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Optimization of the cutting performance of TiAlN coated carbide milling inserts by doping with additional elements

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Titanium aluminum nitride (TiAlN) coatings are commonly used for cutting applications because of their high hardness and high thermal stability. Doping with additional elements and a multilayered film structure can further increase the hardness and oxidation resistance of these hard coatings. The influence of multilayered TiAlN films doped with chromium, zirconium and silicon on the cutting performance of milling inserts was investigated. The multilayered TiAlN/(Cr,Zr,Si)N films were deposited on tungsten carbide-cobalt (WC-Co) milling inserts by direct current (DC) magnetron sputtering. The influence of the doping element content on the adhesion, hardness, microstructure and cutting performance was determined by glow discharge optical emission spectroscopy (GDOES), scratch tests, hardness indentation tests, electron microscopy and milling tests. Moreover, to increase the adhesion of TiAlN/SiN films the effect of gradient in the SiN layer thickness and a variation of the TiAlN/SiN bilayer period were studied. As reference for the cutting performance commercially available TiAlN inserts were used. The TiAlN/CrN and TiAlN/ZrN coated milling inserts showed no improved cutting performance in comparison to the TiAlN reference coating whereas the lifetime of the TiAlN/SiN coated milling inserts was increased significantly. The adhesion and cutting performance of TiAlN/SiN films with silicon contents ≥ 4 at.-% decreased rapidly which could be enhanced by a gradient in the SiN layer thickness and a lower TiAlN/SiN bilayer period.

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