



Hard CrCN/CrN multilayer coatings for tribological applications

B. Warcholinski^{*}, A. Gilewicz, Z. Kuklinski, P. Myslinski

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

ARTICLE INFO

Article history:

Received 19 June 2009

Accepted in revised form 22 December 2009

Available online 4 January 2010

Keywords:

Cathodic arc evaporation

Multilayer coatings

CrCN/CrN

ABSTRACT

Hard coatings were deposited using a cathodic arc evaporation method. The results of investigations of multilayer CrCN/CrN coatings are presented in this article. The microstructure and crystallinity of films have been investigated using X-ray diffraction (XRD). The composition was determined with energy dispersive spectroscopy (EDS). The adhesion of films was estimated on the basis of an analysis of scratch-test results. The hardness and tribological properties of films deposited on hardened and tempered HSS substrates were also investigated. The tribological tests were carried out in a pin-on-disc geometry. The influence of a normal load, sliding speed and a counterpart material on the friction coefficient and the specific wear rate of the coatings were studied. The counterparts were made of HSS and four types of wood: oak, beech, spruce and pine. The hardness and adhesion of multilayer CrCN/CrN coatings are respectively 25 GPa and 120 N.

© 2009 Elsevier B.V. All rights reserved.

1. Introduction

An increasing importance of the wood industry constitutes an impulse to improve the tools for wood machining. The main feature of wood machining is the need of a very high cutting speed and sharpened cutting edges. Coatings for woodworking tools should be very hard, adherent, smooth, and need to have low friction coefficient and wear rate. Nevertheless, they must possess a good wear impact resistance and low residual coating stresses. One of the main problems concerning the application of hard thin coatings on cutting tools for bulk wood cutting applications is rounding of the cutting edge radius by a coating process. Small increase of the edge radius causes the increased tool wear and worse surface quality of a machined wood. Usually the cutting tools have a little curvature radius, which in most of the cases causes preliminary delaminations of the coatings, because of their residual stresses. The blunting of the cutting edge by a depositing or wood-working process leads to an increased tool wear and deteriorates the surface quality of the machined wood.

The materials currently applied in woodworking are hardened steel, high speed steel (HSS), carbides and polycrystalline diamond. They can be replaced by HSS tools with hard thin films covering the cutting surfaces. Those coatings can be deposited either as single or multilayer coatings of CrN, CrCN [1–5], TiAlN and TiCN [6]. Coatings based on chromium, pure Cr, Cr₂N, CrN are well known in metal industry as protective coatings [7]. CrCN coatings show a higher hardness, wear and corrosion resistance and a lower friction coefficient compared to CrN films [8,9]. A small carbon addition to CrN coating results in lower

residual stresses and can improve the adhesion of the CrN film to the substrate.

The main difficulties in the wood machining result from differences in the physical and chemical structure of wood and metals. Basic tribological tests, such as Vickers hardness measurements and scratch tests help to assess deposited coatings [10] in relation to wood and metal with their different wear mechanisms.

The mechanical properties of the coatings often strongly depend on their microstructural characteristics including lattice defect density, residual stress, types of phases existing in the coating and the chemical composition. The microstructure can depend on the choice of the process parameter and deposition conditions used, and can possess a range of mechanical properties mainly hardness and adhesion.

CrN shows almost the same wear resistance as CrCN. The adhesion and cohesion of CrCN are very poor. The highly brittle nature of this coating is a serious problem although their adhesion can be improved by special procedures prior to deposition. One of the most important is the deposition of a special sublayer reducing stress between proper coating and the substrate [11].

In our previous paper [12] we tested monolayer coatings of CrN with a different amount of carbon. The conclusions were: a small addition of carbon between 5 and 20 at.% causes lowering of the friction coefficient and wear rate. We decided to form a multilayer CrCN/CrN coating adding above mentioned amount of carbon.

Although there have been many papers in the literature studying the physical, mechanical, structural and tribological properties of CrN and CrCN coatings, no study has been performed, to our knowledge, where the CrCN/CrN multilayer coatings were tested.

In this work, different hard multilayer CrCN/CrN coatings were examined with respect to a future reducing wear of wood machining tools. In addition, coating properties, including hardness, friction

^{*} Corresponding author.

E-mail address: bogdan.warcholinski@tu.koszalin.pl (B. Warcholinski).