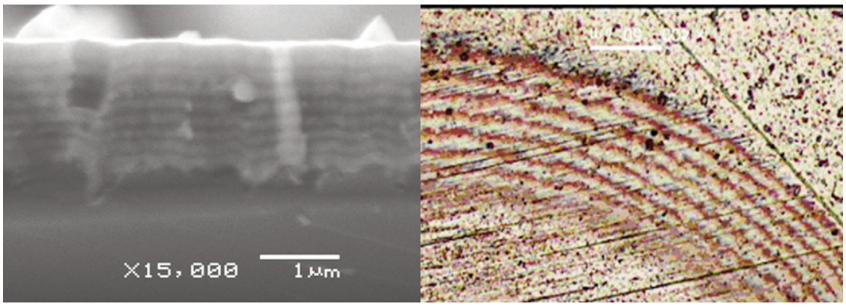
From woodworking to nanotechnology

You are only as good as your tools…

Wood as a construction material has accompanied man from the very beginning of the human race, and despite the abundance of modern metallic, ceramic and composite materials, we can hardly imagine everyday life without wooden products. But contemporary technologies in their production are very demanding technical tasks. The machining of wood and wood-derivative materials belongs to the harshest of cutting operations. The full exploitation of the technical parameters and the productivity of contemporary woodworking machines, as well as the meeting of market requirements concerning production quality, are impossible without tools with modified surfaces.

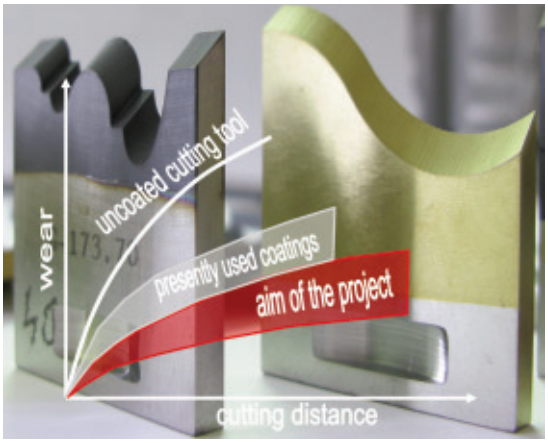
At present, practically all materials used for woodworking tool manufacture require sophisticated surface treatment. Further improvement of wood and wood-derivative material machinability will be limited by the ability to adapt recent achievements in materials science in the applied surface treatment technologies.

Research and development (R&D) in the field of the surface treatment of woodworking tools was started in Koszalin more then a decade ago and now it is concentrated in the Institute of Mechatronics, Nanotechnology and Vacuum Technique (IMNiTP) of Koszalin University of Technology. Some results of this were successfully introduced to industrial practice at the beginning of the year 2000. The first stage of R&D was summarised in the 2008 by the conclusion of the international project within the EU programme INTERREG III A. As a result of the project's execution, two types of multi-layer PVD coatings have been developed and implemented in industrial practice: Cr-based coatings and TiAlN-based mono and multilayer coatings both with a nanometric structure.



Fracture cross section and calotest friction track of the TiAlN/CrN coating

These achievements were rewarded with the prestigious 'The West Pomeranian Nobel 2008' prize and with the gold medal nomination at the International Fair of Machines and Tools for the Wood and Furniture Industry, DREMA 2009, in Poznań. The present, second stage, of R&D carried out on the surface treatment of woodworking tools was started in 2009 as the developmental project 'Hybrid technologies for woodworking tools modification' within the Operational Programme Innovative Economy POIG 2007-2013. The concept of the project is based on achievements to date and is aimed at the development of a new generation of surface treatment technologies for both cemented carbide and high-speed steel (HSS) tools.



The aim of the Developmental Project 'Hybrid technologies for woodworking tools modification'

In order to assure the extensiveness required, with regard to the diversity of wood types and their different moistness, three packages of PVD technologies are being developed for the deposition of titanium-aluminium nitride (TiAlN), chromium nitride (CrN) and carbon-based nanostructured coatings.

