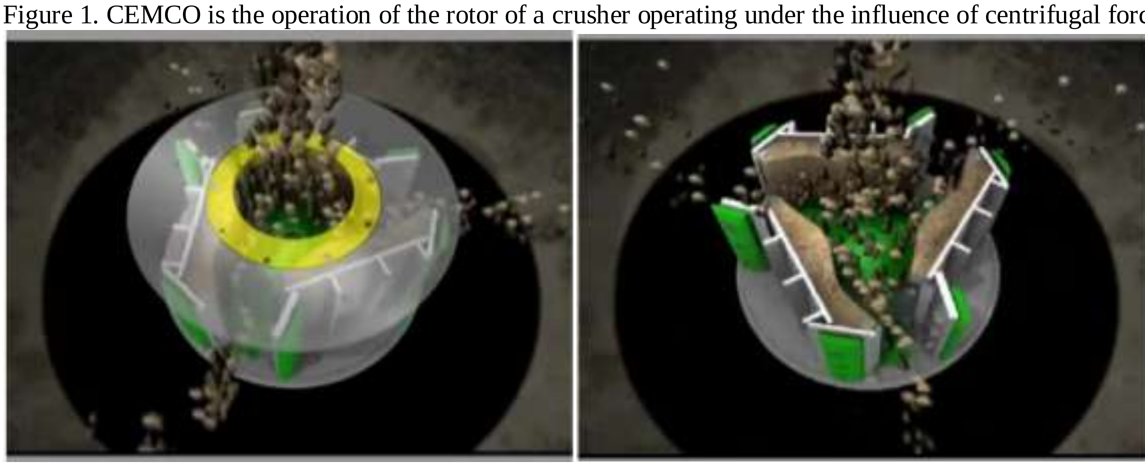


Figure 2. FINGER The operation of the rotor of a crusher operating under the influence of centrifugal force

Uzbek and foreign manufacturers have enriched the internal structure (structure), physical and mechanical properties of ductile alloys, chemical composition of alloys for the production of alloyed white cast iron with a stable structure with alloying elements, improvement of molding technology, as well as out-of-furnace processing of liquid metal. In addition to the transfer, the development of crystallization regimes of the metal in the mold is one of the current issues.

DISCUSSION

At present, the causes of defects in the rotors and pump parts of high-friction CEMCO and BARMAK crushers, which operate on the basis of centrifugal force in the crushing of ores in the production conditions of Navoi Mining and Metallurgical Combine, have been studied and analyzed. A number of suggestions and tasks have been identified in order to increase the service life of parts by providing durability on the surfaces of parts with a high tendency to wear under the influence of strong stress and a high probability of cracking.

Research work of domestic and foreign manufacturers on corrosion-resistant alloyed white cast iron-based cast alloys, as well as research conducted by foreign research institutions and laboratories to extend the service life of cast parts made of corrosion-resistant alloyed white cast iron.

As a result of the research, the effects of Cr, Ni and other alloying elements on the alloy were studied and analyzed. Alloyed white cast irons have high performance properties, from which it is recommended to obtain quality castings. As a result of the alloying of cast iron with various alloying elements, including chromium, its alloying properties increase depending on the amount of chromium. In addition, the corrosion resistance of alloy cast irons is very sensitive to the formation of microstructure in it, that is, when obtaining alloyed white cast iron, it is necessary to form not only the quality of the cast, but also the structure that ensures the brittleness of white cast iron.

The brittleness of cast irons is mainly provided by carbides with a structure of (Cr, Fe) 7 C3, (Cr, Fe) 3 C or Cr (30, Cr, Fe) 23 C6 when the content of Cr is 9.5-15%. The reason is that this carbide is 1.5-2.0 times harder than cementite carbide. Another complication associated with this is that (Cr, Fe) 7 C3, (Cr, Fe) 3 C, (Cr, Fe) 23 C6 The amount of chromium in the alloyed white cast iron, which has 3% S for the formation of carbides in the system, is very high. , Is formed in the range of 5 to 30%.

White cast irons form silicides with iron and silicon (FeSi, Fe3SiO2), which promote the release of carbon in the form of graphite. Therefore, the content of silicon in alloyed white cast irons, which is determined in the production of cast iron for quality alloying white cast iron, is in the range of 0.51%.

