Structure Evolution And Properties Of Multilayer Coatings Based On Refractory Metal Nitride Wn

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ABSTRACT

Recently, the intensive development of modern technologies has been stimulating the need to improve the protective properties of materials and their durability. They must withstand extreme operating conditions, such as high temperatures, external stresses, and aggressive oxidizing environments, which can lead to their degradation and destruction. Therefore, protective coatings with high mechanical and tribological properties, resistance to heat and corrosion, and chemical inertness are successfully used in various industry branches. In particular, transition metal nitrides are very popular for different applications and are actively studied by materials science experts. For instance, in the form of thin coatings, they can be used for multilayer metallization of integrated circuits. Moreover, they can be excellent candidates for diffusion barriers, which are placed between metal and semiconductor/insulator to prevent any harmful interactions between two materials.

For many decades, single-layer nitrides have been widely used for tribological applications. However, numerous studies have shown that the multilayer architecture allows adapting the functional properties of the coating for technologically complex applications. Thus, this work reports on the deposition of WN-based multilayer coatings with different second layer MeN (Me = Zr, Cr, Mo, Nb, TiSi). The differences in microstructure, phase composition, surface roughness, mechanical properties, adhesion strength, friction performance, and wear behavior of the nanoscale WN/ZrN, WN/CrN, WN/MoN, WN/TiSiN, and WN/NbN coating systems deposited by the

cathodic-arc physical vapor deposition (CA-PVD) at the same parameters are comprehensively investigated. Polished stainless steel X6CrNiTi18-11 was used as substrates. The microstructure, chemical composition, mechanical and tribological properties of the samples were investigated using an X-ray diffractometer, a scratch tester with Rockwell-C indenter, a high-resolution scanning electron microscope, nanoindentation unit, and a device for tribological testing according to the "ball on disk" scheme. Coatings were roughly divided into two groups regarding microstructure: (i) all constituent layers had NaCl-type cubic structure (WN/Zr, WN/CrN, and WN/TiSiN) and (ii) WN layers had the face-centered cubic (fcc) W_2N phase, while other layers developed a combination of two hexagonal (WN/MoN) or hexagonal and fcc NaCl-type cubic phases (WN/NbN). The WN/ZrN, WN/CrN, WN/MoN, WN/TiSiN, and WN/NbN coatings exhibited a high hardness range from 33.3 ± 1.7 GPa to 37.3 ± 2.4 GPa. Since all multilayer systems exhibited hardness > 30 GPa, they can be categorized as hard materials.