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Ti -Al SYSTEM COMPOUNDS TO CREATE A COMPOSITE TOOL MATERIAL

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Abstract
The study of methods for obtaining new composite materials based on compounds of the B-N-Al-Ti system using high pressure (up to 5 GPa) and temperatures (up to 1800 K), the study of their physical characteristics to create tool materials on their basis. Studying the prospects for further development of research and practical use of the results obtained.

Keywords : metallic systems, hardness, cutting speed, elbor, hexanit.

Introduction

Today, there is a need to study the nature of the interaction in multicomponent metallic systems based on titanium and aluminum [1, 2]. The theoretical basis for the development and improvement of the technology for obtaining new superhard alloys for instrumental purposes are the state diagrams of these systems. At the same time, the material must meet the requirements of modern science and technology. Thus, the relevance of the topic is due to the interest in studying the effect of alloying additives on the properties of titanium and aluminum, as well as the effect of the structure of the obtained plates on the characteristics of the final product [3,4].

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Methods

The process of cutting with a tool made of new composite materials based on compounds of the B-N-Al- Ti system when machining hardened steels with hardness up to HRC 56, it was studied experimentally. The recommended ranges of turning regime parameters under these conditions are: cutting speed 125÷200 m/min, feed 0.05÷0.15 mm/rev, depth 0.1÷0.5 mm, operation without cutting fluid (coolant) . The roughness of the machined surface with the choice of low feed rates is R_a 0.63÷0.16.

Recommended cutting conditions for cutters made of tool materials based on B-N-Al-Ti joints vary widely. For example, the tool company Seco for machining workpieces made of hardened steel HRC 46 - 65 and tool material CBN 10 recommends a depth of cut of up to 0.5 mm, a feed of 0.05 - 0.15 mm/rev, a cutting speed in the range of 200 - 125 m / min.

Sandvik defines a feed rate of 0.05 - 0.15 - 0.25 mm/rev and a cutting speed of 250 - 190 - 160 m/min for machining HRC 60 hardened steel and SV 7015 tool material.

Table 1 – Mechanical properties of composite materials based on cubic boron nitride

№	Name	Value	
1	Hardness	30-45	GPa
2	Crack resistance	12-16	MPa m $^{1/2}$
3	Tool life when turning hardened steels (HRC 52-54)	60	min.
4	Grain size	5-30	micron
5	Depth of cut	up to 0.5	mm
6	Innings	0.05 - 0.15	mm/rev
7	Cutting speed	200 - 125	m/min.

Similar recommendations exist for other foreign tool firms. There are no quantitative expressions for calculating cutting conditions.

Empirical generalizing equations are given in domestic literary sources for calculating the regime parameters for processing workpieces from hardened steels with boron nitride cutters of the Elbor-R, hexanit-R grades .

In [1,2] the following expressions are recommended for calculating indicators characterizing the processing of hardened steel blanks:

- cutting speed, m/min

$$V = \frac{C_v K_{Tv}}{T^{m_v} t^{x_v} S^{y_v}},$$

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where is $K_{Tv} = (90T)^{m_v}$ the correction factor depending on the resistance;
$C_v = 273$, $m_v = 0.2$, $x_v = 0.15$, $y_v = 0.2$.- taken from the reference book for steel grade 12CrNi3A [3] .

Recommended cutting conditions for cutters made of tool materials based on BN-Al-Ti joints . From Table 3 and Figures 17-19 it follows that the recommended mode with a depth of cut t=0.1 mm, a feed of 0.05-0.1-0.15 mm / rev and a cutting speed with values of 285.4 - 248.5 -229.1 m/min with a tool life of 90 minutes (coincides with the recommendations of foreign companies). And with a depth of cut t \u003d 0.5 mm, a feed of 0.05-0.1-0.15 mm / rev and a cutting speed with values of 224.2 - 195.2-180.0 m / min with a tool life of 90 minutes (coincides with the recommendations of foreign firms). Using the results of the computational analysis, experimental studies of the cutting properties of cutters based on compounds of the B-N-Al- Ti system were carried out.