In alloyed white cast irons, manganese increases the stability of iron carbide (Fe3C) and resists the decomposition of carbon into graphite. At the same time, it removes the sulfur from the cast iron from the FeS compound and transfers it to the slag in the form of MnS, which slightly cleans the cast iron from harmful sulfur. Therefore, when obtaining quality castings, it is recommended that the manganese content in alloyed white cast irons be 0.57%.

In addition, it is important to increase the strength of alloyed white cast iron on the basis of thermal processing, because through thermal processing their mechanical properties can be changed to a wide extent. The purpose of thermal treatment of alloys is to bring their mechanical and physical properties to the required level by changing their internal structure.

According to the G'e-G'e3S diagram, four main phase changes are observed in the thermal treatment of alloys:

1) When the alloy is heated above the phase shift line A1, perlite decomposes into austenite:

G'ea (S) + G'e3S → G'eg (S)

2) When austenite is cooled to a temperature lower than the phase shift line A1, austenite decomposes into perlite:

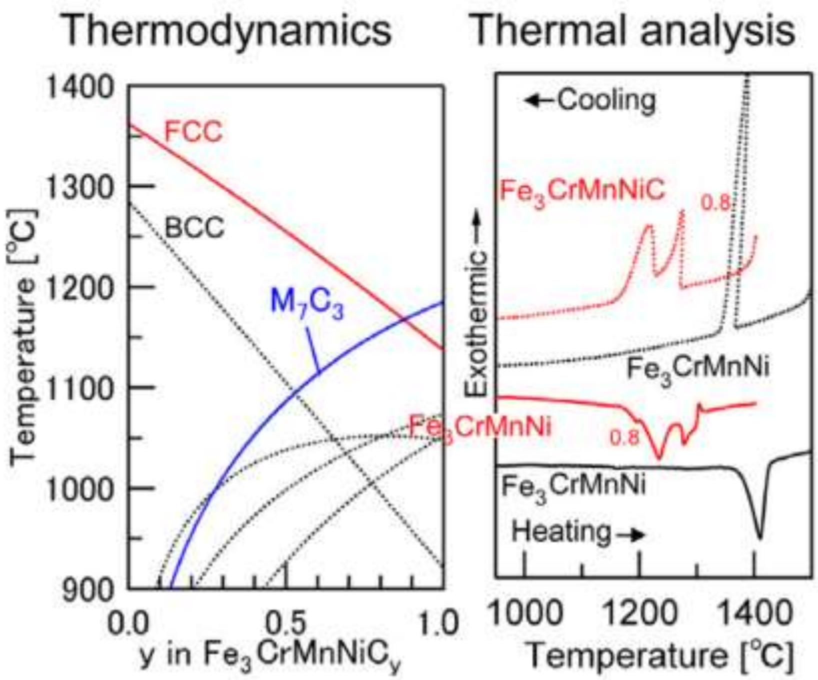
G'eg (S) → G'ea (S) + G'e3S

3) at a temperature lower than the metastable equilibrium temperature, austenite decomposes into martensite:

G'eg (S) → G'ea (S)

4) martensite decomposes into perlite at any temperature:

G'ea (S) → G'ea (S) + G'e3S



1-graph. Thermodynamic calculation of the T_L of FCC and BCC phases, and various carbides in $Fe_xCrMnNiC_y$ HE cast iron alloys.

In addition, in order to ensure the strength of workpieces under the strong stress of alloyed white cast iron, the optimal mode of thermal treatment and chemical composition of the alloy material for the production of stable structural abrasion-resistant alloyed cast iron was increased by 3-4%. Preliminary results have shown that research in this area may yield the expected results.

For the production of stable structural alloyed white cast iron in the laboratory conditions of Tashkent State Technical University developed modes of extraction of liquid metal from the furnace and crystallization in the mold.

Modern, efficient methods of heat treatment were used to increase the internal structure (structure), physical and mechanical properties of alloys obtained by casting.

Scanning electron microscope (SEM) Empyrean Malvern Panalytical diffractometer and Carl Zeiss EVO-MA-10 complex scanning electron microscopes were used to determine the properties and chemical composition of the samples.

Results

Cast-in-place alloyed white cast iron is mainly used in the production of technology to increase the ductility of alloyed white cast iron products in order to increase the service life of high-friction heavy-duty rotors of pump spare parts and centrifugal CEMCO and BARMAK crushers. The chemical composition of the material was enriched with alloying elements. Table 1 shows the chemical composition of the alloy.

