THE NANO MODIFICATION OF HARD COATINGS WITH NITROGEN ION IMPLANTATION

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Thin hard coatings deposited by physical vapour deposition (PVD), e.g. titanium nitride (TiN) are frequently used to improve performance in many engineering applications

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 samples with duplex coating was studied, and subsequent ion implantation was provided with N^{5+} ions. The ion implantation was applied to enhance the mechanical properties of surface. The most successful and widespread model for nanoindentation data analysis is one in which the unloading data are assumed to arise from a purely elastic contact. The form most often used is known as the Oliver and Pharr method.

This paper describes the successful use of the nanoindentation technique for determination of hardness and elastic modulus. In the nanoindentation technique, hardness and Young's modulus can be determined by the Oliver and Pharr method, where hardness (H) can be defined as: $H=P_{max}/A$, where P_{max} is maximum applied load, and A is contact area at maximum load. In nanoindentation, the Young's Modulus, E, can be obtained from: $1/E_r=(1-v^2)/E+(1-v^2)/E_r$, where v_i=Poisson ratio of the diamond indenter (0.07) and Ei=Young's modulus of the diamond indenter. Therefore, in recent years, a number of measurements have been made in which nanoindentation and AFM have been combined.

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. The critical load Lc2 corresponds to the load inducing the partial delamination of the coating.

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.

References:

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[3] J.C.A. Batista, C. Godoy, A. Matthews, A. Leyland, Surface Engineering, 9 (2003) 37.

Figures:

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	42.6	10,1

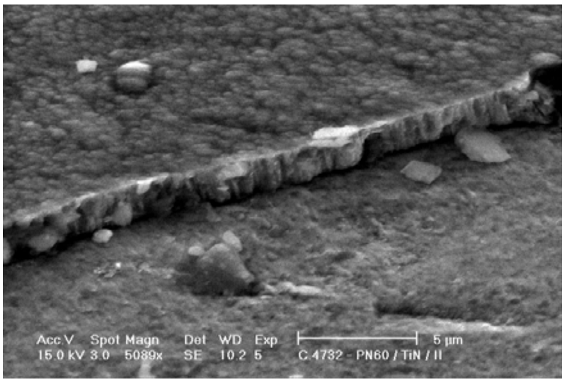

Figure 1.. Surface morphologies of coating.

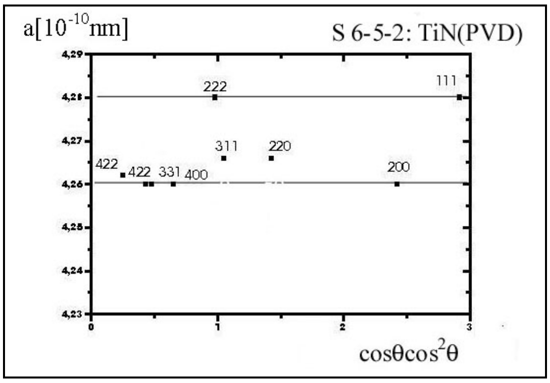

Figure 2. The Cohen-Wagner plot, lattice parameters a_{hkl} vs.cosθcot$^2\theta$.