OR1803

A study of thermal stability, corrosion- and high-temperature oxidation resistance of (Ti,Cr)-(Al,Si,Y)-C-N films

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Tribological coatings for mechanical engineering are expected to demonstrate superior performance under severe cutting, stamping, and bearing conditions, being also resistant against humidity, corrosive environments, and temperature fluctuations. The desired properties can be achieved in hard coatings based on carbides, borides, and nitrides of transition metals by complex alloying with other elements such as Al, Cr, Si, Y, etc. The present work demonstrates the potential of self-propagating high-temperature synthesis (SHS) for fabrication of targets for PVD, magnetron sputtering, and ion implantation assisted magnetron sputtering of SHS targets to produce novel milticomponent nanostructured films with enhanced multifunctional properties.

For film depositions, the TiAlSiCN and TiCrSiCN composite targets with different metals/nonmetals ratios and the MAX-phases $Ti_{2-x}Cr_xAlC$ targets (where x=0, 0.5, 1.5, and 2) were used. The Ti-Al-Si-C-N and Ti-Cr-Si-C-N films with optimal mechanical properties were additionally alloyed with Ti and Y by ion implantation in order to improve adhesion strength and increase coating performance at elevated temperatures. The structure, chemical and phase composition of films were studied by means of X-ray diffraction, transmission and scanning electron microscopy, X-ray photoelectron spectroscopy, glow discharge optical emission spectroscopy, electron energy loss spectroscopy and Raman spectroscopy. The films were characterised in terms of their hardness, elastic modulus, and elastic recovery after annealing at temperatures 600-1200^{o}C in vacuum, adhesion strength, friction coefficient, wear rate, corrosion and high-temperature oxidation resistance. The lifetime of cutting tools with films was also examined.

The results obtained showed that the SHS targets can be successfully used to deposit multicomponent nanostructured films with enhanced characteristics, such as high hardness, low wear and friction, high thermal stability, oxidation and corrosion resistance.

Keywords
SHS Targets
Magnetron sputtering
Thermal stability
Corrosion
Oxidation resistance