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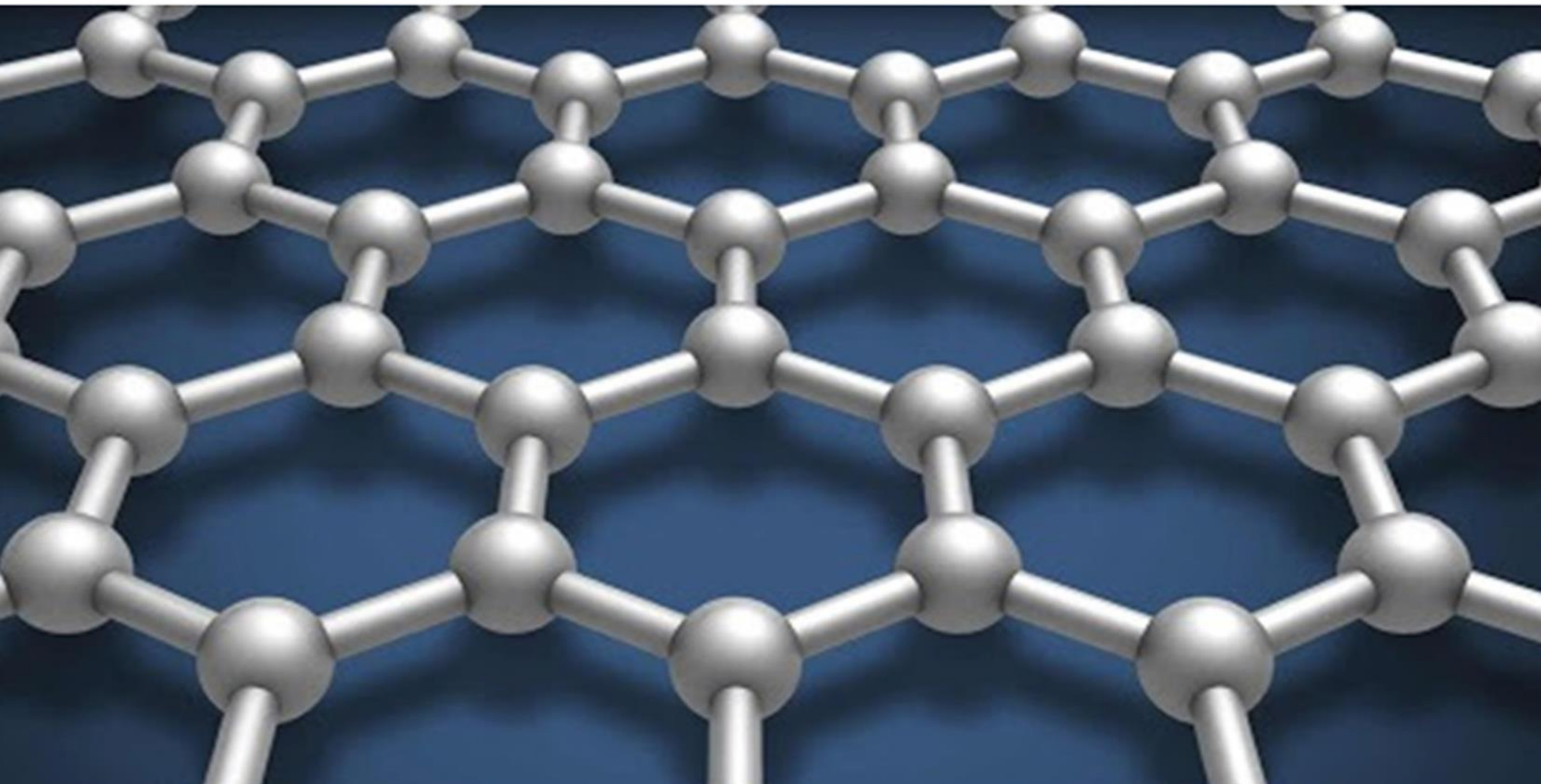
O‘zbekiston

Kompozitsion Materiallar

Ilmiy-texnikaviy va amaliy jurnali



Узбекский научно-технический и производственный журнал

Композиционные материалы

туфайли босимни 50... 60 МПа дан ортиқ ошириб, жараённинг барқарор ўтишига эришиш мумкин эмас.

Хулоса. Электроконтакт пишириш жараёни учун зарур бўлган совуқ пресслашнинг дастлабки зичлиги ва электр қаршилигига темир ва феррохром кукунлари учун 13 МПа дан юқори босимда ва 20% феррохром ёки ундан ортиқ темир аралашмалари учун 25 МПа дан юқори босимда эришиш мумкин.

Темир ва феррохром металл кукунлари зарядига бор карбид қўшилиши сиқишни ёмонлаштиради ва аралашманинг электр қаршилигини оширади.

Аниқланишича, электр ўтказувчанлик шартларига кўра, темир-феррохром аралашмасига киритилган 1...3 wт.% B_4C ҳам 50...60 МПа дан юқори босиш босимини талаб қилади, бу ҳар доим ҳам мақсадга мувофиқ эмас.

