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CHANGES IN THE SURFACE STRUCTURE OF SAMPLES MADE OF HIGH-SPEED STEELS DURING THEIR MAGNETIZATION

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ABSTRACT:

In this paper, alternations in the surface structure of samples made of high-speed steels during their magnetization are studied. Also, the optimal modes of magnetization have not yet been determined. The experiments were carried out only for some brands of processed and instrumental material.

Keywords: Surface, steel, magnetization, cutting, cutting tool.

INTRODUCTION:

Many works have been devoted to the questions of the influence of the magnetization of high-speed tools on the productivity of machining and on the wear resistance of cutters [1, 2, 3]. According to the data of these studies, when magnetizing a cutter made of high-speed steel, it is possible to achieve an increase in its durability by a factor of 1.5-2 under specific cutting conditions.

However, the optimal modes of magnetization have not yet been determined. The experiments were carried out only for some brands of processed and instrumental material. The influence of tool geometry and cutting modes on the efficiency of tool magnetization has not been studied; the issue of the influence of tool magnetization on the efficiency of the external environment is not fully considered, although this influence is very important from a technological point of view. In addition, there are contradictory opinions on the mechanism of the influence of the magnetic field on the wear resistance of the cutting tool [4,5,6, 7]. Analysis of the existing hypotheses shows that none of them can explain the questions that arise when using magnetized high-speed tools. All this complicates the practical application of this method in a production environment.

MAIN PART:

Metal surfaces always have various imperfections. These include irregularities, crystallographic imperfections associated with the conditions for the formation of the surface and dislocation structure of the metal, chemical imperfections, and others. It is these imperfections of the surface of a real crystal that determine its reactivity. The chemical reaction of oxidation of metals has the following general form:

$$\mathrm{M_e} + \frac{1}{2}\mathrm{O_2} \leftrightarrow \mathrm{M_eO_2}$$

The thickness of these oxidized films can vary over a very wide range.

With increasing temperature, the rate of formation of oxide films on metal surfaces increases significantly. It was found that the constant of the chemical reaction and the diffusion coefficient depend on the temperature. Therefore, the rate of oxidation is also highly dependent on temperature.

Изменение скорости окисления и ее зависимость от температурі может біть віражено следующим уравнением:

$$u = \frac{\mathrm{d}y}{\mathrm{d}\tau} = A \cdot l^{-\frac{\mathrm{Q}}{\mathrm{RT}}}$$

Where: A and Q are constants;
R – gas constant; T – base of natural logarithms;
l – absolute temperature; y – film thickness; τ – time.

It can be assumed that even in the absence of any deformations during magnetization of metal samples, surface structures appear that differ in their properties from the structures of films formed in a non-magnetized sample. To confirm this assumption, we made samples of high speed steel P18. Two magnetized and non-magnetized samples of each grade were heated at 400° C, 500° C, 600° C, 700° C, 800° C for one hour. At the same time, free air access was provided to the furnace. In addition, two magnetized and non-magnetized samples were immersed in a 10% solution of potassium permanganate, since potassium permanganate is a strong solvent.

To study the structural change of the grinding surface, X-ray diffraction patterns of these samples were taken (Fig. 1, 2). Here 1 is a non-magnetized sample, 2 is a magnetized sample.

Analysis of the X-ray diffraction pattern of the samples shows that the peaks in the X-ray pattern taken from the P18 high speed steel specimen correspond to WO_3; $FeWO_4$; $FeVO_4$; Fe_2O_3; $FeMoO_4$; CrO_2; and MoO_3.

Comparison of the X-ray diffraction patterns of samples heated at different temperatures shows that new peaks appear with a change in temperature. Changes in the intensity of individual lines indicate a change in the structure of the surface layer of the grinding sample.

An analysis of the X-ray diffraction patterns of magnetized and non-magnetized samples at the same temperatures shows that at t = 400° C (Fig. 1), the diffraction maxima of $FeWO_4$ and CrO_2 for the magnetized sample decrease relative to the non-magnetized one. At t = 500° C, on the contrary, there is an increase in the diffraction lines of $FeVO_4$, $FeWO_4$, and CrO_2 in the magnetized sample.

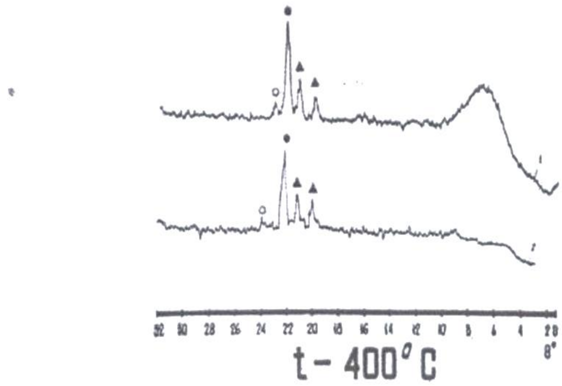

Fig. 1. X-ray diffraction pattern at t = 400 ° C o - WO_3; • - $FeWO_4$;
▲ - CrO_2

At t = 700° C (Fig. 2), new diffraction maxima appear in the magnetized sample, corresponding to the WO3 and FeVO4 phase, and in turn, the diffraction maximum corresponding to the FeWO4 phase disappears. At t = 800 ° C, an increase in the intensification of the diffraction maximum corresponding to the FeWO4 phase is observed.

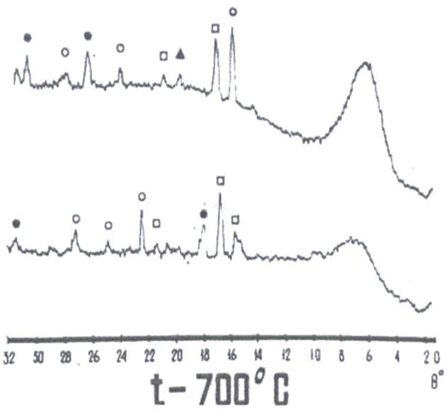

Fig. 2. X-ray diffraction pattern at t = 700 ° C o - WO3; • - FeWO4; ☐ - CrO_2

Comparison of the X-ray diffraction patterns obtained at t = 600 ° C shows that the intensification of the diffraction maximum corresponding to the $FeWO_4$ phase decreases for the magnetized sample. Qualitatively similar data can be observed when the samples are preliminarily kept in a 10% aqueous solution of potassium permanganate.

CONCLUSION:

The data obtained suggest that even before the cutting process (in the absence of plastic deformation), the magnetization of metal samples leads to a change in the structure of their surface layer.

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