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Mechanical properties and cutting performance of multilayered AlTiN/TiBN hard coatings

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Transition metal nitrides, such as AlTiN, TiN and TiBN, have been used as protective hard coatings due to their excellent tribological properties. In this study, AlTiN/TiBN coatings were synthesized by cathodic-arc evaporation. AlTi and TiB alloy cathodes were used for the deposition of multilayered AlTiN/TiBN coatings. During the coating process of AlTiN/TiBN, different interlayers of AlTiN and TiBN were deposited to enhance mechanical properties and adhesion strength between the coatings and substrates. The multilayer thickness and alloy content of the deposited coating were correlated with the evaporation rate of cathode materials. By controlling the cathode current and rotation speed, the deposited multilayered AlTiN/TiBN coatings possessed periodic AlTiN and TiBN layers. In this study, the microstructure of the as-deposited and high temperature annealed coatings was characterized by field emission scanning electron microscope (FESEM), high resolution transmission electron microscope (HRTEM) and X-ray diffraction (XRD) using Bragg-Brentano and glancing angle parallel beam geometries. The composition depth profile of the oxidized coatings was evaluated by secondary ion mass spectrometry (SIMS). Mechanical properties, such as the hardness and elastic modulus, were measured by means of nanoindention. Meanwhile, the multilayered AlTiN/TiBN, which forms stable and dense diffusion barriers at high temperature, is expected to possess good resistance to high temperature oxidation. The design of the multilayered AlTiN/TiBN coatings by using proper interlayers is anticipated to increase the adhesion, hardness, toughness and cutting performance of coatings. For the high speed cutting test of Ti-6Al-4V alloys, under proper cutting parameters, the multilayered AlTiN/TiBN with an interlayer of TiBN showed the lowest flank wear and the surface roughness of the machined Ti alloy.

Keywords
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