Technology to Increase the Hardness and Resistance of High – Chromium White Cast Iron

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Abstract: In this article, the optimal chemical composition for resistance white cast iron has been developed and the microstructure of the alloy as well as its chemical composition have been thoroughly examined using an electron microscope scanner. The ductility of the alloy was also tested depending on the amount of carbon and chromium in the alloy.

Keywords: resistance white cast iron, chromium, manganese, metalworking industry, mechanical properties, furnace, carbon, sand – clay mold, tungsten carbide, microstructure

INTRODUCTION

One of the most important tasks in the world today is to cast cheap and resistance castings on the basis of increasing the strength, quality, mechanical and operational properties of machine parts obtained by casting. [1]. Research work in the field of foundry worldwide, including: development of high – quality and economically inexpensive alloys without changing the chemical composition of the alloy, depending on the operating conditions of the alloy, taking into account the working environment of ductile white cast iron; correct selection and improvement of the system of injection molding of ductile white cast iron in casting molds; It is important to study the effect of liquid alloy casting from above on the casting sand during casting, to calculate the heat dissipation coefficient of the alloy when pouring the alloy into the mold, to develop and use new optimal heat treatment standards for ductile alloys [2,3].

Scientific innovations are being made in a number of areas for the liquefaction of ferrous metals and the production of high – quality alloys from ductile white cast iron in foundries. In this regard, the United States, Spain, Egypt, Mexico, Russia, Ukraine and other countries are the leaders in the production of white cast iron. Due to the annual increase in the production of castings in the foundry industry, special attention is paid to the development of technology for the production of high-quality, malleable cast iron products on the basis of an efficient method that saves resources [4,5].

MATERIALS AND METHODS

Although the world practice has accumulated extensive experience in the use of low – alloy high – chromium and chromium – manganese cast iron as anti – friction material, defects in castings during heat treatment or crystallization, increasing friction and mechanical properties remain problematic [6,7]. It is urgent and necessary to solve these problems with the help of additional research on the processes of alloying, microalloying, modification and heat treatment [8 – 10].

One of the most common types of abrasive friction is hydroabrasive, which involves the cleaning of hydraulic ash from parts of thermal power plants. This process is carried out depending on the working conditions of the details. The following chemical composition was recommended in this study.

Table 1 Chemical composition of high chromium manganese cast iron

Elements, %					
C	**Si**	**Mn**	**Cr**	**P**	**S**
2,7 – 3,2	0,4 – 0,8	3,8 – 4,0	19 – 20	0,05 – 0,06	0,04 – 0,05

The study of the effect of chromium and manganese on the hardness and corrosivity of resistance white cast iron and their high performance properties in different environments was found [11 – 14].

In the metalworking industry, mechanical properties play a major role in selecting the right alloy for every detail. During the entire casting and processing process, as well as during the service life of the products, the selected material is exposed to many external forces. It is up to the manufacturers to create products that work at the desired level at each stage.

By increasing the amount of manganese in the alloy, the impact viscosity and resistanceness of the alloy are improved. However, as the manganese content exceeds 1%, the erosion of the inner layer of the furnace crucible (coating) accelerates.

Mechanical properties describe how a material reacts to applied loads or forces. These properties are not constant, they vary depending on temperature and other external factors, so manufacturers should have a thorough knowledge of the working environment of the part before recommending the appropriate material.

As shown in Figure 1, the ductility of cast iron improves with increasing chromium content in ductile white cast iron. When the chromium content is in the range of 18 – 30%, in practice there is no effect on the ingress of cast iron.

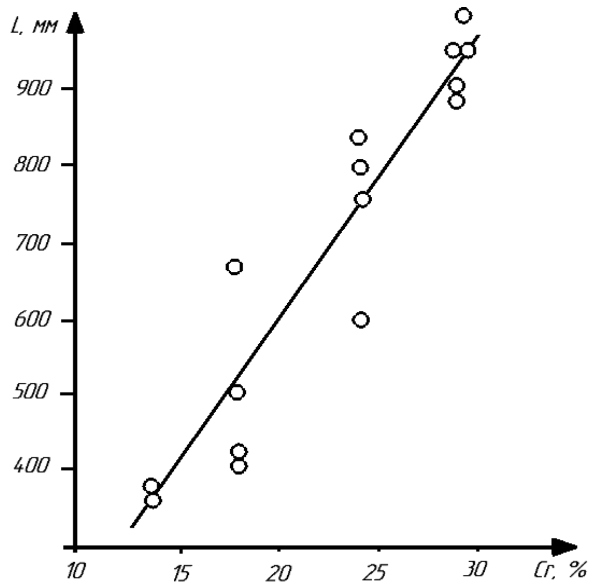


Figure 1. Graph showing the ductility of cast iron with a carbon content of 2.8 – 3.2% depending on the amount of chromium

As the amount of carbon and chromium in this alloy increases, its ductility and heat improve.