Table 1

Chemical composition of the proposed alloy

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Brand	**Elements, %**									
	C	Si	Mn	P	S	Cr	Ni	Mo	Ti	Cu
300X32H2M2TЛ	2,67	1,13	0,57	0,043	0,018	31,58	1,93	0,37	0,2	0,07
300X32H2M2TЛ shale composition of the branded alloy										
Cast iron	Л2				ГОСТ 4832-95					
Choyan lom (return)	Б 65				ГОСТ 2787-75					
Nerjaveka lomi	Никел Н12				ГОСТ 1969-2009					
Ferrochrome	ФХ-100				ГОСТ 4757-91					
Ferromanganese	ФМн-88				ГОСТ 4755-91					
Cast iron	ФС-45				ГОСТ 1415-93					

Before and after heat treatment of the samples, the length of the projection of geometric distances in the horizontal plane, ie the distances between corresponding points on the flat and horizontally oriented surface of the object, was determined using an electron microscope scanning the image of the element analysis. The electron beams were constantly examined on the surface of the object, the part of its image formed by the microscope. In addition, each point on the surface of the object was indicated by a corresponding point on the image generated in the microscope view. When electron beams were exposed to the surface of an object, multiple response signals occurred simultaneously. Depending on which signal detector was introduced, the microscopes produced one or more clear images.

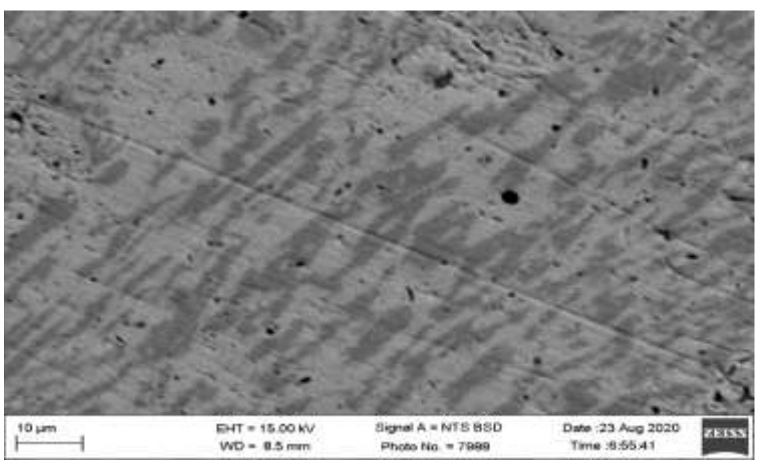


Figure 3. 28x imaging image based on CEM Zeiss EVO MA 10 scanning electron microscope before heat treatment of 280X29NL alloyed white cast iron.

