NEW GENERATION OF CERAMIC TOOLS FOR MACHINING OF WOOD-BASED MATERIALS

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Abstract

New generation of ceramic tools for machining of wood-based materials. Paper describes development of new generation ceramic tools for machining of wood based materials, especially those of high tool wearing ratio.

Key words: *machining of wood-based materials, milling, woodworking tools, ceramic nanocomposites*

INTRODUCTION

In woodworking industry, cutting tool, especially in high-precision and quality demanding operations, became one of the if not most important factor in overall product quality and production profitability. Over the years, woodworking industry switched from solid wood to wood-based materials, especially chipboard, which cost and quality slowly declines, causing many technological problems. Above material usually happens to be contaminated with mineral particles, causing regular tools to become obsolete because of their shortened lifetime. Overall tool wear resistance became more and more important factor during machining of wood-based materials.

Polycrystalline diamond tools, introduced some time ago, when machining of chipboard show 17 times longer lifetime than comparable tools made of hardmetal, according to I.E.Clark (1993). Critical wear of traditional tools in milling of chipboard showed after 3000 meters, PCD tools reached 50 000 meters. Tools coated only with PCD or other superhard materials used normally for cutting of metal and plastics did not show any good results (Beer P. and others 2003), probably because of high cutting speed, repeated shocks and increased temperature caused by relatively high friction coefficient. Developed cBn nanocomposite tools which were described couple of months ago (Zbiec M, Jabłoński M. 2008) show some promising results increasing cutting lifetime about 60 times in comparison to traditional hard metal tools.

Analysis carried out by many authors showed that new tool material for machining of contaminated wood-based materials has to be developed.

METHODOLOGY

After successful tests with nanocomposite materials, new ceramic submicro-composite tool material was developed in the Institute of Advanced Manufacturing Technology in Cracow. Detailed specifications obviously can not be presented before patent application.

Improved material consists of micro and submicro cBn powder with little addition of sub micrometric binding powder, as described in the literature [Niihara 1993].
Presented and previous composites are believed to be able to work in temperatures exceeding 1200°C without risk of thermal degradation or oxidation, which is much more than comparable PCD materials. Tests performed in Department of Mechanical Woodworking have shown that in machining of wood or wood based materials tool temperature near the cutting edge may possibly exceed 800 degrees Celsius. To accurately simulate really hard working conditions, tests performed on regular chipboard could be inadequateand excessively time consuming. Tool wearing was performed during edging operation of specially manufactured boards, containing of 2.5% corundum, simulating extremely low quality mineral contaminated boards. Grain size of corundum reached 80 – 120μm. Initial tests showed complete wear of hard metal tools after around 15 meters which stands for really extreme conditions. Figure 1 shows view of experimental stand.

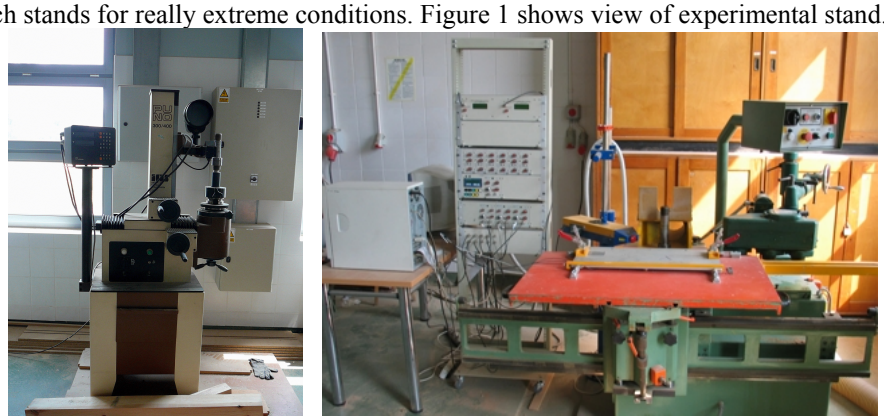

Fig.1. Experimental stand

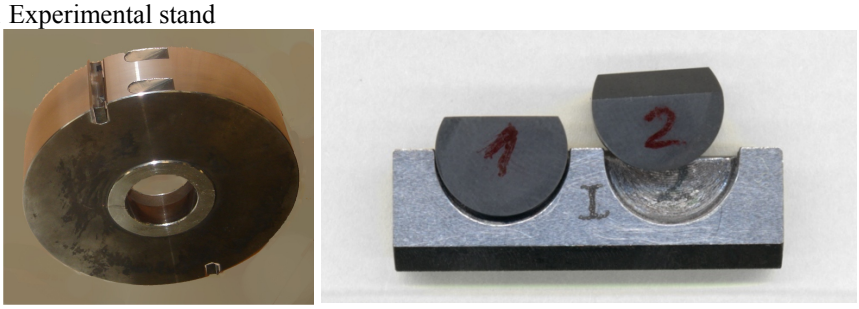

Fig. 2. Test cutting head and nano and submicro composite cutters

Nanocomposite tools were made of micrometric and nanometric mixture of cBN powder, bonded with Si_3N_4. Micro-submicro composites were made basically of the same material with different grain sizes and mixture proportions. Unfortunately, due to planned patent application more detailed specifications cannot be yet revealed.