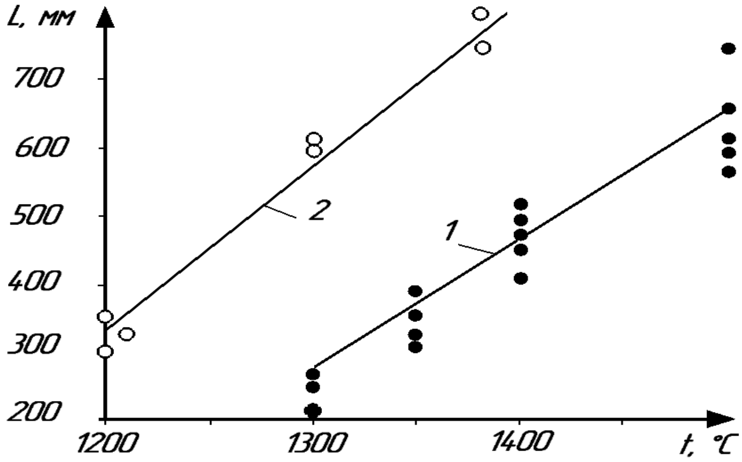


Figure 2. Graph showing the effect of the temperature of molten cast iron during combustion on the fluidity of the solution. 1 – resistance white cast iron; 2 – gray cast iron

As the casting temperature of the cast iron increases, their ductility also increases linearly, and at a temperature of 1500^0 C it reaches 600 mm along the Kerry spiral (Figure 2). [15 – 18].

RESULTS

The resistance white cast irons were liquefied in an IST – 2.5 ton induction furnace, poured into a sand – clay mold and cooled, and the castings were cleaned of sand that had stuck to the surface. Samples with a diameter of 8 mm and a length of 20 mm were then cut from the sample, and the samples were processed step by step using abrasive papers of 500, 1000 and 2000 microns. The surface of the samples was polished using WC (tungsten carbide) paste. After the grinding process, the samples were exposed to reagents in accordance with GOST 5639 – 82. Solic (NCl) and picric (C_6H_2 $(NO_2)_3OH$) acids were used as reagents. The main purpose of reagent exposure to the structure of the samples is to divide the structure of the samples into phases and examine them under a microscope. As a result, the structure of brittle white cast irons was able to be clearly demarcated. Samples were magnified on the CEM Zeiss EVO MA 10 scanning electron microscope from x500, x2000 to x5000 times at the Center for Advanced Technologies under the Ministry of Innovation Development. The obtained microstructures are shown in Figures 3, 4 and 5.

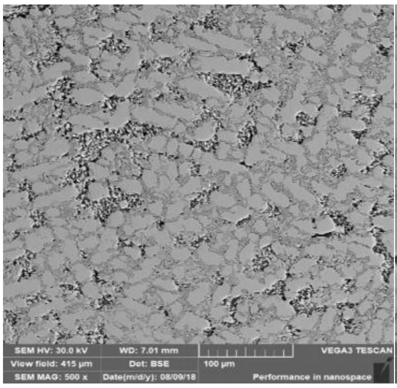


Figure 3. CEM Zeiss EVO MA 10 scanned electron microscope x500 magnification image

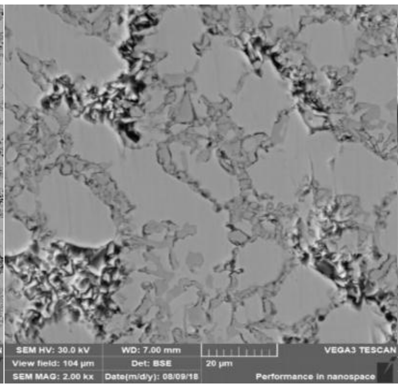


Figure 4. CEM Zeiss EVO MA 10 scanned electron microscope magnified image x2000 times

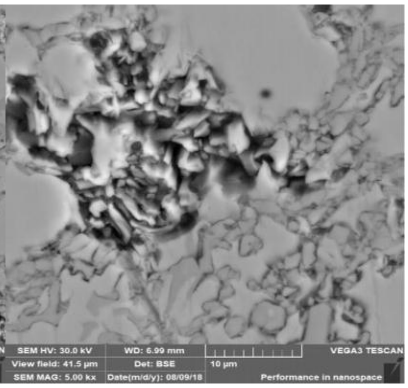


Figure 5 CEM Zeiss EVO MA 10 scanned electron microscope magnified x5000 times

The chemical composition of the alloy was also examined using a scanning electron microscope, and the results are shown in Figure 6.