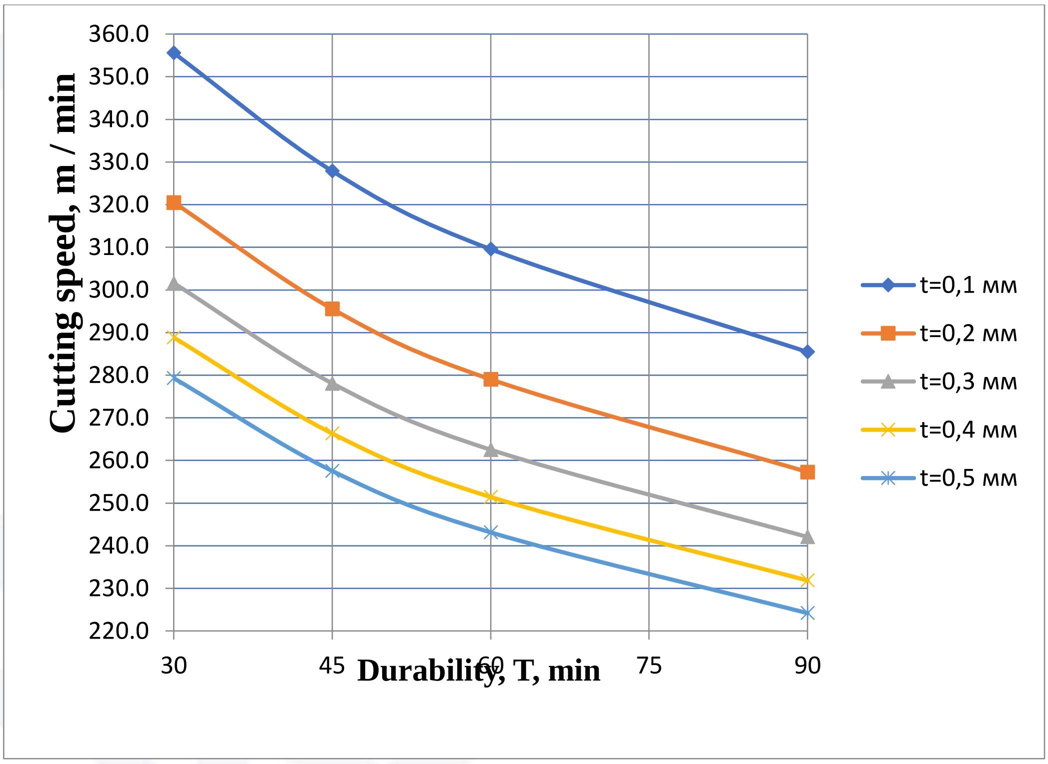

Figure. 1 - Dependence of resistance on the calculated speed values cutting at the same feed rate of 0.05 mm/rev and changing the depth of cut 0.1 to 0.5 mm

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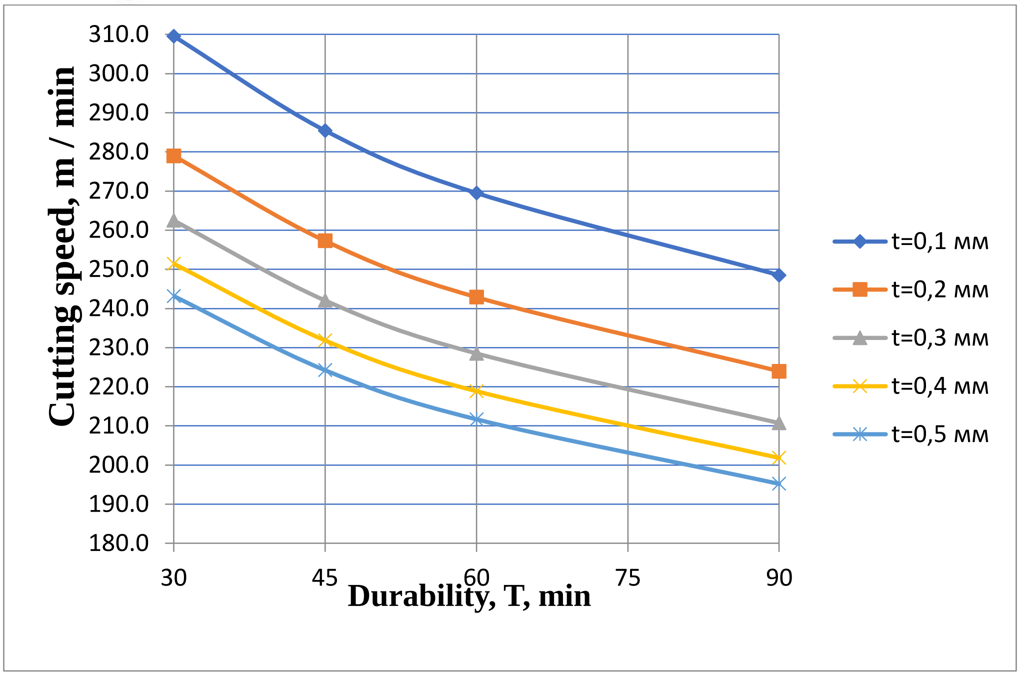

