PO2033

Increase of the Tool Life of Cutting Inserts by Optimizing CrAlN-Based Coating using Cutting Simulation

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The conventional development of a coating system for cutting inserts includes a variety of test series with elaborate experimental parameter studies. In particular, conventional investigations of the cutting behavior by trial and error cause a considerable consumption of time, resources and costs. Therefore, it is desirable to reduce the effort for the development significantly by using simulations of the cutting process to adapt the coating properties to the requirements of the cutting task.
Thus, the main influencing factors for the thermomechanical loading of the cutting tools were analyzed by 2D FEM simulation of the cutting process. For that matter, physical and technological boundaries for CrAlN-based reference films were taken into account. The CrAlN-based coatings were deposited onto cutting inserts using an industrial PVD magnetron sputter unit CemeCon CC800/9. For the deposition two target concepts were used: On the one hand the CrAlN coatings were deposited by reactive magnetron sputtering of two chromium and two aluminum targets using nitrogen as reactive gas on the other hand four segmented targets with chromium and aluminum segments were used. Furthermore, CrAlYN and CrAlSiN coatings were deposited by additional use of yttrium and silicon segments, respectively. The coated specimens were comprehensively characterized in order to feed the cutting simulation with the physical and mechanical coating properties. The cutting performance of the coated inserts was experimentally tested and the results of the simulations were compared with the results of the cutting test.
The significance of the coating's properties on the cutting performance was analyzed by FEM simulation. Based on the simulation, the deposition parameters were optimized to increase the lifetime of the cutting insert.

Keywords
CrAlN
PVD
Cutting Simulation
Cutting Test