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

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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 (at both the ion etch and deposition stages). 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.
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. Based on these findings, further batches of coatings with different architectures were deposited onto 6mm diameter twist drills, which were then tested to failure against EN9 steel. A wide range of results were obtained, with some coating architectures failing after a similar number of holes to an uncoated drill, whereas other architectures out performed commercially available tools by a factor of four and had an average lifetime approaching 66% of a CrTiAlN coated tool.

Keywords
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magnetron sputtering
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