Figure.2 - Dependence of resistance on the calculated speed values cutting at the same feed rate of 0.1 mm/rev and changing the depth of cut 0.1 to 0.5 mm

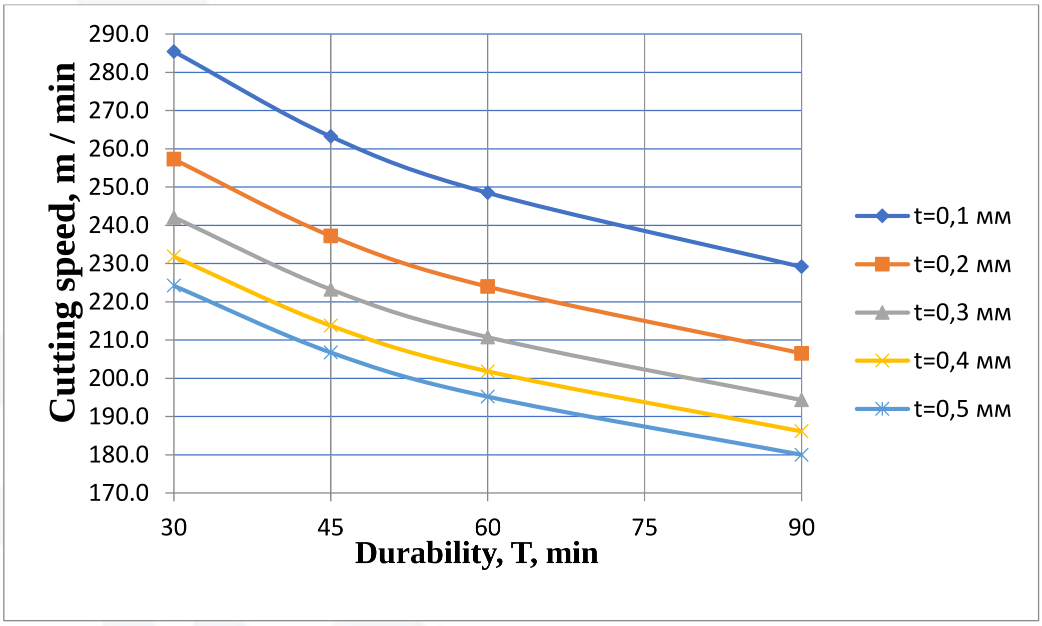

Figure. 3 - Dependence of resistance on the calculated speed values cutting at the same feed rate of 0.15 mm/rev and changing the depth of cut 0.1 to 0.5 mm

3. Experimental Part

Study of methods for obtaining new composite materials based on compounds of the B-N-Al- Ti system using high pressure (up to 5 GPa) and temperatures (up to 1800 K), study of their physical characteristics to create tool materials on their basis.

When exposed to high pressures of 5.5 GPa and temperatures of 1750-1800 ^{0}C, single-crystal powder superhard materials are formed with specified characteristics depending on their further use (cutting, grinding or polishing tools).

The nano- and microstructure of cubic boron nitride is used to create composite materials for instrumental purposes, formed under thermobaric exposure.

The synthesis was carried out at a pressure of 5 GPa (taking into account a thermal pressure increase of ~0.8 GPa) and temperatures of 1670–1910 K in hard-alloy high-pressure chambers of the “anvil with a hole” type in containers made of lithographic stone. At given synthesis parameters, 5 identical experiments were carried out.

