OR2604

DETERMINATION OF HARD COATING MECHANICAL PROPERTIES BY NANOINDENTATIONS AND IMPACT TESTS AT AMBIENT AND ELEVATED TEMPERATURES

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Up to now nanoindentations were applied on thin films at ambient temperatures. Recently, nanoindentation instruments for conducting measurements at elevated temperatures have been developed facilitating nanoindentations up to 600ºC, whereas both indenter and specimen are heated. To avoid oxidations, the measurements can be also conducted in an inert atmosphere. In the described investigations nanoindentations were conducted on specimens coated with $Ti_{35}Al_{65}N$, $Ti_{46}Al_{54}N$, TiAlN/TiSiN as well as DLC PVD films. The obtained results were evaluated using appropriate FEM algorithms for determining the films' stress-strain constitutive laws versus the temperature. In the conducted FEM calculations, a rate-independent anisotropic plasticity with kinematic hardening material law was considered. By this method accurate determination of the film's elasticity modulus, yield, fatigue and rupture strength at various temperatures was accomplished. The results demonstrated a non-linear temperature dependence of the film properties. An enhancement and moreover a worsening of the mechanical properties at temperatures of ca.200 ºC and over 500 ºC respectively was revealed. These dependencies can be attributed to dislocations movements and stress concentrations avoidance in the coating material induced by the temperature raise. Perpendicular impact tests on the coated cemented carbides inserts were conducted at temperatures up to 400ºC for investigating the film's impact behavior. The developed impressions were recorded by scanning electron microscopy and white light scans by confocal microscopy. The fatigue endurance was determined by impact tests and evaluated by ITEC software. Correlation between the film fatigue endurance and the mechanical properties of PVD coatings at various temperatures determined by impact tests and nanoindentations respectively is revealed.

Keywords
PVD coatings
nanoindentation
impact test
elevated temperatures
mechanical properties