Cutting tests were performed by edging of 2.5% aloxite (corundum) contaminated board, at 3000 rpm and 3 m/min feed speed. Cutting depth was set at 1 mm.

TEST RESULTS AND ANALYSIS

Cutting tests and tool wear experiment on nanocomposite cutters gave quite satisfactory results. On micro-submicro composite tools results were not less than

outstanding. Fig 3 shows tool wear curve, with classic hard metal, nanocomposite and micro-submicro composite tools while edging aloxite contaminated board.

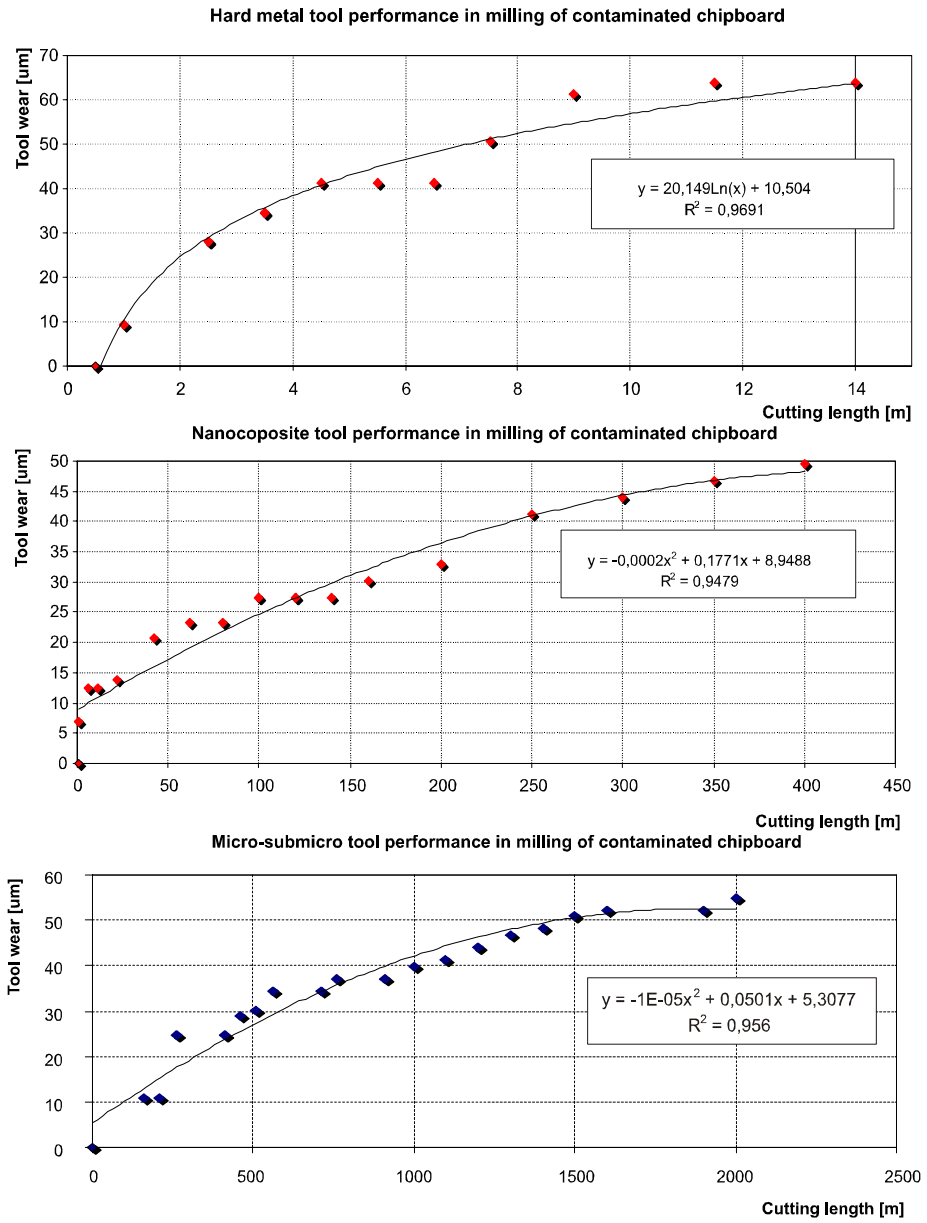

Fig 3. Cutting length of hard metal, nanocomposite and micro-submicro composite tools in milling of aloxite contaminated chipboard.

Tool was assumed to be worn, along with industry standards, when edge recession reaches 50µm. As one can clearly see, raw cutting length with application of nanocomposite tool in place of regular hard metal extends from around 7 meters to over 400 meters. In case od micro-submicro composite cutting path extends to 2000 meters.

First, preliminary nanocomposite products applied instead of hard metal extends working time or cutting length 60 times. Improved composites with bigger grain size extended cutting path 140 times.

Work on other composite materials is still being performed, so results will most likely improve significantly. Other cutting parameters, like forces and machined surface temperature will be published later, along with other materials tests, most likely after patent application

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