Figure 4. Obtained High Pressure Synthesis Samples
(without machining)

Experimental studies of cutting properties of cutters made of B-N - Ti - Al bond

Experimental studies of cutting tools based on compounds of the B-N-Al- Ti system were carried out in the mechanical workshop of the UE "Uzbektemiryumashta'mir " JSC " Uzbekiston temir yullari »

The blower shaft was turned, made of 12CrNi3A steel, 57 mm in diameter with a hardness of 56 HRC (Fig. 5). The feed rate was 0.05 mm/rev, with a cutting depth of 0.1 mm and a cutting speed of 285 m/min, the tool life was 88 minutes.

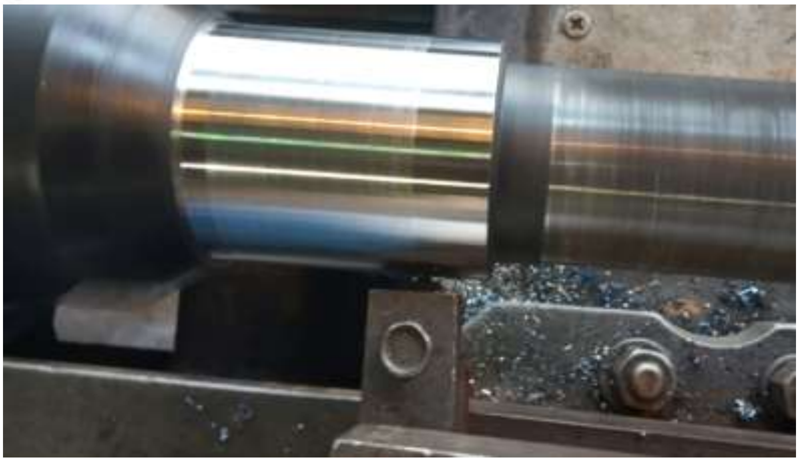

Figure. 5 Processing of steel grade 12XH3 with a diameter of 57 mm

Turning the blower shaft, steel grade type 12CrNi3A, having a hardness of 56 HRC , at at a feed rate of 0.15 mm / rev, a depth of cut of 0.1 mm and a cutting speed of 229.1 m / min - while the tool life was 82 minutes (Fig. 6).

Figure 6 - Processing of steel grade 12CrNi3A

Figure 7 - External longitudinal turning of a shaft made of hardened steel grade 12CrNi3A with a cutter made of tool material based on the B-N-Al- Ti system

External longitudinal turning of a shaft made of hardened steel grade 12CrNi3A, having a hardness of 56 HRC , at at a feed rate of 0.05 mm / rev, a depth of cut of 0.5 mm and a cutting speed of 225 m / min - while the tool life was 86 minutes (Fig. 7).

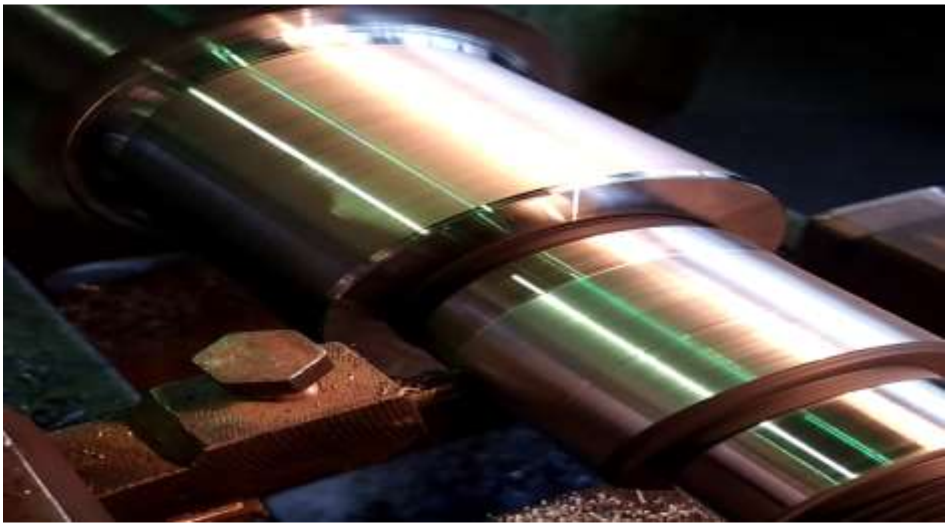

Figure 8 - External longitudinal turning of a shaft made of hardened steel grade 12CrNi3A with a cutter made of tool material based on the B-N-Al- Ti system

External longitudinal turning of a shaft made of hardened steel of steel grade 12CrNi3A, having a hardness of 56 HRC , at at a feed rate of 0.1 mm / rev, a depth of cut of 0.5 mm and a cutting speed of 195 m / min - while the tool life was 82 minutes (Fig. 8).