The main aims of the project are:

- The development of surface treatment technology of high-speed steel woodworking tools that will ensure their superiority over unmodified HSS tools and will allow, at least, the equalisation of the durability of modified HSS tools with that of unmodified carbide tools at lower market prices; and
- The development of surface treatment technology of cemented carbide woodworking tools that will allow the attainment of durability comparable with that of polycrystalline diamond (PCD) tools at significantly lower market prices.

Visualisation of the Clausius Tower on the background of Koszalin University of Technology and the stone indicating the location of the tower

It is assumed that the above formulated aims will be reached with the use of cathodic arc evaporation (CAE) technology and its combination with plasma nitriding technology (for HSS tools).

IMNiTP has been established in the beginning of the year 2007 as a successor to the former Institute of Materials Engineering of Koszalin University of Technology. Human potential and a long-standing tradition in education and research in the field of materials science, vacuum technologies and surface finishing are the key attributes of the institute.

The institute offers graduate courses in mechatronics, materials engineering and biomedical engineering. The course of mechatronics focuses on modern control and the monitoring of industrial processes. The course of materials engineering emphasises the application of the vacuum technique in nanotechnology. Biomedical engineering, the newest course starting in 2010, concerns the application of the thin films of nanomaterials in medical devices.

Within the international research activity in the field of nanoscience and nanotechnology, the institute coordinates a work package of the European Network of Excellence Complex Metallic Alloys (CMA), but the strategic goal of the institute is to foster the economic development of the Middle Pomeranian region of Poland in close inter-regional collaboration with the industry of neighbouring countries in the Baltic Sea region. Within this field of activity the institute is a member of the Pan-Pomeranian association BalticNet PlasmaTec, which promotes clean, environmentally friendly, low-temperature plasma technologies in the industry. After three years of existence IMNiTP has become a significant part of Koszalin University of Technology.

Clausius Tower and Foucault pendulum

Koszalin University of Technology was created in 1968 as a state university, and with more than 10,000 students at present is the main academic centre in Middle Pomerania. The university contributes significantly to the development of European and regional scientific and economic cooperation through the participation of its faculties and institutes in international networks of excellence and technology transfer centres.

European cooperation and integration are matters of special significance, not only for the academic community, but also for the local community of Koszalin. Very soon, citizens of Koszalin will be witnessing the construction of a unique structure: a tower of more than 20 metres in height where a Foucault pendulum will be placed. The entire construction will be named the Clausius Tower – after one of the greatest scientists in history, who was born in Koszalin in 1822.

Today, this famous scientist is considered to be one of the most outstanding physicists ever. It is worth acknowledging that – alongside such celebrities as Newton, Einstein, Amper, Ohm – he was admitted as a member of the Royal Society of London for the Improvement of natural knowledge. The project of the Clausius Tower (the only one of its kind in the world) was officially presented on 21st September 2009, during the international conference organised by the IMNiTP. The conference was devoted to the latest achievements in vacuum-based science and technology, and was supported by the German and Polish vacuum societies. The presentation of the pendulum tower design was accompanied by a special one day session dedicated to Rudolf Clausius. This was when the ceremony of laying the cornerstone of the tower took place and the placement of the tower was marked.

The Rector of Koszalin University of Technology, Professor Tomasz Krzyżyński, said on this occasion: “Choosing this patron we want to show that, despite the difficult Polish-German history, we can focus on what we have in common instead of what differs between us. And considering that Foucault was a Frenchman, our project symbolises what is most important in the European Union”.

Publication part-financed by the European Union within the European Regional Development Fund

IMNiTP

Jerzy Ratajski

Jan Walkowicz

Witold Gulbiński

Jan Staśkiewicz

Institute of Mechatronics, Nanotechnology and Vacuum Technique
ul. Racławicka 15-17
75-620 Koszalin
Poland

Tel: +48 94 34 78 345
Fax: +48 94 34 78 489

imnitp@tu.koszalin.pl
imnitp.tu.koszalin.pl