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Evolution meets plasma surface engineering - a biomimetic thin film concept for self-sharpening cutting toolsHanno Paschke¹, Marcus Rechberger²¹Fhl Schicht- und Oberflächentechnik, Dortmund, Germany ²Fhl Environmental, Safety and Energy Technology, Oberhausen, Germany

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Nature is showing how optimized cutting systems should be constructed. Rodents for instance exhibit highly sophisticated teeth in order to use the wear of high abrasive food as a tool to form optimized cutting edges. These are basing upon a special material concept of the teeth paired with specific microstructures of the enamel. For an effective accomplishment of cutting tasks technical cutting tools also need sharp edges. In the presence of high amounts of abrasive particles within the processed material, the cutting edge radiuses will increase immediately. This is resulting in high cutting forces, bad production qualities and a very short operating life of the tools.

An adaptation of a biomimetic principle deduced from rodent teeth leads to a promising concept for the wear reduction of industrial cutting tools. The underlying material concept uses differences in the wear resistance of the blade material and the cutting zone. Therefore the blade material is constructed of tool steels with low carbon content. As a result they provide a tough but due to low hard phase contents not sufficient wear resistance. Using a combination of a plasma diffusion treatment and plasma deposition technique a wear resistant thin coating covering the edge is possible. Thus an assembly is achieved consisting of a tough blade body forming the cutting edge using the occurring abrasive wear. The function of the diffusion treatment is the formation of a gradient in hardness for a bearing capacity in the subsurface near zone. A following composition of a ternary composition of Ti-B-N in a special multilayer design is assumed to operate analogue to enamel structures. The alternating nanostructured composition plays an important role while forming the active cutting radius.

Inspired from natural archetypes a technically usable material concept paired with plasma surface treatment technologies enables industrial cutting tools to self-optimize their wear behavior.

Keywords

Biomimetic principle

Cutting tools

Nanostructured multilayers