WEAR OF CARBIDE PLATES WITH DLC AND MICRO-NANO POLYCRYSTALLINE DIAMOND COATINGS DURING MILLING OF COMPOSITE ALLOY AL/SIC[i]

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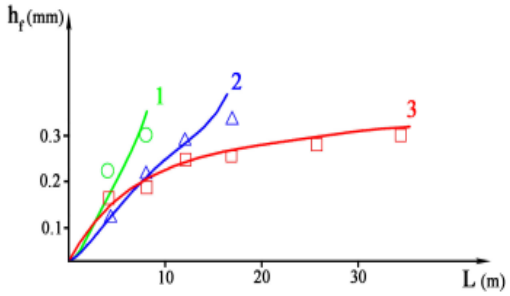
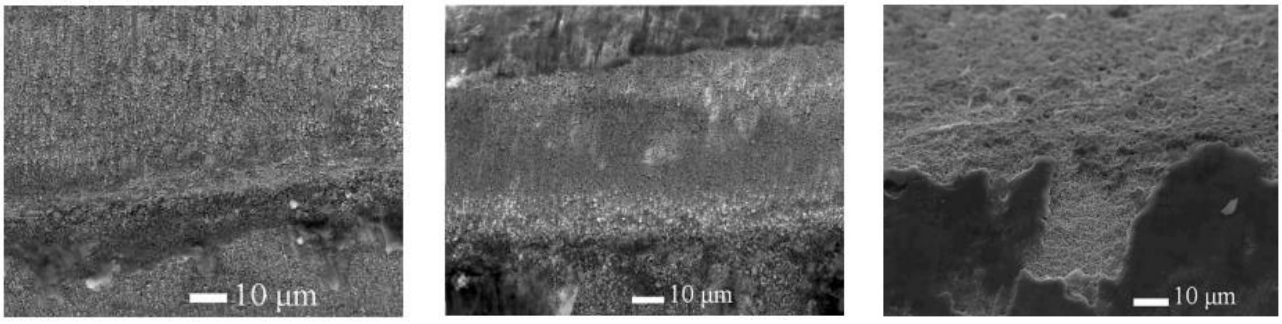
The matrix composite (MMC) based on aluminum has bad machinability, which are caused by the high abrasiveness of the material and its tendency to stick to the cutting surface. A significant achievement of modern MMC processing technologies has been using tools with carbon coatings, diamondlike and polycrystalline diamond, with high hardness and a low coefficient of friction. The conducted studies show that a tool with an NCD/MCD coating can be the most effective, due to its high thermal conductivity, chemical inertia, and wear resistance.



A CoroMill 200 indexable mill with two round-shaped inserts made of hard alloy H10F with a submicron carbide grain size of 0.8 μm, cutting group S, were used. The tests with passing milling were carried out along the end of the cylindrical work-piece in a spiral. The cutting mode was as follows: the cutting speed 800 m/min, the feed per tooth 0.2 mm, the cutting depth 1 mm, and the milling width 12 mm. The processing time for one pass of the cutter (complete processing of the end surface of the workpiece) was 20 s, corresponded to the cutting length of 0.4 m with each insert.

Fig.1 The durability of ball-end mills with coatings: 1 — uncoated, 2 — AlTiCrN/Si3N4+DLC, 3 —MCD/NCD.

For uncoated tools, the milling time before the edge reaches the critical wear value 0.3 mm on the back surface was T=400 s at a cutting speed of 800 m/min, which corresponds to a cutting length of L=8.5 m; the cutting length of the carbide insert with ATiCrN/Si_3N_4+DLC coating doubled (T = 800 s, L = 17 m), and the plate with PCD coating increased four times when the wear criterion was reached (T = 1600 s, L = 34 m).



(a) (b) (c)

Fig.2 SEM image of a worn CoroMill 200 plate without coating (a), ATiCrN/Si_3N_4+DLC coating (b), with MCD/NCD coating (c) after 20, 40, and 80 passes of the cutter accordingly.

The primary mechanism of wear of an uncoated carbide tool under a given cutting mode is soft abrasion, in which wear on both the front and back surfaces occurs due to the extrusion of a cobalt binder between tungsten carbide grains, followed by their loss. A diamond-like coating can change the wear mechanism of the cutter, but only on the front surface, where the abrasive mechanism is manifested. At the same time, the wear rate slows down. A diamond multilayer coating based on alternating layers of micro- and nanoscale polycrystals (MCD/NCD) completely changes the wear mechanism, preventing the tung sten carbide grains from staining from the cutting surface of the plate, providing better tool durability with such a coating. Thus, this research shows the advantage of a diamond-coated tool.

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