Wear 270 (2010) 32–38

Contents lists available at ScienceDirect

Wear

journal homepage: www.elsevier.com/locate/wear

Anti-wear multilayer coatings based on chromium nitride for wood machining tools

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ARTICLE INFO

Article history:
Received 12 March 2010
Received in revised form 27 August 2010
Accepted 20 September 2010
Available online 25 September 2010

PACS:
81.05.Je
81.40.Pq
81.15.Dj
81.70.Bt

Keyword:
PVD coatings
Cutting tools
Wear testing
Profilometry

ABSTRACT

The performed experiments revealed that the anti-wear resistance of chromium nitride and chromium carbonitride multilayer coatings obtained by the PVD method was higher than each of the phases separately.

The CrN/CrCN coatings were obtained using cathodic arc evaporation. They consisted of seven modules, each approximately 400 nm thick, characterised by different thickness ratio of the CrN and CrCN layers in the modulus. A layer of chromium 0.1 μm thick was used as a sublayer. The adhesion of the coatings was determined using scratch test and Rockwell test. Hardness and stress as well as friction and wear coefficients when used to work timber were determined. Industrial milling tests of dry wood were carried out. The results of above measurements showed that the best useful properties were observed when the thickness ratio in coatings' module was 2:1 which could be attributed to its very good adhesion to the substrate (about 115 N) and low wear rate. The tools with multilayer CrN/CrCN coatings improve the quality of the treated wood surface in comparison with uncoated knives.

1. Introduction

From the point of view of its mechanical and chemical properties, timber should be treated as heterogeneous material. In order to improve the quality of the processed wood and wood-derived elements, it is necessary to employ tools which have been appropriately prepared and to elaborate such surface processing technologies of the applied tools which will improve significantly their life and reliability. Increased resistance to abrasion and mechanical strokes is of paramount importance in the case of tools used in timber industry.

Both fibrous structure and viscoelastic properties of wood as well as high values of friction coefficients and use of high cutting and feed speeds place considerable requirements regarding the adhesion of the coating to the tool. Coatings of tools employed in wood processing must be characterised by numerous, frequently mutually excluding, characters, such as: considerable hardness, good adhesion to the base and small roughness. Other important traits include: low friction coefficient and wear rate.

At present, the following materials are used to manufacture wood processing tools: tool steel, high-speed steel, sintered carbides and polycrystalline diamond. The tools manufactured from high-speed steel covered with hard antiwear coatings can provide a valuable alternative for expensive tools made of sintered carbides or sintered polycrystalline diamond [1].

The dominant wear process in wood machining is abrasion, hence one can often observe erosion of the tool material and blunting of milling edges limiting possibilities of its application. This explains numerous current investigations concerned with the prolongation of tool life thanks to the introduction of proper coatings.

Due to their properties [2–7], chromium nitride coatings are employed to cover tools used for metal, wood and wood-based material processing [8–11]. Coating architecture modification [12] makes it possible to improve its useful properties. The application of the multilayer coating structure reduces the increase of column structure, blocking cracks in the interlayer zone. In addition, it may also reduces stresses forming in the coating. The coating adhesion to its substrate can also be enhanced by the introduction of transitional layers which decrease stress between the coating and the substrate [13].

There is no information in the available literature about multilayer CrN/CrCN coatings or their comprehensive investigations.

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doi:10.1016/j.wear.2010.09.002