Improving the efficiency of shaving through the use of wear-resistant coatings

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Improving the efficiency of shaving through the use of wear-resistant coatings

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Abstract. The influence of the preparation and use of various types of wear-resistant coatings on the tool shaver of high-speed steel R6M5K5 with a hardness of 60-65HRc for shavinging parts such as gear driven made of steel 20HGNMTA with a hardness of 160-210 HB. The use of hydroabrasive cleaning with ceramic balls made it possible to obtain a clean surface with a rounding of the cutting edge to 7 microns. For the analysis of durability, coatings based on titanium nitride (TiN) and a multi-component coating of titanium and aluminum (AlTiN) were used. The coating on the basis of titanium nitride (TiN) increased the resistance 1.35 times. Multi-component coating of titanium and aluminum (AlTiN) increased resistance 1.61 (AlTiN) times.

As finishing operations for parts Gear driven, manufactured from steel 20ХГНМТА with hardness 156-207 HB, the technological operation of shaving with shaver R6M5K5 high-speed steel with hardness of 62-64HRc is performed.

It is known that the shaver is a gear wheel, the teeth of which are cut by transverse grooves 1.5 mm wide [1-5]. These grooves form a set of blades, which are in constant engagement with the response profile of the blank cut (shave) with her thin chips. Thus the resulting accuracy class reaches 5-6 degrees (Ra 0.63-0.16 μm) [1,3-5,7-9].

The main goal of the tool management process is to increase efficiency and reduce the user costs of a tool for processing by optimizing processes and / or increasing tool durability [2-6]. In the case of shaving operation, the most optimal way to reduce costs is to assume the use of various methods of hardening cutting edges [4, 7, 8–10]. First of all, we are talking about physical vapor deposition in a vacuum (Arc-PVD vacuum arc method) or, in other words, ion-plasma coating [11]. However, taking into account the design features of shavers, the use of this type of hardening has not previously been possible. The problem was the proper preparation of cutting edges and deep cleaning of the grooves between the cutting edges. The presence of burrs on the cutting edge did not allow to form a perfect blade evenly coated [12]. And pollution in relatively deep grooves did not allow to achieve the required purity of the coating process (see Fig.1).

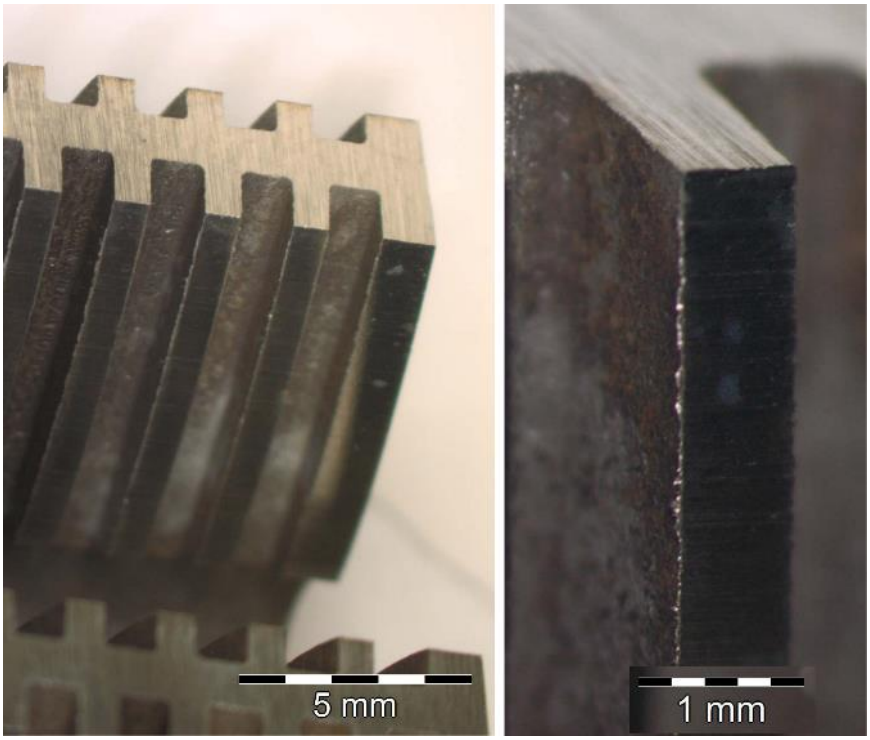

Fig.1 Shaver cutting edge in the initial state

The use of hydroabrasive cleaning with carriers in the form of ceramic balls (for removing burrs and rounding the edges) and aluminum oxide powder made it possible to solve part of the problems connected with preparing for the coating process. Namely, an evenly cutting edge was obtained, rounded off by an insignificant radius (up to 5-7 microns), while all surfaces were subjected to deep cleaning and activation, which, together with an ultrasonic cleaner, realized the maximum surface cleanliness (see Fig.2).

