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Effect of Cr additions on the structure, oxidation resistance and high temperature tribological performance of TiAlN films deposited by sputtering

Filipe Fernandes[1], Martin Danek[2], Tomas Polcar[3], Albano Cavaleiro[1]

[1]SEG-CEMUC, Coimbra, Portugal [2]Czech Technical University in Prague, Prague, Czech Republic [3]nCATS, School of Engineering Sciences, Southampton, United Kingdom

filipe.fernandes@dem.uc.pt

Machining of hard to cut materials such as hardened steels or strong materials for high temperature aerospace applications are challenges of modern engineering. Nowadays, TiAlN is the most widespread coating because of its sufficient thermal stability, up to 900°C, high hardness, oxidation resistance and adhesion resistance. The addition of Cr to this system has been reported to hinder the spinoidal decomposition of this system by slowing the diffusion and formation of c-TiN and c-AlN domains. This work is focused on the effect of Cr alloying on the structure, oxidation resistance, kinetics of ions diffusion and high temperature tribological behaviour of TiAlN coatings. The coatings were deposited in an industrial chamber by unbalanced close field magnetron sputtering with RF sources, onto Si, FeCrAl alloy and WC substrates as well as onto tungsten carbide drills with 5.5 mm diameter. The crystal structure of the films was analyzed by X-ray diffraction. Oxidation of films was assessed by thermogravimetric analysis (TGA), by isothermal exposing the coatings at temperatures in the range of 800-1000 ^{0}C. The surface, as well as the cross section morphology, of oxidized coatings was characterized by SEM. Elemental line scans along the cross section and elemental maps were acquired to study the oxide scale growth. Tribological experiments were performed in a high temperature pin-on-disc tribometer at RT, 600 and 700 ºC, using Al2O3 balls as counterpart. The tribological experiments were then complemented with in-real machining tests by studying the lifetime of coated drills. Increasing of Cr content on TiAlN coatings increases their oxidation resistance. The tribological performance revealed a slight improvement at room temperature with Cr content addition which abruptly increased at high temperature. The in-service tests confirmed an improving in the lifetime of Cr-containing TiAlN coatings in good agreement with their better tribological performance.

Keywords
TiAl(Cr)N films
Oxidation behaviour
High temperature tribology