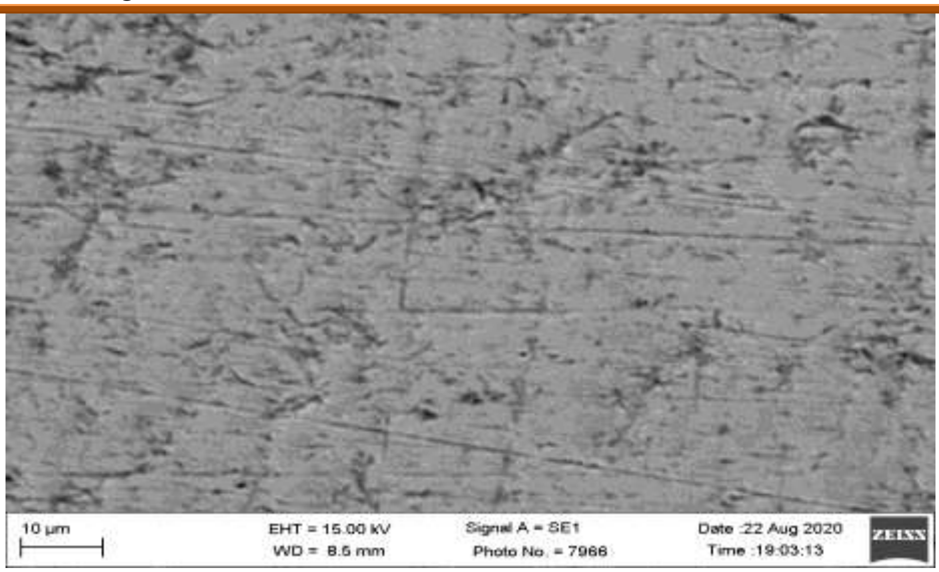
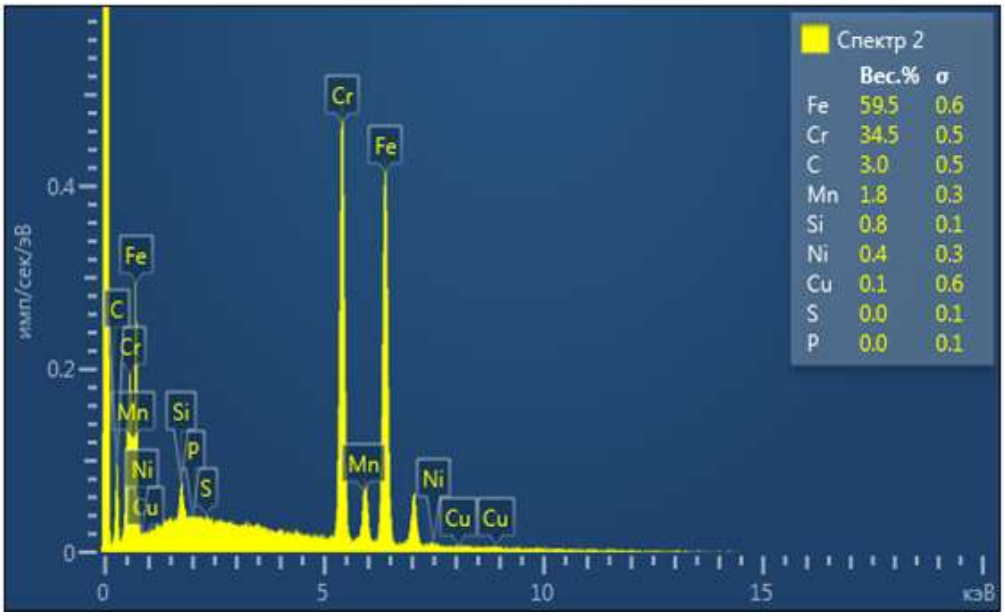
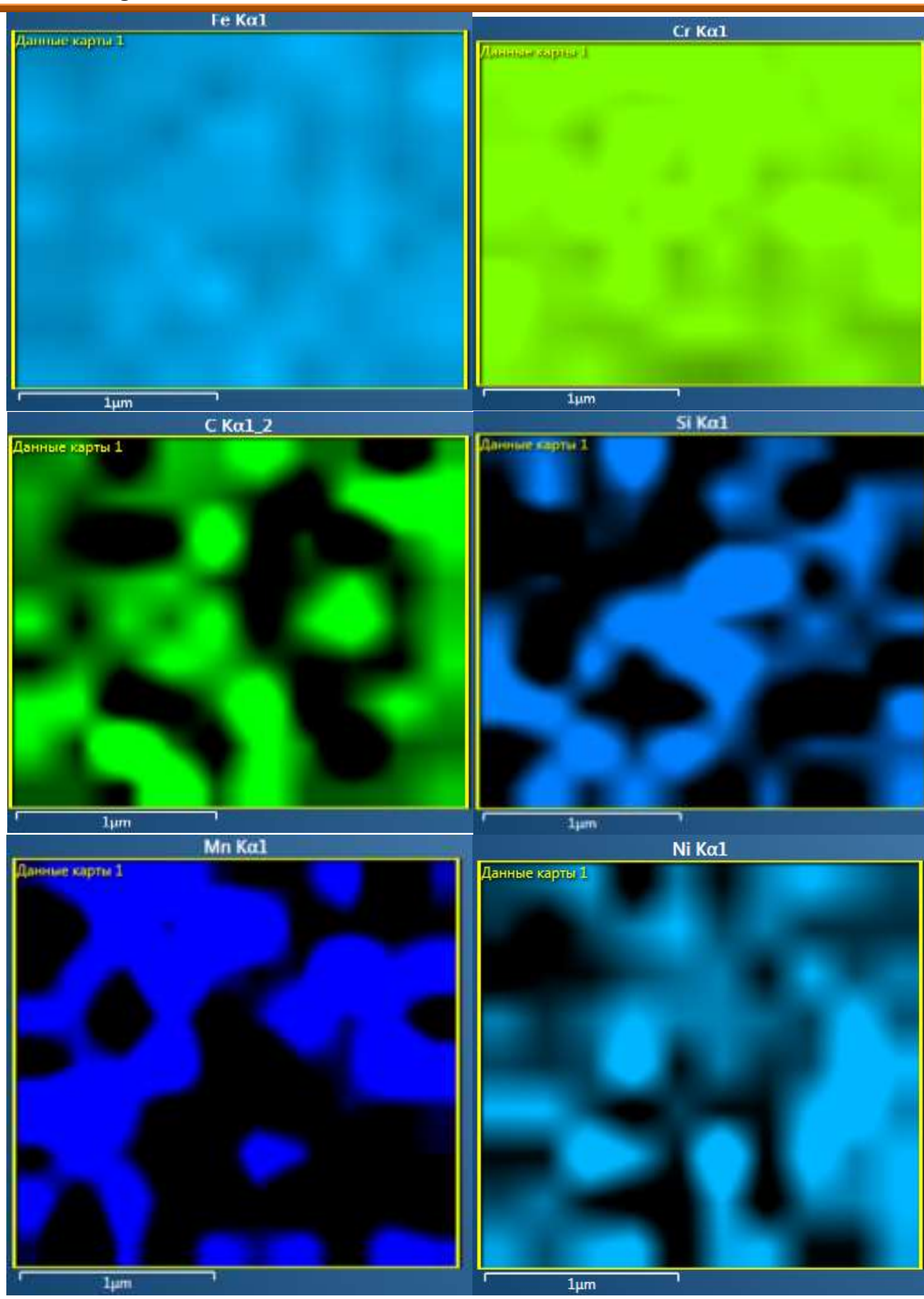
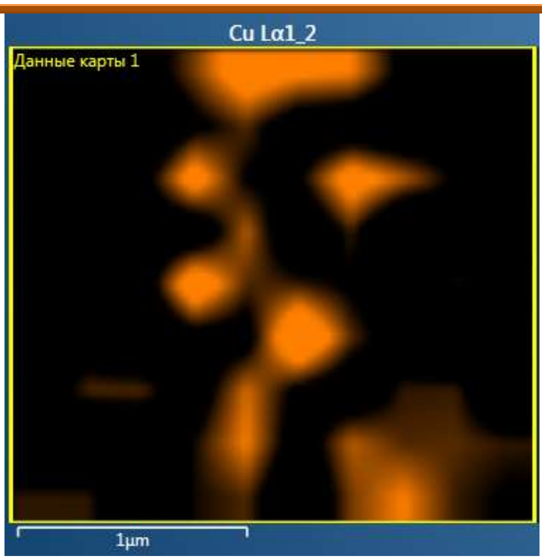


