Tribological analyses of thin Cr2AlC films

Wolfgang Tillmann¹, Jan Herper¹

¹Institute of Materials Engineering, Dortmund, Germany
wolfgang.tillmann@udo.edu

To extend the tool life and thus, to save costs, the reduction of friction and wear is a required goal in many industrial applications. The forming and cutting industry is very interested in innovative coating systems in order to improve the tribological behavior of tool surfaces. Cr₂AlC belongs to the Mn⁺¹AXₙ phases (n=1-3), also called MAX phases, which are nanolayered ternary metal carbides or nitrides. M is an early transition metal, A is an A-group element of the periodic table (mostly IIIA and IVA) and X is either carbon or nitrogen. MAX phases which crystallize in a hexagonal structure are a class of materials which have metal and ceramic properties. They are characterized by high Young’s moduli, a good machinability, and good damage tolerances. Furthermore, these phases show an excellent thermal shock resistance as well as a good corrosion resistance.

The Cr₂AlC MAX phases were discovered in 1963, but only in recent years they were produced as thin protective layers by the PVD technology. Among the high quantity of MAX phases, Cr₂AlC shows very high strengths and an excellent oxidation resistance.

In this study, monolayer as well as multilayer Cr₂AlC-coatings were deposited by means of magnetron sputtering and analyzed afterwards. The multilayer coating system consists of Cr₂AlC layers with thin chromium interlayers to reduce the crack extension. High speed steel S6-5-2 was used as substrate material.

To compare the mechanical and tribological properties, the coated surfaces were analyzed by nanoindentation, scratchtests, ball-on-disc-tests as well as scanning electron microscopy.

Keywords
Cr₂AlC
MAX-phases
PVD
magnetron sputtering
multilayer coating system