Tailoring the Properties of Nanocomposite Ti-C-N Coatings Deposited by Industrial-Scale DC Magnetron Sputtering

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Nanocomposite coatings consisting of TiN, TiC and/or Ti(C,N) nanocrystallites embedded in an amorphous carbon matrix were deposited by reactive DC magnetron sputtering with an industrial-scale deposition system. A mixture of argon and N\textsubscript{2} reactive gas was used in combination with graphite and titanium targets. A systematic variation of the substrate bias voltage and the deposition temperature was performed to study the interdependence of the microstructural, mechanical and tribological properties of the various coatings. The mechanical properties – hardness and elastic modulus – were extracted from nanoindentation data, and the residual film stress was determined from substrate bending. XRD, TEM and XPS were employed to study the nature of the crystalline phases, whereas Raman spectroscopy in combination with TEM provided information on the amorphous matrix. The friction and wear properties were investigated with a pin-on-disc setup. An increase in the negative substrate bias voltage or in the deposition temperature promoted the nanocrystalline phases, while the overall composition of the coatings was only slightly affected. However, whereas an increased substrate bias voltage caused an increased compressive stress, the compressive stress decreased from 1.9 GPa to 1 GPa when the deposition temperature was increased from 150°C to 340°C. The presence of nanocrystallites significantly increased the hardness of the coatings, whereas the amorphous carbon matrix was essential for obtaining a low friction coefficient.

Keywords
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