Figure 4. 28x X-ray image of CEM Zeiss EVO MA 10 scanning electron microscope after heat treatment of 280X29NL alloyed white cast iron.



5-расм. 280X29NL маркали легирланган оқ чўянни сканерловчи электрон микроскопда термик ишлов беришдан аввал элементлар таҳлили.


Fe Kα1
Данные карты 1
1μm
Cr Kα1
1μm
C Kα1_2
Данные карты 1
1μm
Si Kα1
Данные карты 1
1μm
Mn Kα1
Данные карты 1
1μm
Ni Kα1
Данные карты 1
1μm



6-расм. 280X29NL маркали легирланган оқ чўянни скайнерловчи электрон микроскопда 1 μm майдондаги элементларнинг фазаларда жойлашиш тасвири.

Conclusion

Based on the above, a technology has been developed to increase the service life of corrosion-resistant alloyed white cast iron parts. Based on the analysis of the initial results, the following conclusions were made:

- There is an opportunity to increase the operating resource by 1.3-1.5 times and develop resource-saving technology in the production of pump spare parts and rotors of crushers;
- Increasing the service life of working surfaces for corrosion on the basis of providing directed crystallization served to increase resource savings by 6-8%;
- Enrichment of the chemical composition of the slag with alloying elements before loading into the furnace for the production of white cast iron with a stable structure served to increase economic efficiency;
- Improving the modes of heat treatment of castings served to increase the service life of the product;
- Increased economic efficiency by 10-15% through the introduction of production conditions.

2. References

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