

# Mechanical properties of multilayer TiAlN/CrN coatings embedded by cathodic arc evaporation

B. Warcholinski, A. Gilewicz

Koszalin University of Technology, Institute of Mechatronics, Nanotechnology and Vacuum Technique, Koszalin, Poland

## ABSTRACT

The results of the investigations of multilayer TiAlN/CrN coating deposited using cathodic arc evaporation applying TiAl (50:50 at.%) and elemental Cr cathodes are presented. The bilayer TiAlN+CrN thickness was about 250 nm with the thickness ratio of TiAlN:CrN layers as approximately 1:1. The atomic ratio of Ti/(Al+Ti) in the coating was 0.60. As the reference, the mono- TiAlN and multilayer TiAlN/TiN coatings were selected. All the coatings were embedded on CrN sublayer to reduce stress and improve adhesion of them. The investigated coatings show good adhesion in the range 80-90 N. The TiAlN/CrN coating shows lower friction coefficient and meaningfully lower wear rate than reference coatings, more than 10 times.

*Keywords:* TiAlN monolayer coating; TiAlN/CrN and TiAlN/TiN multilayer coatings; Mechanical properties

## 1. INTRODUCTION

Titanium nitride is historically the first and widest applied covering material produced using PVD processes. Addition of aluminum to TiN leads to an increase of the thermal stability of the coating [1] and considerably improves the properties of TiAlN, raising the hardness, wear and oxidation resistance even to 800°C [2-8]. These features point to a potential industrial application of the coatings, reducing manufacturing costs and raising productivity in many dry high speed processing, both metal and wood. Therefore in last years industrial application of mono- and multilayer coatings based on TiAlN and deposited using PVD methods considerably increases. These coatings can be formed using different PVD methods as magnetron sputtering [2,3], cathodic arc evaporation [5,6]. The arc deposition is often used because of high plasma ionization. It enables deposition of the coating with a dense structure and an excellent adhesion to the substrate.

Chromium nitrides shows a very good corrosion and wear resistance. CrN added to TiAlN coatings causes an increase of their oxidation resistance [9-11]. The durability of cutting tools covered by TiAlCrN coatings exceed those coated only TiAlN. The bilayer period  $\Lambda$  (understood as a configuration of two different lamellae with defined thickness ratio of them) and the chromium amount in them can have an effect on the microstructure and mechanical properties of the multilayer and/or nanocomposite TiAlCrN coatings [8,9]. Chromium nitride coatings exhibit versatile applications. These coatings can be embedded on tools both for metal and wood (wood product) machining [12-15]. Because of a higher oxidation temperature, TiAlN coatings with chromium are deposited on tools to wet wood machining. An addition of about 3 at. % of chromium to TiAlN results in raising oxidation resistance to about 920 °C [6]. A higher amount of chromium in the coating decreases the oxidation rate.

In this paper, comparative investigations of multilayer TiAlN/CrN coating were carried out. As the reference, monolayer TiAlN and multilayer TiAlN/TiN were used. All the coatings were deposited using cathodic arc evaporation with Ti<sub>50</sub>Al<sub>50</sub> cathode.