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The Nano Modification of Hard Coatings with Nitrogen Ion Implantation

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Abstract – In this paper, we present the results of a study of TiN films which are deposited by a Physical Vapor Deposition and Ion Beam Assisted Deposition. In the present investigation the subsequent ion implantation was provided with N^{2+} ions. The ion implantation was applied to enhance the mechanical properties of surface. The film deposition process exerts a number of effects such as crystallographic orientation, morphology, topography, densification of the films. The evolution of the microstructure from porous and columnar grains to densel packed grains is accompanied by changes in mechanical and physical properties. A variety of analytic techniques were used for characterization, such as scratch test, calo test, SEM, AFM, XRD and EDAX. The experimental results indicated that the mechanical hardness is elevated by penetration of nitrogen, whereas the Young's modulus is significantly elevated.

Indentation was performed with CSM Nanohardness Tester. The results are analyzed in terms of load-displacement curves, hardness, Young's modulus, unloading stiffness and elastic recovery. The nanohardness of coating measured by Berkovich indenter is about 42.4 GPa. The analysis of the indents was performed by Atomic Force Microscope. The stress determination follows the conventional $\sin^2\psi$ method, using a X-ray diffractometer The analyzed AE signal was obtained by a scratching test designed for adherence evaluation. AE permits an earlier detection, because the shear stress is a maximum at certain depth beneath the surface, where a subsurface crack starts. Coating is often in tensile stress with greater microhardness. The film deposition process exerts a number of effects such as crystallographic orientation, morphology, topography, densification of the films.The evolution of the microstructure from porous and columnar grains to densel packed grains is accompanied by changes in mechanical and physical properties. A variety of analytic techniques were used for characterization, such as scratch test, calo test, SEM, AFM, XRD and EDAX. Therefore, by properly selecting the processing parameters, well-adherent TiN films with high hardness can be obtained on engineering steel substrates, and show a potential for engineering applications.

The experimental results indicated that the mechanical hardness is elevated by penetration of nitrogen, whereas the Young's modulus is significantly elevated.

The deposition process and the resulting coating properties depend strongly on the additional ion bombardment.

Table 1: Surface microhardness ($HV_{0.03}$) and nanohardness (load-10mN).

	Unit	pn/IBAD	PVD	pn/PVD/II	Fused Silica
Average	Vickers	2007	3028	3927	943
Average	GPa	21.6	32.6	42.4	10,1

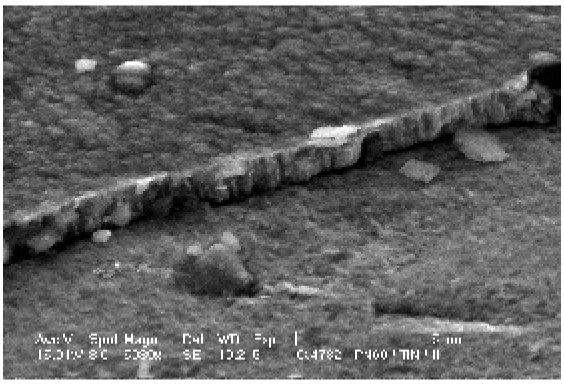

Figure 1: Surface morphologies of TiN-.

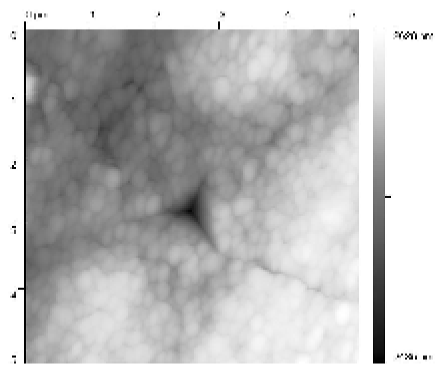

Figure 2: AFM image of a indentation

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Reference

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