OR1806

Self-lubricating and Wear Resistant Coatings Based on (Cr,Al,V)N and (Cr,Al,Ti)N Deposited by HPPMS

Ricardo Henrique Brugnara[1], Kirsten Bobzin[1], Nazlim Bagcivan[1], Mara Ewering[1]

[1]Surface Engineering Institute RWTH, Aachen, Germany

brugnara@iot.rwth-aachen.de

The increasing demand for lightweight and high-strength materials in recent years has led to increased application of forming processes like extrusion and hot forging. For this reason, the optimization of tool surfaces gains importance in terms of increasing the tool life by reducing friction and wear. In this regard, nanostructured self-lubricating (Cr,Al,V)N and (Cr,Al,Ti)N films were sputtered on 1.2999 hot working steel by using the HPPMS (High Power Pulse Magnetron Sputtering) technology. The combination of a hard (Cr,Al)N matrix embedded with transition metals vanadium and titanium provides an excellent dry sliding wear resistance and low friction coefficient by high temperature activation. The reason for this friction reduction is the formation of the so called Magnéli phases at elevated temperature.
The mechanical properties like hardness, Young's modulus and adhesion of the deposited coatings were investigated by using nanoidentation and scratch test. The maximum hardness value was about 25 GPa. Furthermore, high temperature Pin-on-Disk (PoD) tribometer measurements and high resolution analysis like SEM (Scanning Electron Microscope) and EDX (Energy Dispersive X-ray Spectroscopy) were carried out to analyze the tribological behaviour of the coatings at different temperatures. The analyses show a clear reduction of the friction coefficient from 0.6 (25 °C) to 0.2 (600°C) and 0.05 (800 °C) for the (Cr,Al,V)N coating. In contrast to this, the (Cr,Al,Ti)N coating shows lower friction coefficient (0.5) at room temperature but no more reduction of the friction is observed up to 800 °C.
In addition, XRD (X-Ray Diffraction) measurements after 4 h annealing at RT, 600°C, 800°C and 1000°C in an oxygen containing atmosphere were performed in order to analyse the formation of the self-lubricating Magnéli phases. For the (Cr,Al,V)N coating a formation of VO_2 and V_4O_9 at the surface can be obtained. Moreover SEM and TEM (Transmission Electron Microscopy) analyses show the coating's morphology and the diffusion of the transition metals to the surface after the annealing experiments.

Keywords
HPPMS
Self-Lubricating Coating
Magnéli Phase
(Cr,Al,V)N
(Cr,Al,Ti)N