PO3002

The effects of nano-architecture on CrN thin films deposited by reactive magnetron sputtering with pulsed substrate biasing

Peter Kelly[1], John Freeman[1], Glen West[1], James Bradley[2], Bernd Liebig[2], Ivanka Iordanova[3]

[1]Manchester Metropolitan University, Manchester, United Kingdom [2]University of Liverpool, Liverpool, United Kingdom [3]University of Sofia, Sofia, Bulgaria

peter.kelly@mmu.ac.uk

The effect of nano-architecture on the through-thickness structure of CrN thin films has been studied in an attempt to improve the tribological performance of these coatings. The coatings were deposited onto tool steel by DC reactive magnetron sputtering with DC or mid frequency (100-350 kHz) pulsed DC biasing at the substrate. Pulsed DC biasing is known to result in enhanced ion current densities incident at the substrate, which can be beneficial to film properties. However, excessive ion bombardment may lead to high intrinsic stresses and poor film adhesion. Hence, in this study, alternative layer architectures have been investigated to optimise both film properties and adhesion. In all cases a Cr adhesion layer of varying thicknesses (50-500 nm) was deposited initially. The introduction of nitrogen gas was also varied in time and flow rate to produce a series of coatings in which this interlayer was graded in composition from Cr to CrN. Following this, varying layer thicknesses of CrN were deposited with DC biasing at the substrate. The remainder of the film were then deposited using pulsed substrate biasing. The thickness of the material deposited by pulsed substrate biasing was adjusted so that all the samples had a total thickness of approximately 2 microns The coating structures have been analysed by X-ray diffraction (XRD) and scanning electron microscopy (SEM) and their tribological properties have been assessed by nano-indentation, scratch test adhesion and thrust washer wear testing. From these results, an optimised layer architecture is proposed, which demonstrates enhanced tribological performance compared to coatings with more conventional structures. This work is taken from a larger study of the impact of pulsed substrate biasing on the magnetron sputter deposition process. To elucidate the mechanisms through which pulsing the bias at the substrate modifies the deposition plasma, temporally-resolved measurements of the electron density and temperature as well as the plasma-induced emission have also been made.

Keywords
Chromium nitride coatings
magnetron sputtering
pulsed biasing
tribology
plasma diagnostics