11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

# Enhancement of mechanical properties by using a $[TiCN/TiNbCN]_n$ multilayer system

J. C. Caicedo[1], C. Amaya[1,2], M. E. Gómez[1], G. Zambrano[1], J. Alvarado-Rivera[3], J. Muñoz-Saldaña[3], and P. Prieto[1, 4]

(1) Grupo de Películas Delgadas, Universidad del Valle, Cali, Colombia
(2) Laboratorio de Recubrimientos Duros, CDT-ASTIN SENA, Cali, Colombia
(3) Centro de Investigación y de Estudios Avanzados del IPN, Unidad Querétaro, México
(4) Centro de Excelencia en Nuevos Materiales, CENM, Calle 13 #100-00 320-026, Cali, Colombia

**Abstract** – $[TiCN/TiNbCN]_n$ isostructural multilayered systems with various periods (λ) have been synthesized by reactive magnetron sputtering and deposited on AISI 4340 steel. We growth $[TiCN/TiNbCN]_n$ systems with various period and observed enhancement of both hardness and elastic modulus by increasing the number of bilayers (n) in the coating and also a decrease of the roughness with the increase of (n). Samples with length period (λ) of 15 nm (n=200 bilayers) revealed the highest hardness (42 GPa) and highest elastic modulus (408 GPa), corresponding to 1.6 and 1.3 times better than those values for the coating with n =1, respectively.

Since approximately 1980, a reactive sputtering of thin films is intensively investigated because the sputtering of metallic and ceramic targets in the presence of reactive gas makes it possible to easily form compound films, such as nitrides, oxides, carbides or their combinations. [1]. Multilayer coatings have been used for many years in applications such as optical, magnetic, electronic, corrosion protection, and tribological. For tribological applications, successful coatings generally exhibit high hardness and adhesion, as well as good oxidation resistance

In this work, we sought enhancement of mechanical properties of steels by using $[TiC_{1-x}N_x/Ti_{1-y}Nb_yC_{1-x}N_x]_n$ multilayered coatings. We grew $[TiCN/TiNbCN]_n$ multilayers via reactive *r.f.* magnetron sputtering technique by systematically varying the length period (λ) or the number of bilayers(n) and maintaining constant the total thickness of the coating and all other growth parameters. The coatings were characterized by X-ray diffraction, atomic force microscopy (AFM), scanning electron microscopy (SEM), and glow discharge spectroscopy (GDS) for the chemical profile. The mechanical properties were determined via nano-indentation tests by using an UBI1-Hysitron Fig. 1. From them we measured hardness and elastic modulus for the different samples. The enhancement effects in these $[TiCN/TiNbCN]_n$ multilayered coatings could be attributed according to the Hall Petch effect in multilayered coatings, where the interfaces act as a barrier against the dislocation movement. If the bilayers of materials have different mechanical properties, this generates an inhomogeneous system that inhibits the advance of potential micro-cracks [2].

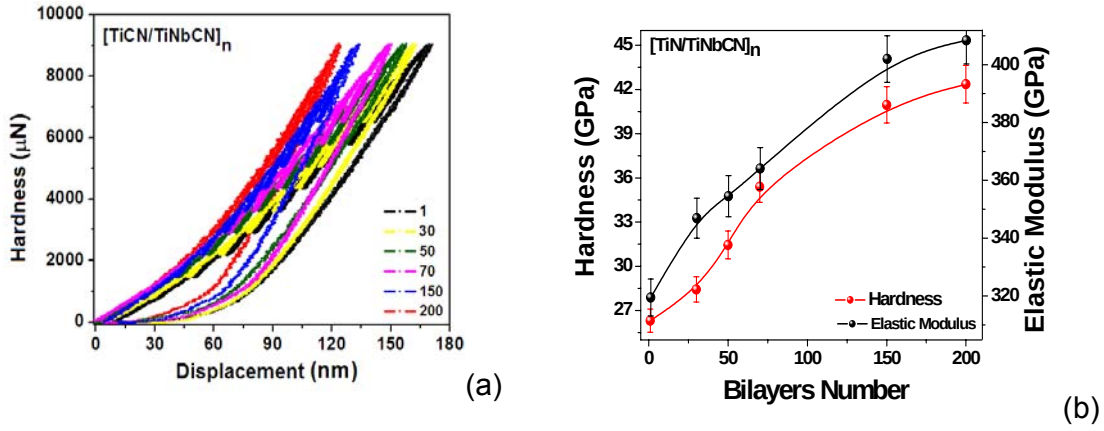


**Figure 1:** Mechanicals properties (a) Load-displacement curves, (b) Hardness of deposited films measured as a function bilayers number.

[1] S. Schiller, U. Heisig, Chr. Korndfrfer, G. Beister, J. Reschke, K. Steinfelder, J. Strqmpfel,, Surf. Coat. Technol. 33 405 (1987)
[2] C. Philip Yashar, D.William Sproul. Vacuum 55, 179-190, (1999)