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Preparation of Tungsten Carbide-Based Solid Alloy Samples for Microstructural Analysis and Prospects of Analysis of Analysis Results

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Abstract: *In the article, the preparation of VK-6 brand tungsten carbide-based material samples produced by the Kirovgrad Hard Alloy Plant of Russia (Kirovgradskiy Zavod Tverdyx Splavov) and Uzbekistan's Almalik Mining Metallurgical Combine for microstructural analysis, stages of preparation for analysis, analysis of the obtained analysis results, and technological processes of pressing through the analysis results information on drawing conclusions about achievements and shortcomings is presented.*

Keywords: *microstructural analysis, grinding, chemical-mechanical polishing, wax, rosin, copper cup, corundum, electrocorundum, polishing (shlifovanie), polishing (polirovanie) and polishing (travlenie).*

Scientific basis of microstructural analysis of samples. In the last 30 years, tungsten carbide-based hard alloys have been widely used in agriculture, food, machinery, oil and gas, ferrous metallurgy, pharmaceutical, chemical, chemical engineering and mining metallurgy and similar fields worldwide [1] and "Emergen Research" based on the conclusions made based on the results of the analyzes carried out by , the demand for tungsten carbide will reach 27.70 billion US dollars in 2027 [2]. Currently, in a number of developed countries, including the USA, Belgium, Germany, Russia, and Belarus, scientific and practical work is being carried out at a rapid pace to improve the technology of recycling tungsten carbide-based materials and extracting tungsten and cobalt powders from them [3]. In particular, one of the largest manufacturing enterprises of our country, Almalyk Mining and Metallurgical Combine (OTMK), produces an average of 9,800 kg of VK-6 hard alloys per year [4]. It follows from the scientific conclusions of the conducted researches and the conclusions obtained from the production enterprises that tungsten carbide-based hard alloys produced in our country wear out 1.5-2 times faster than foreign production enterprises.

The degree of polishing (grade of alloy, weight in grams) and grinding level of VK-6 hard alloys of the Russian plant "KZTS" JSC (Kirovgradskiy Zavod Tverdyx Splavov) and Uzbekistan's OKMK JSC were compared (Table 1) .

Table 1

	"KZTS" JSC	OKMK JSC
Length , mm	232	232
Diameter i , mm	38.1	38.1
Mass , grams	3 954	3,800

The creep resistance of the alloy was carried out on a KEV-96 rotor crusher under production conditions, and the crusher was operated at moderate power during the test.

Performance indicators of the WC finger produced by JSC "KZTS" .

Table 2

T/r	D robilk a number	Time, hour	Number of fingers	Time	The reason for the substitution
1	Rotor crusher "KEV-96" #3	452.1	3 pc.	2014 year	Eating
2	Rotor crusher "KEV-96" #7	395.8	3 pc.	2014 year	Eating
The average working time is 423.95 hours					

Performance indicators of the WC finger produced by JSC "OKMK " .

Table 3

T/r	D robilk a number	Time, hour	Number of fingers	Time	The reason for the exchange
1	Rotor crusher "KEV-96" #12	281.0	3 pc.	2014 year	Eating
2	Rotor crusher "KEV-96" #2	265.4	3 pc.	2014 year	Eating
Average run time 273.2 hour					

The results of comparing the second and third tables show that the fingers developed by JSC "KZTS" worked one and a half times longer than the fingers developed by JSC "OKMK " (1.55 times). The data of this comparison was made in 2014, and in recent years, the working life of the fingers produced by "OKMK " JSC has dropped sharply, averaging 111.55 hours.

Several conclusions can be drawn as reasons for this. These are: the fact that the pressing processes of the radio manufacturers are carried out using advanced technologies and with high precision, the processes of heating tungsten carbide powders in a protective atmosphere and under vacuum conditions are in different modes or the accuracy of this process, the difference in the size of the tungsten carbide powders used as hard alloy raw materials , the high working surface level processing etc. For example, JSC "KZTS" has increased the physical-mechanical and operational tolerance of hard alloys by 10-20% in recent years by using innovative technologies [5].

