Wood is an important raw material used in applications such as construction, furniture, heating, transport and packaging. The huge popularity of wood as a raw material is due to its specific properties and aesthetic qualities. Wood processing plants and furniture manufacturers tend to move towards increasing production, reducing the time per unit of product and improving the quality of manufactured items to lower the unit cost of production.

Rising energy prices and increasing environmental requirements have inspire companies to invest in modern systems for woodworking, invent devices to evaluate the quality of wood, and design new processing technologies and tools.

Manufacturers of wood products need to tailor the type of tools and machining parameters to a workpiece. Species of hardwood, such as oak, ash, hornbeam, ebony and pink lapacho, require completely different tools to softwood species, such as spruce, pine, larch. The structure and chemical composition of wood species, including quantity of minerals and resin significantly affect this choice.

One of the factors determining the cost and product quality is the selection of tools that are relevant to the type and processing parameters of the material. Downtime associated with tool replacement generates losses — longer tool life will lower production costs. Searching for stable and relatively cheap tools is therefore extremely important.

Wood is a hygroscopic material and heterogeneous in terms of mechanical and chemical properties, this places high demands on the tools used for processing. The high
cutting speed, feed rate and dry environment without the use of cutting oils like in metalworking favour the formation of high temperature on the edge of the tool.

Modification of the tool may include a number of areas:
- modification of tool material (such as heat or thermo-chemical treatment),
- modification of tool geometry,
- modification of working surfaces of the tool (for example, wear resistant thin film).

**Technologies To Improve Wear Resistance**

The development of tool material is towards a combination of high hardness and high toughness, and the improvement of their mechanical, tribological and thermophysical properties. These will increase the durability of the cutting tools. There are two main groups of technologies that can be used to improve the wear resistance of tools.

The first includes methods for improving the tool's mechanical properties, such as heat or thermo-chemical treatment. Heat treatment can give tools the desired mechanical, physical and chemical properties by changing the structure, while thermo-chemical treatment can enrich a target element, such as carbon, nitrogen, aluminium, chromium or silicon, or a combination of elements in the surface layer of the alloy.

The aim of these treatments is to give the surface layer specific physical properties, mainly resistance to abrasion, and chemical properties, such as resistance to oxidation at high temperatures. The quality of the tool is improved by applying heat treatment to obtain the desired hardness of the blade, the appropriate fine-grained structure of steel and toughness.

Thermo-chemical treatment, especially nitriding, has a beneficial effect on the performance characteristics of tools. Studies have indicated an increase in wear resistance of nitrided tools for woodworking. Depending on the type of technology used, this increase can be as high as 100 percent.

The second group of technologies includes working surface modification techniques through the application of coatings with special properties. Among these coating methods are chemical vapour deposition (CVD) and physical vapour deposition (PVD).

---

**Look East... to floor the future!**

Don’t miss the most dynamic construction market: Asia!

Shanghai - 27-29 March 2012

[Domotex Asia Chinafloor]

+86 21 61956088

www.domotexasia chinafloor.com
Chemical Vapour Deposition
CVD allows deposition of coatings through gaseous chemical reactions. Coating deposition process occurs at atmospheric pressure or slightly lower and at a high temperature of 700-1100 deg C. The advantage of this method is the possibility of coating deposition with a thickness of tens of micrometres that is well adhered to the substrate.

The need for the disposal of residues from the working atmosphere and the high temperature requirement, often much higher than the tempering temperature of the steel substrates, are some disadvantages that limit the adoption of this technique.

Physical Vapour Deposition
PVD allows the deposition of coatings in gaseous state through physical reactions. Application of coating takes place at relatively low temperatures of 100-400 deg C in vacuum environment. The nature of the substrate-coating combination is purely adhesive and largely depends on the purity of the substrate surface.

PVD coatings increase resistance to abrasion tool and for cutting tools, result in better drainage chip, protection against oxidation on tool surface, formation of a thermal barrier to limit the growths on the knife’s edge and reduction of friction. The use of PVD coatings on the surfaces of working tools increases its durability and reduces associated downtime for replacement. Increase in cutting speed is an additional benefit of this method.

Reasons For Thin Coatings
Among the many factors, the most important motivations for the use of thin hard coatings on tools are technological and economically driven. Extension of durability reduces downtime necessary for changing or replacing tools and lowers the possibility of errors by the operator.

The aim of applying coatings on tools is to reduce friction, extend durability, lower energy consumption, and improve the quality of the machined surface. Reduced cutting forces lower a tool’s temperature during processing and directly increase its durability. Improper tools or machining parameters lead to premature and irreversible destruction of the tools, as well as inadequate workpiece surface quality.

Cutting properties of tools are improved to increase productivity over a diverse range of workpiece materials. In the case of machining, productivity is a measure of the cutting speed and feed rate adopted to achieve a certain quality of the products. The development of machine tool design enables the achievement of high feed speed for the machining of wood materials.

Tools are designed to perform within a specific range of feed speeds. These parameters themselves cannot be changed. The only way to enhance the performance of a tool is to modify the processing technology and treatment to accommodate the operational capabilities of modern machines.

The temperature on a knife’s edge at high-speed cutting often exceeds 700 deg C. Study conducted by Rech on the flow of heat from coatings to titanium tools and research by Kusiak on chromium nitrate coatings on woodworking tools have shown a reduction in total heat flux transferred. The use of coatings may therefore be possible to increase both the feed speed and tool life.

Thin Coatings For Woodworking Tools
Coated tools are not commonly used in the woodworking and furniture industry. In recent years, there has been significant progress in material technology for the modification of tools used to process wood and wood-based products. This includes the deposition of thin layers of carbide, oxide or nitride of titanium, chromium or aluminium, both as single-
layer and multilayer coatings on the working surface of steel and cemented carbide tools. At the moment, the possibility of using polycrystalline diamond coatings and diamond-like carbon are being explored.

Under Poland’s Innovative Economy Operational Programme, approved by the European Commission, research on ‘hybrid technologies for woodworking tool modification’ is currently being conducted. The aim of this project is to develop surface treatment technology of high speed steel woodworking tools that is superior over unmodified tools, with similar durability to unmodified carbide tools at lower market prices.

There are four parts to the project, three of which involves the design and formulation of coatings using titanium, chromium and carbon as the main ingredient. The fourth component is on the ionic nitriding of tools for woodworking.

So far, coatings based on chromium demonstrate good functional properties. They are characterised by high adhesion to the substrate and relatively low surface roughness, depending on the parameters of the deposition process. Adhesion, hardness and wear rate of coatings increase as their structure change from monolayer to multilayer.

Carbon addition to chromium nitride coatings causes reduction of friction forces and lower coefficient of friction and wear rate. Coatings, in addition to improving tool life, also show a beneficial effect on the quality of the machined wood surface. Application of coatings on tools can reduce a workpiece’s surface roughness.

Benefits of the application of hard protective coatings are apparent both from the tool and machined material surface point of view:
- improves tool life by several times — reduction of production costs associated with new tools and servicing old ones,
- reduces energy consumption,
- reduces carbon dioxide emission,
- improves of the quality of machined surface,
- increases the parameters of machining,
- enhances the capability of machining without cutting fluid or with a minimum amount of coolant.