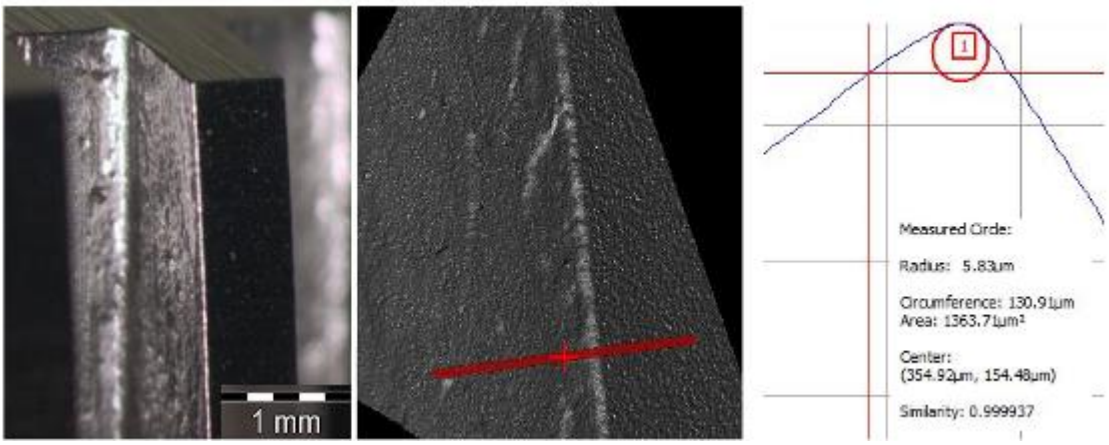

Fig.2 Shaving cutting edge after surface preparation

The next stage of the study was the selection of the optimal type of coating [13-17]. Taking into account the nature of the work of a multi-blade tool, when a small amount of chips is cut in one touch, it can be concluded that the local heating of the cutting wedge is extremely small. That is, as variants of coatings, it is possible to consider both widely known titanium nitride (TiN) with a low threshold value of temperature destruction and oxidation of about 600 ° C [17, 19], as well as all kinds of

advanced multicomponent coatings based on titanium and aluminum (AlTiN) with temperature indicators from 800-900 ° C [18,20,21,22]. To obtain complete information, experiments were carried out with two types of coatings (see Fig.3).

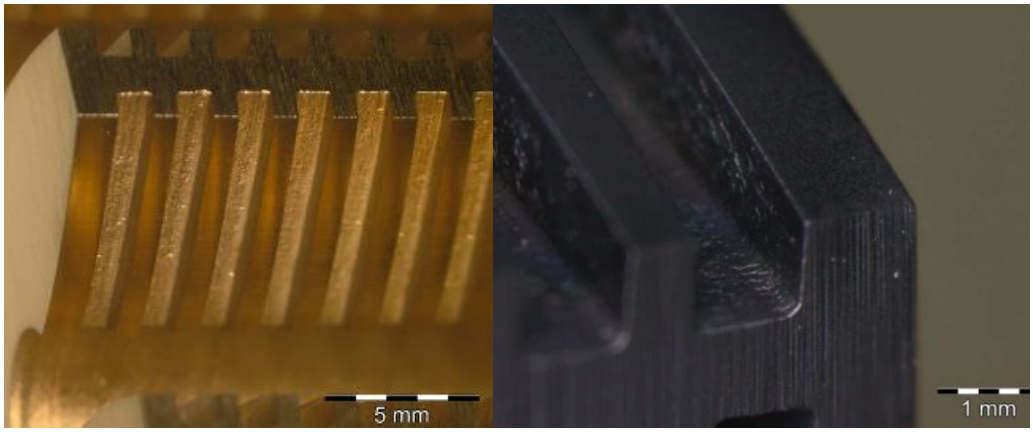

Fig.3 Shaving cutter with TiN and AlTiN coating

The analysis of the application of these shavers in the technological cycle showed an increase in durability 1.35-1.61 times and is shown in the diagram (see Fig.4).

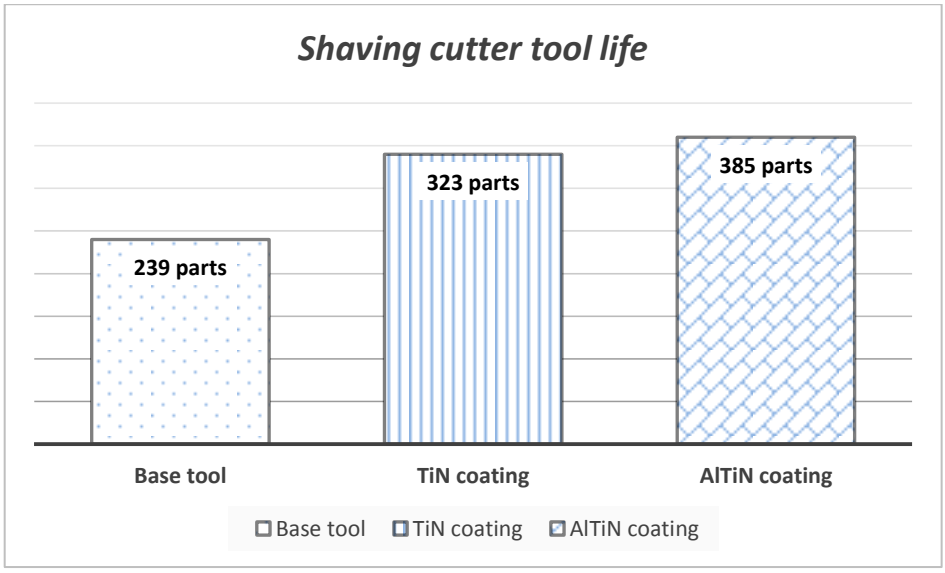

Fig.4 Diagram of change of shaving cutter tool life

In addition to increasing the overall resistance, undoubted increase in the quality of the blank surface on one or two classes was obtained, which in turn, at no additional cost, improved the characteristics of the gear and, ultimately, should increase the durability of the gear. Taking into account that a relatively similar increase in resistance has been obtained for different types of coverage, the choice of a specific type of coverage should be made after calculating the cost of consumables. It is also necessary to provide further work on the selection of the optimal coating, taking into account the greater resistance to abrasion wear.

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