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MICROSTRUCTURE OF GRAY CAST IRON AND ITS EFFECT ON MECHANICAL PROPERTIES

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Abstract: This article presents a microstructural analysis of gray cast iron cast in sand-clay molds. The effect of modifier elements introduced at different stages of the liquefaction process on the formation of lamellar graphite, matrix structure and phase composition was analyzed. Metallographic studies showed significant microstructural changes that directly affect the mechanical properties of the samples.

Keywords: cast iron, gray cast iron, SCH24, JSM – IT200, Axiovert 40 MAT, fluidization, casting, pearlite, ferrite, copper phospite, ferrosilicon, alloys.

Introduction. One of the important tasks in the world today is to obtain high-quality, inexpensive thin-walled cast products based on improving the strength, quality, and mechanical and operational properties of parts used in the engineering and production industry obtained by the casting method. Also, in order to reduce energy and fuel consumption, the need for lightweight products with high strength is increasing.

By using gray cast iron alloys or by reducing its thickness while maintaining its strength, casting parts obtained in the automotive industry reduce the cost per vehicle by almost 15% compared to parts made from steel or aluminum alloys. As a result of the increased demand for thin-walled cast products in the world, many techniques and technologies have been developed, which require the production of high-quality, cheap and competitive parts. For reference, gray cast iron accounted for the largest market share of 37% in the global steel and cast iron manufacturing market in 2021. It has been studied by the world's leading scientists that it is possible to obtain cheap, durable details by modifying its composition and improving casting technologies in obtaining thin-walled high construction details from gray cast iron alloys. Mining, metallurgical and engineering details are cast from gray cast iron by adding modifiers to it, improving its corrosion resistance, hardness, fluidity, and other important properties while controlling the cooling rate [1-3].

Main part. For the casting of gray cast iron thin-walled lifting roof thin-walled details, the DSP-0.5 electric arc furnace with three-phase current, with vertically installed coal graphite electrodes, widely used in the industry, of the "Casting - Mechanics" shop of the “Uzmetkombinat” JSC enterprise was selected. Before loading solid materials, it was checked whether the oven was suitable for work, whether there were any cracks or cracks in the lining part. 450 kg of secondary gray cast iron slag was used for the furnace, and ferromanganese FeMn17 GOST 4755-91, ferrosilicon FeSi75 GOST 1415-93, and ferromolybdenum (FeMo70) and copper phosphite CuP2 GOST 4515 based on GOST 4759-91 were used as modifiers. The amount of elements in the samples of the G24 brand GOST 1412-85 gray cast iron GOST 1412-85, which is used in the casting of lifting roof details in the “Uzmetkombinat” enterprise Casting-mechanics shop, and the proposed new composition, are listed in table 1 below.

Table 1.

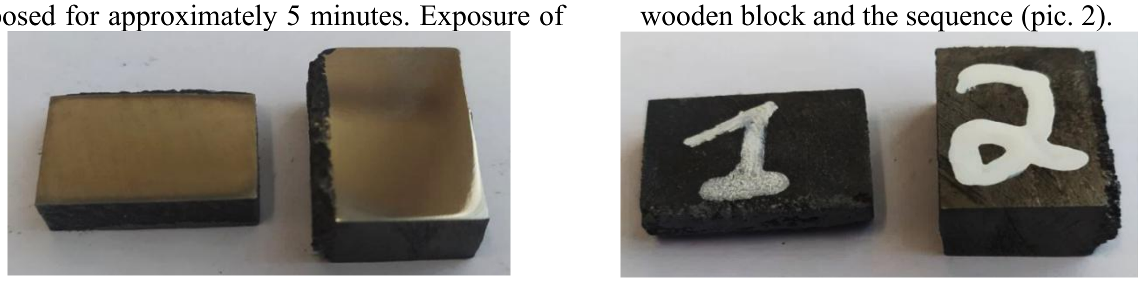
The chemical composition of the proposed casting of the lifting roof detail

Samples	The mass amount of elements %								
	C	Mn	Si	Cr	P	S	Ni	Cu	Mo
Lifting roof N – 1	3,30	0,69	2,14	0,11	0,074	0,064	0,06	0,10	0,3
N – 2	3,35	0,69	2,15	0,11	0,074	0,064	0,06	0,20	0,3
N – 3	3,32	0,65	2,20	0,11	0,074	0,064	0,06	0,50	0,3

The following solid (G24), secondary cast iron alloys were used to liquefy the samples of this experiment. Particular attention was paid to the fact that the content of phosphorus and sulfur, which are harmful elements in the mixture, does not exceed 0.01 –0.04%. The temperature of liquefaction during casting of the researched samples was from 1400 to 1470 ^{o}C. Before pouring the liquefied alloy into the furnace, slag cleaning was performed. The temperature of pouring the liquefied alloy into a sand-clay mold was 1400 to 1460 ^{o}C.