Figure 9. External longitudinal turning of a shaft made of hardened steel grade 12CrNi3A with a cutter made of tool material based on the B-N-Al- Ti system

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External longitudinal turning of a shaft made of hardened steel grade 12CrNi3A, having a hardness of 56 HRC , at at a feed rate of 0.15 mm/rev, a depth of cut of 0.5 mm and a cutting speed of 180 m / min, while the tool life was 78 minutes (Fig. 10).

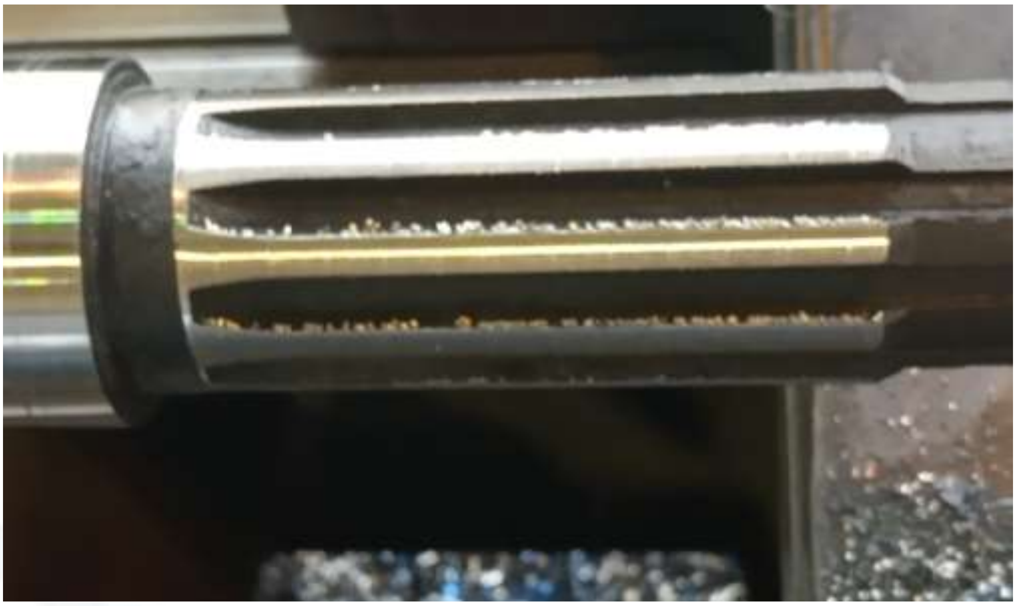

Figure 10 - Impact tests of steel grade 12 CrNi3A when turning a longitudinal shaft

Impact test was also carried out on the blower shaft of steel grade 12 CrNi3A with a hardness of 56 HRC . The shaft diameter is 60 mm, the length of the surface being turned is 70 mm with a cutting depth of up to 0.5 mm, the cutting speed was 125-200 m / min with a feed of 0.05-0.1-0.15 mm / rev. The length of time for turning the cutter to final wear was 15–30 minutes (Fig. 11). Therefore, when processing in gear places, a cutting speed of 125 m / min is recommended with a cutting depth of up to 0.1 mm at a feed rate of 0.05 mm / rev.

Conclusions

- The resulting composite compounds are a prerequisite for creating a bond based on the Ti - Al system for specific industrial applications.
- Relying on several connections of the system, it is possible, by changing the composition and not significantly adjusting the technological process, to quickly obtain instrumental composite materials of various directions.
- Several mechanical tests were carried out on various steel grades. The total durability of the incisors was 78 - 88 minutes.
- The test results show good characteristics of the cutters to impact and thermal effects.

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It can be said that the tests carried out by us correspond to technical and regulatory documents, which leads to better results.

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