Effect of negative substrate bias voltage on the CrN film deposition using modulated pulse power magnetron sputtering

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Abstract

CrN_x coatings have been deposited by Modulated Pulse Power (MPP) magnetron sputtering in a closed field unbalanced magnetron sputtering system at different negative bias voltages (V_b) from 0 to -150 V. During the depositions, the peak and mean substrate ion current densities (I_{sub}) increased rapidly from 67 to 250 mA/cm^2 and from 10 to 48 mA/cm^2 respectively as the V_b was increased from -20 to -50 V. A saturation of both the peak and mean I_{sub} was observed as the V_b was higher than -50 V. The structure and properties of the CrN_x coatings deposited at different V_b voltages were characterized using electron probe micro-analysis, x-ray diffraction, scanning electron microscopy, nanoindentation, and ball on disk wear test. It was found that the Cr/N ratio of the coating increased as the V_b was increased, which resulted in the formation of a large mount of β-Cr_2N phase in the coating deposited at a -150 V bias. The increase in the V_b led to a refinement of the grains and an increase in the hardness of the CrN coating, but the wear resistance of the coating decreased rapidly as the V_b was increased to -150 V, which is related to the formation of a large amount of the hexagonal Cr_2N phase in the coating. The detailed effects of V_b on the microstructure, mechanical and tribological properties of the MPP sputtered CrN coatings will be presented.