WEAR OF RADIUS END MILLS WITH ANTIFRICTION COATINGS TiB_2 AND DLC DURING NICKEL ALLOY MILLING[i]

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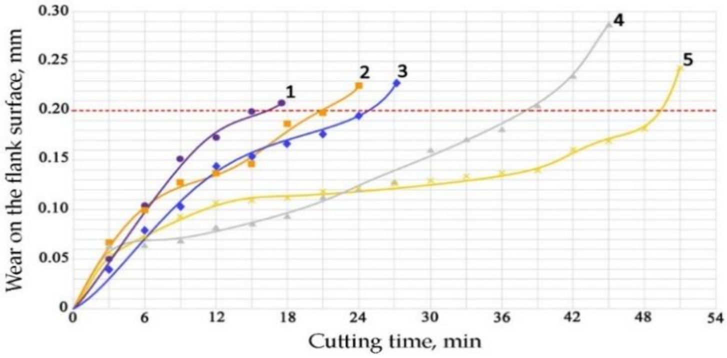
One of the most common modern ways to increase the reliability and service life of a cutting tool is the application of multilayer composite coatings, as well as their modification of the surface by applying a number of functional coatings on top [1]. Among the various types of such coatings, diamond-like carbon (DLC) is of particular interest. As a result of saturation of the carbon phase with nickel and chromium from the workpiece and their oxides, secondary structures appear on the friction surface that can influence the development of fatigue failures in stress concentration zones.

Researches have shown that the temperature near the cutting edge is a parameter that limits the cutting ability of end mills with DLC coating when processing nickel alloys [2]. It is certain that the wear-resistant coatings on the basis of (TiCrAlSi)N, on which the DLC is applied when the temporary exposure to the state temperature does not exceed 650°C. A significant self-lubricating effect of TiB_2 coatings has also been observed, associated with the formation of B_2O_3 tribo-films when interacting with oxygen from the environment [3], which reduces friction at the tool-chip interface. In the area adjacent to the cutting edge, the tool may be heated to a temperature exceeding 800°C in this case.



Radius cone size Ø12 mm with holes (CTX beta 1250 TC (DMG), 250 m/min, 0.05 mm/tooth, Ni45Fe30Cr14Mo4W3Ti2NbAl milling): 1 – without coating, 2 – TiB_2, 3 – AlCrN/Si3N4+DLC, 4 – AlCrN/Si3N4+TiB_2, 5 – AlTiN/Si3N4+TiB_2. The total thickness of the coatings was 2.5 – 2.7 µm with an antifriction layer thickness of 0.6 – 0.7 µm. The microhardness for all coatings was in the range HV^{10} = 34 -38.5 GPA.

Fig.1. The durability of ball-end mills with coatings

Curves 2 and 3 correspond to the instrument with the discoveries of TiB_2 and AlCrN/Si3N4+DLC respectively. The durability of these cutters is approximately the same and amounted to 20-24 min at the specified cutting mode, that is, increased by 30-50%. An interesting effect was achieved by combining nitride-based coatings, which have good resistance to abrasive wear, and a surface layer of TiB_2, which provided a decrease in adhesive setting, apparently due to the formation of tribo-films based on boron oxide. A practically twofold increase in durability was obtained (curves 4 and 5).

Thus, if we adhere to the hypothesis that the temperature and adhesion of the processed material due to the growth of the adhesive component of wear are closely related, then we can conclude that tribo-films containing B_2O_3, which was formed during the oxidation of titanium diboride, are able to significantly reduce the temperature in the contact zone and ensure the operation of the intermediate coating layer, well resistant to the abrasive component of wear [4].

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[i] The research was funded from the funds of the state assignment in the field of scientific activity of the Ministry of Science and Higher Education of the Russian Federation, project No. FSFS-2023-0003.