13th International Conference on Surface Modification of Materials by Ion Beams
Program & Abstracts

San Antonio, Texas, USA
September 21-26, 2003
Microchemical and Microstructural Evolution of WC-TiC-Co Hard Alloy Treated by Ion Implantation

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The effects of plasma nitriding and metal implantation on the microchemical and microstructural changes of WC-TiC-Co hard alloy are studied. Plasma nitriding is carried out at room temperature using a plasma immersion ion implanter. The nitrogen density is $-5 \times 10^6$ cm$^{-2}$ and the substrate bias voltage is -20 kV. Molybdenum and tungsten metal implantation is conducted employing a metal vapor vacuum arc source. The pulse voltage and average implant current in metal implantation is -20 kV (mean implantation energy of Mo is 60 keV due to the high average ion charge state) and 1 A, respectively. The elemental depth profiles, microchemistry, and microstructure of the implanted cemented carbide are determined by X-ray photoelectron spectroscopy (XPS), glancing angle X-ray diffraction (GXRd), and scanning electron microscopy (SEM). The results show that new nitride phases or quadruple carbides are formed and they can be in the form of solid state precipitates or nano-clusters dispersed inside the surface grains of WC and TiC. Mechanical test results show that the dramatic increase in the surface hardness is due to the new hard particles being able to better withstand the external load.