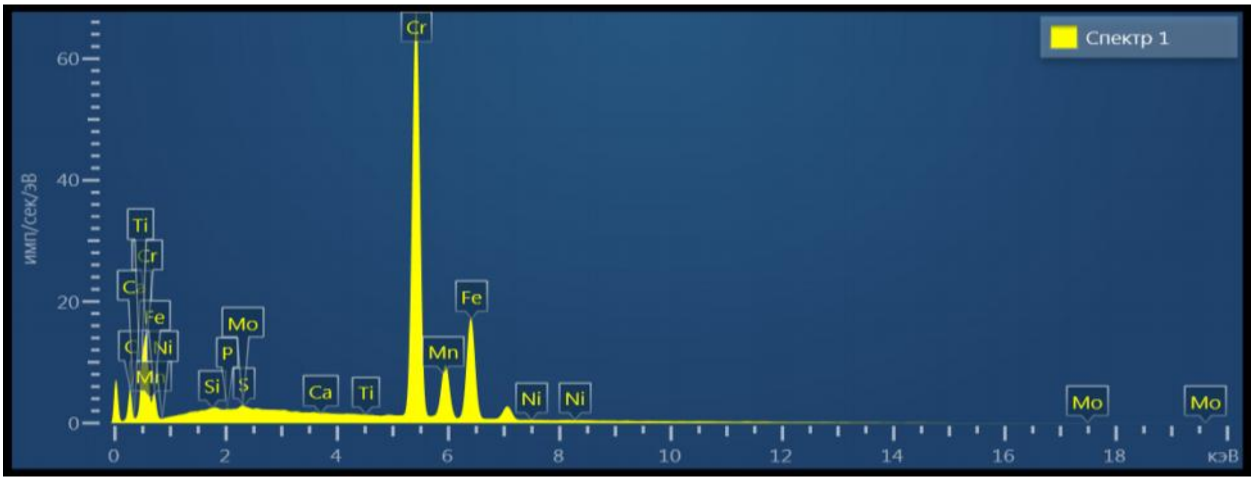
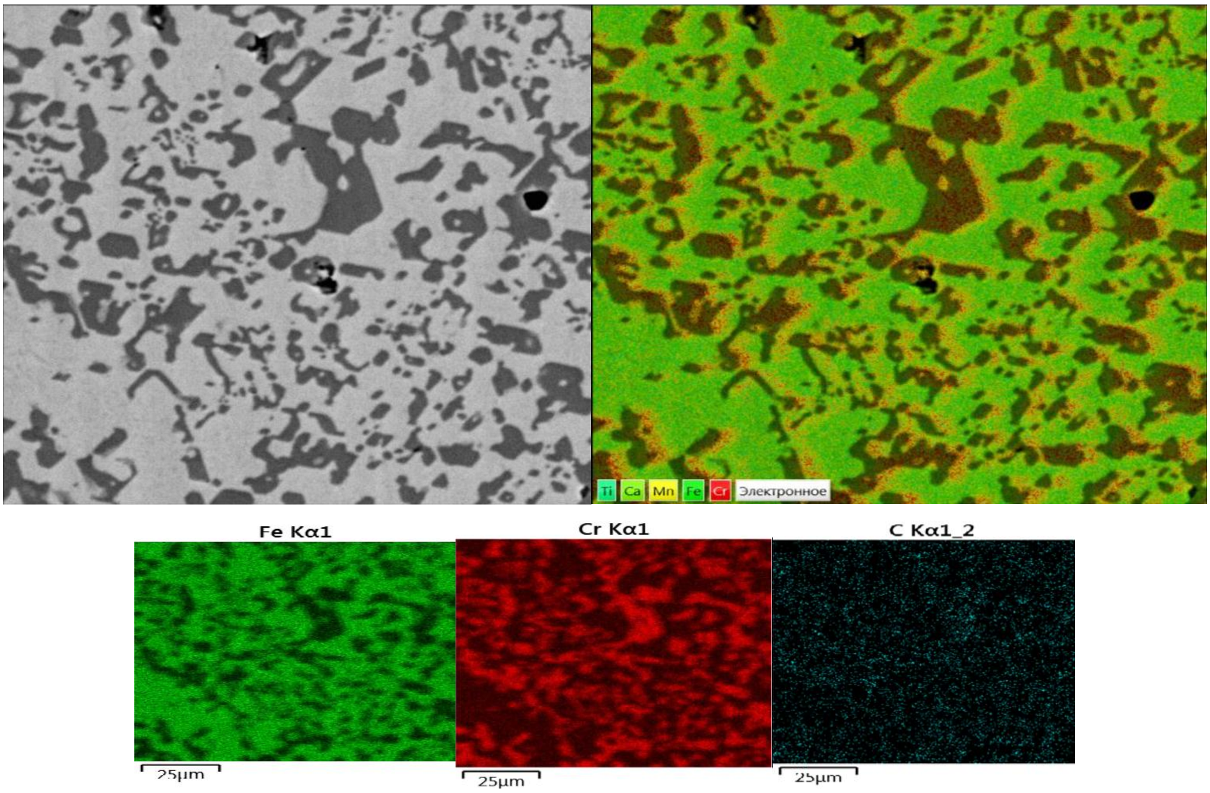


