INCREASE WEAR RESISTANCE HARD ALLOYS T15K6 BORIDE COATINGS

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Abstract: The results of studies on the application of complex boron coating powder method on hard alloys. Defined phase and chemical composition, thickness and microhardness of the coating on alloys.

It was established that after diffusion saturation of hard alloy in boron mixture for 4 hours formed coating with boride phases TiB, WB, CoB and WC, TiC, whose thickness is 50-60 microns. At complex saturation with boron and copper for 4 hours diffusion saturation formed coating with boride phases TiB, WB, CoB and WC, TiC and separate inclusions of copper with a thickness of the diffusion layer up to 70-80 microns.

Boriding and complex saturation with boron and copper allows in 2 – 2.5 times increase the microhardness of the surface layers of hard alloys, that in turn leads to increased wear resistance.

KEYWORDS: BORON CARBIDE, BORIDING, BORON LAYER, COPPER, STRUCTURE, DIFFUSION, FRICTION, MICROSTRUCTURE, MICROHARDNESS, WEAR RESISTANCE, CRACK RESISTANCE.

1. Introduction

Hard alloys provide high capacity under different operating conditions. Hard alloys WC-TiC-Co – titanium tungsten is used for the treatment of viscous materials: steel, brass [1 – 2], but their application field is narrowed due to low strength. One of the ways to improve the operational characteristics alloys are applying coatings, such as the use of chemical – heat treatment (CHT) [3 – 5]. However, doesn't definitive data on the positive effects of this method CHT to improve wear resistance hard alloys products [6 – 7]. To create technology of boriding hard alloys that gives stable results, it is necessary to investigate the mechanism of boride layer, processes of diffusion and redistribution of elements in boride layer and the transition zone hard alloy.

The aim of this work was to investigate the structure and characteristics of complex diffuse boride coatings on hard alloys obtained in boriding powder mixtures with the addition of various copper containing elements: Cu₂O, Cu₃P and installation of saturating powder environment impact on parameters wear resistance, thickness and microhardness coating obtained after a complex saturation with boron and copper.

2. Materials and Experiment

Integrated borating powder method performed in a special container under reduced pressure at a temperature of 975 °C for 4 hours using fusible valves. The investigate was conducted on samples from hard alloys T15K6.

Saturation alloys boron and copper performed in mixtures containing technical boron carbide B₄C and powders Cu₂O, Cu₃P. As the activator used ftoroplast.

Heating the crucible and the subsequent isothermal exposure was carried out in a laboratory furnace type SNOL – 1,6,2,5,1/11M.

After the isothermal exposure container with details removed from the furnace and cooled to room temperature in air, disclose and take out details with clean surfaces that do not require further purification.

This method has the following advantages: simplicity of the process, allows the processing of products of different configurations can be obtained diffusion layers of different thickness.

Polishing was performed on samples of diamond polishing circles paste grit from 28 to 1 micron, that provided to obtain high surface quality research. As a reagent for chemical etching using 3...5% - solution was nitric acid in ethanol; exposure – 90 sec.

Visual study, measuring the thickness of diffusion layers and microstructure coatings, investigate performed on metallographic microscope OLYMPUS GX-41, producer Japan, in the range the increase 100...1000.

Microhardness measurements were performed on microhardness DuraScan, the company EMCOTEST, Austria, with a load of 50 grams.

Phase composition of coatings analyzed on X-rays diffractometer Ultima-IV, of Rigaku, Japan, in copper Kα, Kβ monochromatic radiation and chemical composition was determined by scanning electron microscope SEM – 1061.

3. Results and discussion

In this paper was investigate the structure, phase composition and properties of boride coatings obtained on hard alloys T15K6.

It was established that after the diffusion saturation hard alloys in boriding mixture for 4 hours formed coating from boride phases TiB, WB, CoB and phases TiC, WC, coating thickness of 50-60 microns. After a complex saturation with boron and copper 4 hours diffusion saturation formed coating from boride phases TiB, WB, CoB and phases TiC, WC, and separate inclusions of copper with diffusion layer thickness to 70- 80 microns (Fig.1).

Table. Chemical composition diffusion layer obtained after complex saturation with boron and copper

<table>
<thead>
<tr>
<th>Elements</th>
<th>Position</th>
<th>Fig.2 (a)</th>
<th>Fig.2 (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti (K)</td>
<td>+1 +2</td>
<td>0.80</td>
<td>0.55</td>
</tr>
<tr>
<td>Co (K)</td>
<td>+1 +2</td>
<td>10.89</td>
<td>0.37</td>
</tr>
<tr>
<td>W (K)</td>
<td>+3 +4</td>
<td>85.10</td>
<td>99.08</td>
</tr>
<tr>
<td>Cu (K)</td>
<td>0.00</td>
<td>3.21</td>
<td>0.00</td>
</tr>
</tbody>
</table>
To determine the chemical composition of the coating was applied microanalysis by using scanning electron microscope – SEM-106I with increasing in 2000 time, accuracy 0.01 wt. %. Determination of the chemical composition performed by EDS, calculation of quantitative chemical composition – the method ZAF.

Microrengenospectral analysis has established presence copper on the surface of boride coating (Fig. 2, Table). Formation separate inclusions copper leads to increased wear resistance, such as copper in the coating under dry frictional wear acts as solid lubricant.

Established that boriding and complex saturation with boron and copper allows in 1.5 – 2.5 times increase microhardness of the surface layers of hard alloys, which in turn leads to increased wear resistance. After boriding on the surface hard alloys obtain coating microhardness which is 31 - 33 GPa, base – 13 – 13.5 GPa. At the complex saturation with boron and copper obtain coating microhardness which is 24 – 25 GPa (Fig. 4).
Testing wear resistance were carried out on rollers produced of hard alloys, which are used to rolling aluminum profiles (Fig.5 and Fig.6).

![Fig.5: Rollers (a) and topography surface wear coating on the rollers(b)](image)

Investigations have shown that the boride coating allow in 2 times increase the term of operation rollers. When the rollers working without coating can be made of 10 tons aluminum profiles, whereas at the application of the boride coatings is reached value of 21 tons.

4. Conclusions

Investigate the structure and characteristics boride and complex saturation with boron and copper coatings on hard alloys T15K6 obtained in environments powder with the participation boron carbide and copper containing powder Cu2O or Cu3P. X-ray phase analysis established that at diffusion saturation in the surface layers of hard alloys formed phases: TiB2, WB, CoB, WC, TiC and respectively Cu. At the addition in environment for boriding copper containing powder identification of clear lines Cu (111) (200) (220).

X-ray analysis confirmed the local distribution of copper in the surface zone boride coatings obtained after complex saturation with boron and copper.

Boriding and complex saturation with boron and copper allows forming of boride phase in the surface zone hard alloys and increase the microhardness to 33 GPa and 25 GPa (respectively) compared with basic material (13.5 GPa) and thus increase the wear resistance of hard alloys in 2 times.

5. References


