Effect of plasma nitriding pretreatment on the mechanical and wear properties of tungsten carbide substrate, and AlCrN coating deposited by high-power impulse magnetron sputtering

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Abstract

This paper examines the mechanical and wear properties of Tungsten Carbide substrates subjected to plasma-nitriding (PN) before, and after being coated with AlCrN by high-power impulse magnetron sputtering (HiPIMS). Low-temperature (~300 °C) plasma nitriding treatment was applied for various durations (0 hr, 0.5 hr, 1 hr, and 1.5 hr) with the aim of maximizing the adhesion strength and wear resistance by improved the mechanical properties of the tungsten carbide substrate for after AlCrN coating. XPS and TEM revealed the effect of plasma nitriding on the tungsten carbide substrate, the diffusion of nitrogen into the tungsten carbide substrates to form new nitrides as such W-N and C-N bonding. Result in the hardness is enhanced from 1534 to 2034 Hv. After that, the AlCrN deposited on nitride tungsten carbide substrate by HiPIMS process. The measurement results indicate that the adhesion strength was improved from 70 to above 150 N, and the hardness was enhanced from 2257 to 2568 Hv with increasing plasma nitriding durations. Due to substrate hardening effect led to the wear rate can be decreased from 14.5 to 3.4 (10^{-8} mm^3/Nm). Therefore, the AlCrN coating deposited on tungsten carbide substrate with plasma nitriding pretreatment is proved can enhance the mechanical and wear properties of the AlCrN thin film.

Keywords: plasma nitriding, high-power impulse magnetron sputtering, AlCrN coating