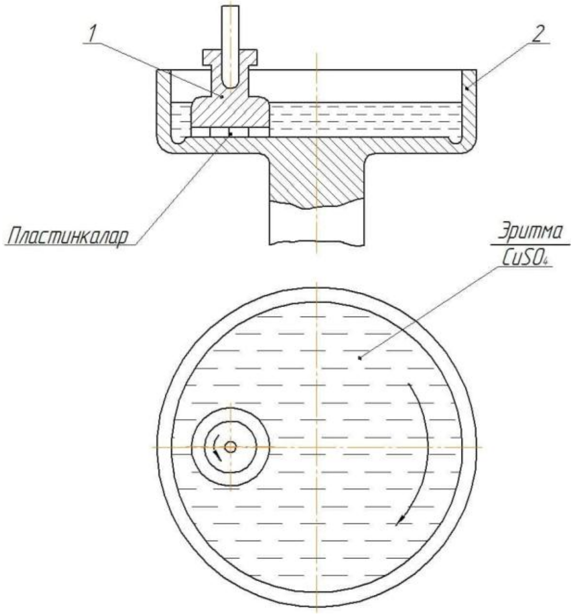
In order to identify and eliminate the above, we begin to study the causes by microstructural analysis of hard alloy samples produced by OTMK and foreign manufacturers.

Preparation of samples for microstructural analysis.

Microgrinding includes four main steps, namely sample cutting, polishing (shlifovanie), polishing (polirovanie) and polishing (travlenie) [6,7].

There are several methods of preparing microsands, and we use the method of chemical-mechanical polishing of our samples. Because the chemical-mechanical polishing method is more effective compared to other methods, and due to the heat of the plates during the polishing process, the appearance of micro-cracks is prevented, and the polished surface is clean.

Instructions for chemical-mechanical polishing of hard alloy plates. This method is based on the principle of breaking the cobalt bond on the surface being polished by the rotation of two discs, which is mounted on a special polishing machine as shown in Figure 1 using a copper sulfate solution.



Picture.1 Scheme of chemical-mechanical polishing of plates:

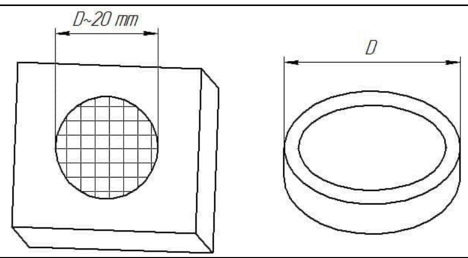
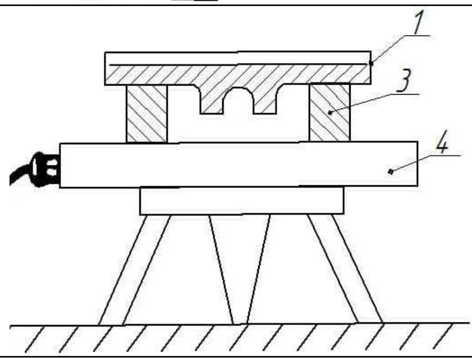
1-Upper disk, 2-Lower disk

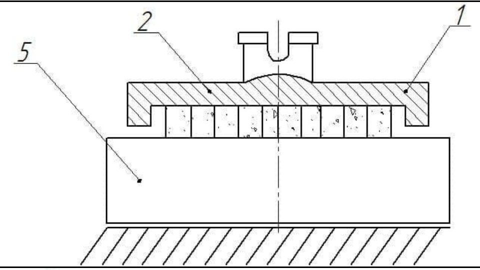
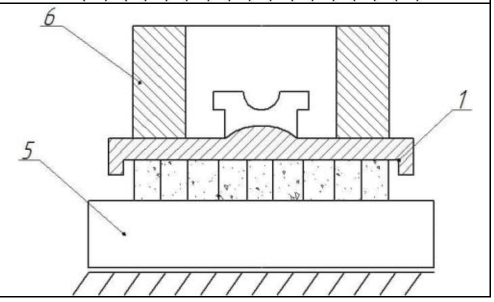
The polishing process is carried out on a lower disk made of copper or stainless steel.

