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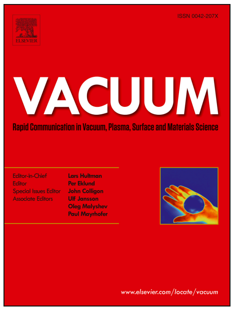

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Physical Properties Evolution on Ternary and Quaternary Carbonitride Coatings

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Abstract

The ternary and quaternary multilayers were synthesized via physical deposition processes. The aim of this work is to determinate the evolution of mechanical behavior in TiCN/TiNbCN multilayers systems as a protective coating. The multilayers characterized by X-Ray Diffraction (XRD) exhibited the crystallography orientation (111) for TiCN and TiNbCN phases. The multilayer periodicity and coherent assembly were determined by transmission electron microscopy (TEM). The mechanical properties, such as hardness and elastic modulus, were determined by nanoindentation measurements. The internal stress analysis in multilayer hard coatings, made possible by radius of curvature coatings using profilometry, found a stress reduction around 80% when the number of layers (n) were increased from n = 1 to n = 200. Changes in the increase of size of indentation track and growth of crack length allowed the determination of the increase in the fracture toughness around 85% as a function of bilayer period from Λ = 1.5 µm to Λ = 15 nm. Finding a direct relationship among reduction of residual stress, evolution of mechanical properties, and fracture toughness when the bilayer number has been changed, indicates that multilayer coatings may be a promising material for mechanical industry.

Keywords: Hard coatings, mechanical properties, internal stress, fracture toughness.

1. Introduction

Many heterostructures have been studied and used for many years in coating technology to enhance performance in industrial uses. Taking into account structural, chemical and physico-mechanical properties can change due to the multilayer configurations [1-4]. Moreover, the multilayers coatings based on metal ceramic systems such as TiN/CrN, AlN/CrN and TiCN/ZrCN have presented enhancements in the mechanical, tribological and chemical properties [4-6]. In this sense nitride, carbide and carbon-nitride -coated tools, have emerged in recent years; thus, principles, advantages and limitations of the various nitride coating processes for steel tools are summarized; the microstructures and mechanical properties are reviewed, and finally new developments in property design of hard coatings are presented by many authors [7, 8]. The metalworking industry reports loss in mechanical performance devices subject to wear or corrosion effect. Coatings based on carbides and nitrides synthesized as single-layers and multilayers have tried to give partial solutions to the tribological phenomena that deteriorate mechanical devices [8]. Taking into account the last criteria, various authors try to relate the intrinsic properties of the multilayer type coatings with the functional properties in services such as fracture toughness [9]. Therefore, it is possible in literature to find contributions in relation to structural development with the evolution of the mechanical properties [10-12]. However, the multilayers coatings based in the interaction of metal carbon-nitride synthetized with transition metals, e.g *TiNbCN which is a modification of TiCN based on Nb incorporation that partially substitutes the Ti elements; therefore, is possible to obtain a material with different physical and chemical properties in relation to TiCN. Due to the ionic radius of the Nb and the electronegativity, high hardness and high resistance to corrosion can be found in TiNbCN material, so the TiCN and TiNbCN into the multilayer system exhibit the synergy between*