Picture 1. Samples cast in an electric arc furnace from a gray cast iron alloy in a sand-clay mold for research

Samples with a diameter of 10 mm and a length of 25 mm are cut from the alloys, and their surface is treated for a certain time with abrasive papers of 500, 800, 1000, 1500, 2000 microns. After that, the surface of the samples is smoothed using WC (tungsten carbide) paste. After the polishing process, the reagents are exposed according to GOST 5639 – 82. As reagents, picric ($C_6H_2(NO_2)3OH$) and hydrochloric (HCl) acids are exposed for approximately 5 minutes. Exposure of the reagents to the surface of the sample is the division of the structures of the analyzed samples into phases, as well as its microscopic examination. As a result, it became possible to obtain results by dividing the structures of gray cast iron into clear boundaries. The sand used in the preparation of the mold material was first sieved, quartz sand and bentonite clay were added in the amount specified in the table and mixed, then it was molded into a wooden block and the sequence (pic. 2).



Picture 2. Samples prepared for examination in Emission scanning electron microscope

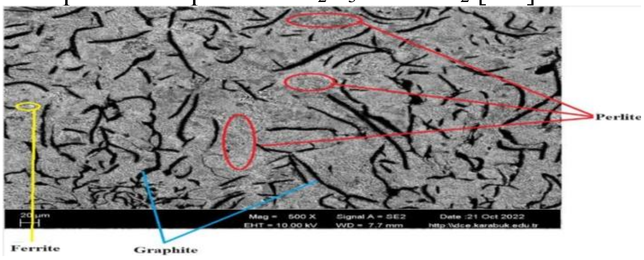
Table 3.

Table of composition of used mold material

Used sand, %	70 – 80
Quartz sand, %	5 – 10
Kaolin clay, %	6– 8
Water, %	3 – 7

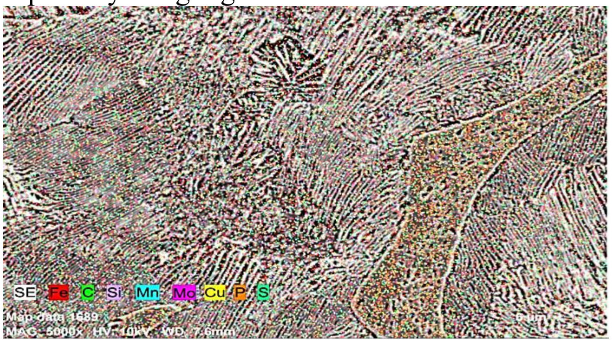
Kaolinite binder used as mold clay listed in table 3 is obtained from Al_2O_3, $2SiO_2$, $2H_2O$ minerals, its density is according to the 2...2.5 scale, its density is 2.58 - 2.60 g/cm^3, and the melting temperature is 1750 - 1790^{o}C. and kaolin clay becomes hygroscopic when heated to 100 – 140 ^{o}C, and at 350 – 580 ^{o}C clay loses moisture and turns into metakaolinite (Al_2O_3 * $2SiO_2$), in which the process of losing the binding properties of clay is called “liamotization of clay” and metacaolinite at

900 – 1050 ºC $3Al_2O_3$ $2SiO_2$ (mullite) is formed between 1200 and 1280 ºC when it decomposes into amorphous components Al_2O_3 and SiO_2 [4-9].



Pic 3: Microstructures of copper phosphide 0.5% and molybdenum 0.3% in Carl Zeiss Ultra Plus Field Emission University image magnified x500 times scanning electron microscope in the laboratory of "Iron and Steel" Institute of Karabuk.

Separation of graphite from carbon is usually considered an important process in the production of details by liquefying cast iron, and is especially necessary in the production of thin-walled products. It was observed that the ductility, strength and hardness of gray cast iron increased. When copper phosphide (CuP_2) is added to 0.8% or more, it was found in the course of research that, although its fluidity and hardness increased, its brittle property was high. In figure 17, the volume distribution of the liquidized samples according to the content in Table 1 was checked by magnifying x5000 times in the Carl Zeiss Ultra Plus Field Emission scanning electron microscope of the Karabuk University "Iron and Stell" Institute laboratory (pic 4). In the sample studied in figure 18 below, the elements are iron (Fe) red, carbon (C) green, silicon (Si) purple, manganese (Mn) blue, chromium (Cr) black, nickel (Ni), phosphorus (P) brown , sulfur (S) is shown separately in light green colors.



Pic 4: Volume distribution of elements in gray cast iron samples taken by Carl Zeiss Ultra Plus Field Emission scanning electron microscope in the laboratory of the Iron and Steel Institute of Karabuk University

Conclusion. The microstructural analysis of thin-walled gray cast iron samples, combined with the evaluation of their mechanical properties, has demonstrated the effectiveness of advanced casting technologies in achieving high-precision and high-quality cast products. By introducing various modifiers at different stages-both in the furnace and in the ladle-the alloy composition was optimized to enhance its structural integrity. The findings highlight the critical role of uniform elemental distribution across the material's volume, which is particularly essential in the casting of thin-walled components. These results provide a foundation for further improvements in the production of high-performance gray cast iron parts with enhanced durability and reliability.

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С О Д Е Р Ж А Н И Е

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