The polishing technology is as follows:

1. Plates are fixed to the upper disc made of brass (Table 4) with glue with the following composition: 1 part of wax and 2 parts of rosin (rosin - $C_{19}H_{29}COOH$) by weight. Wax and rosin in appropriate proportions are heated in a porcelain vessel and thoroughly mixed until a homogeneous mixture is obtained. After cooling, the glue is ready to use.

Table 4. ***Hard alloy upper disk reinforcement technology***

T/r	The name and transition of the operation	Sketch
1	Place the hard alloy plates on the 5 special plates, the grinding surface should be facing down. Plates are placed on a plate within the control circle, the diameter of which is 20 mm less than the diameter of the upper disk.	
2	For gluing, the disc is placed on a hot plate together with pieces of glue. The thickness of the glue after melting is calculated to be 3-5 mm.	
3	The disc is heated on a hot plate until the glue melts.	
4	The disc is cooled together with the melted glue.	

5	A sample of hard alloy is glued on the disc. Plates should be immersed in glue for 1/3 - 2/3 of their height, so that the surface of the hard alloy sample to be polished rubs against copper sulfate and abrasive powder.	
6	In order to stick the hard alloy to the plates more firmly, a ring load 6 of 15-20 kg is placed on the disk. After the glue hardens, the ring load is removed.	

2. The disc is placed on the machine with hard alloy samples. It is polished with the following composite suspension: water - 44%, copper oxide - 12%, sample powder (corundum or electrocorundum) grain size 10-6-44%.

To prepare copper sulfate solution, copper sulfate is dissolved in hot water (80° - 90°). After cooling the solution, abrasive powder is poured into it. A disc with hard alloy plates moves against each other and during polishing, the disc rotates at a speed of 80-90 rpm.

Plates are polished for 40-45 minutes.

3. The disc is removed from the machine and the plate is washed with water.
4. After washing, abrasive treatment is carried out with green silicon carbide powder in water for 15-20 minutes (40 g of powder and 500 g of water).
5. The disk together with the plate is washed again in water. If there are traces of copper on the plate, polishing is continued.
6. By heating the plates, they are removed from the disk.
7. Plastinas are boiled in 15% cold water .
8. Plastinas are washed in hot water.
9. Plates are dried.

After processing, plates should have the same matte (matte) color: Cu, soda or glue cannot be on the surface of the plate [8].

Microstructural analysis is performed after the polishing process.

Summary

In the USA, Belgium, Germany, Russia, and Belarus, details necessary for use in the mining industry from tungsten carbide-based materials are produced on the basis of powder metallurgy. These details are 1.5-2 times more durable than the details developed in our country. Comparison of the physical, chemical, and mechanical properties of the details developed in our country and abroad is the first step in the development of the technology of obtaining bend-resistant details.

Through microanalysis of metals and alloys 1) study of the shape, size and mutual arrangement of crystals in metal or alloys 3) determination of structural and phase composition; 3) identification of defects in the internal structure; 4) it is possible to solve such things as studying the changes in the internal structure caused by the external influence of materials.

As a result of the mistakes made in the processes of polishing (shlifovanie), polishing (polirovanie), and polishing (travlenie), the formation of lines of different sizes in the sample and, as a result, the level of visibility of its structure, WC-Co border, and the shape of WC are not clearly visible.

"KZTS" JSC and OKMK JSC were viewed under a NEOPHOT 21 microscope (magnified 1500 times). During the production process of the detail manufactured by KZTS JSC, the powder grains are uniform, the WC and Co powders are evenly distributed over the entire surface of the detail, and the pressing process is carried out under alternating pressure, so it has high resistance to bending .

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