Figure 6. The chemical composition of ductile white cast iron was determined using CEM Zeiss EVO MA 10 scanning electron microscope

The distribution of the chemical elements in the samples under study was examined using an electron microscope that scanned the surface of the alloy. The main reason for this is that the mechanical properties of the alloy are affected by the distribution of the chemical elements in the alloy. The distribution of chemical elements across the surface is shown in Figure 7.



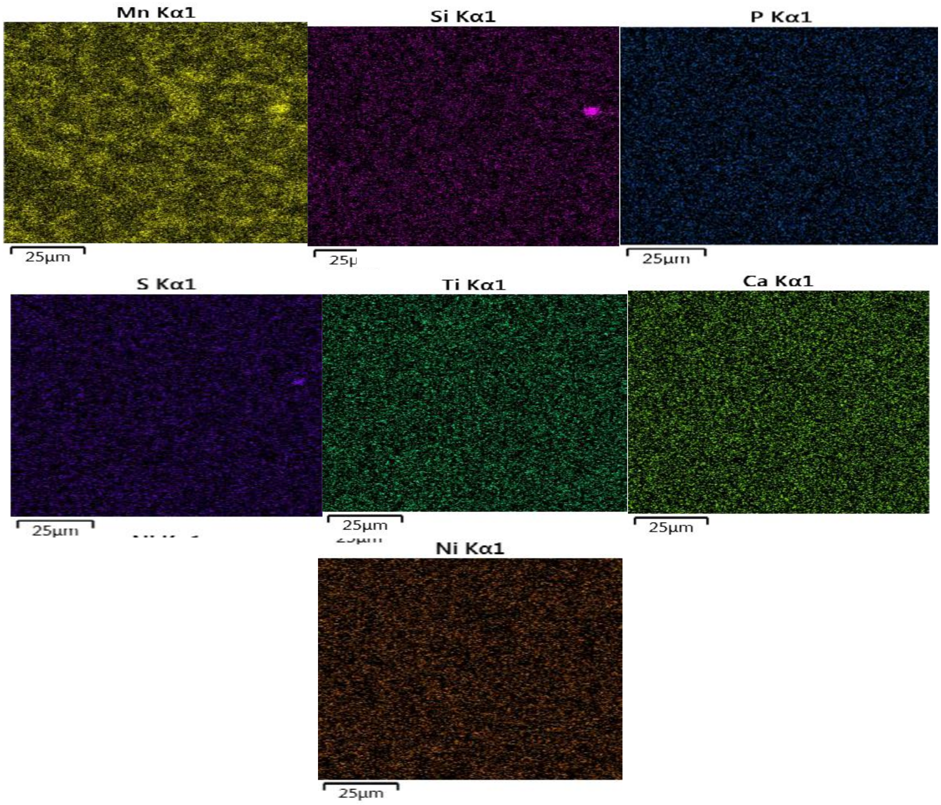


Figure 7. Dispersion of the chemical elements of corrosive white cast iron across the surface

CONCLUSION

The results of the microstructure, chemical composition, and surface dispersion of the alloys are presented using an electron microscope that scans the liquefied samples. The ductility of the alloy and its effect on the penetration of chromium in edible white cast iron at 18 to 32% were also studied.

In addition, the effect of the chemical composition of the elements of the alloy on the lining of the electric furnace was analyzed and an optimized chemical composition was developed.

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