

My Tool, My Coating

Precision tools ■ Coating technology ■

Equipment for SME



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Masthead

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special reprint



1 All cutting tools, from sawblades to HSC end mills, necessarily require coatings to significantly increase their performance (© Platit)

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The continuous performance increase of cutting tools results primarily from their coatings. To run own coating units is a must for large tool manufacturers, for small and medium it becomes more and more common and very beneficial.

Without a doubt the most dynamic developments for cutting tools are taking place in coating technologies.

In order to keep up the pace with this development, tool manufacturers have to integrate one or more flexible coating units which facilitate state-of-the-art coating techniques into their own production system.

The PVD-ARC techniques are in control of the technology scene. They assume more and more jobs – even in

mass production – despite the latest developments in CVD technology. Today, coatings on the basis of Al, Cr, Si, boron and oxide with nanostructures, triple structures and quad structures primarily allow for maximum power (Fig. 1).

CVD diamond coatings are being used more and more for processing aerospace materials (CFRP, Ti, Al alloys, etc.). The exciting question here is whether the considerably less expensive DLC coatings which can be reground are

capable of providing a technically acceptable alternative.

Many developers at universities and institutes are raising fresh hope for sputtering with the use of HIPIMS technology. Here, industry-ready solutions can mostly be found in the combinations of ARC and high performance sputter technologies which unite the advantages of both techniques. The purpose of this article is to introduce some of the most important technological trends using industrial examples.

The most important PVD coating generations and coating processes

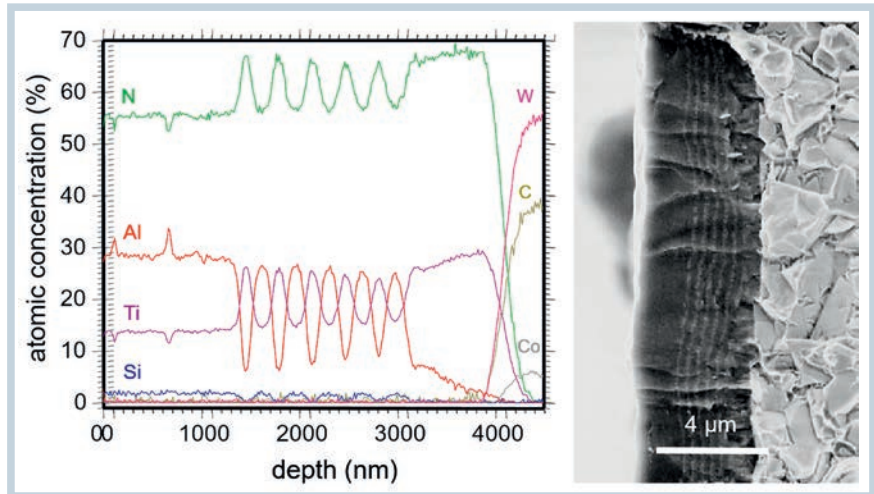
The simplest monoblock coatings are still often deposited. The reason for this is not only because this is the simplest to produce but also because it provides the highest degree of productivity at coating. All cathodes can run simultaneously thereby vouchsafing the highest level of output for job coating. The 2nd generation coatings with an adhesion layer already have a much more complex structure. The most advanced are the nanolayer coatings and the nanocomposite coatings, which can increase both toughness and hardness at the same time [1].

The coating generation used most frequently today is a triple coating [2]. It begins with TiN or CrN because these simple coatings have the best adhesive properties. The middle layer is usually composed of an extremely tough multi-layer structure (Fig. 2) such as an absorption damper for protection from the high dynamic strain of the cutting process. The surface layer displays a high degree of hardness in order to attain a high degree of wear resistance directly at the cutting edge. The super hard nanocomposites [3] are strongly recommended for this task. Most recently, it is the quad coatings that have found their way onto the market [4]. In addition to the triple structure, they contain a fourth block for special (dedicated) purposes – typically a DLC coating (diamond like coating) for reducing friction or an oxide layer for increasing resistance to heat [5] [6] [7].

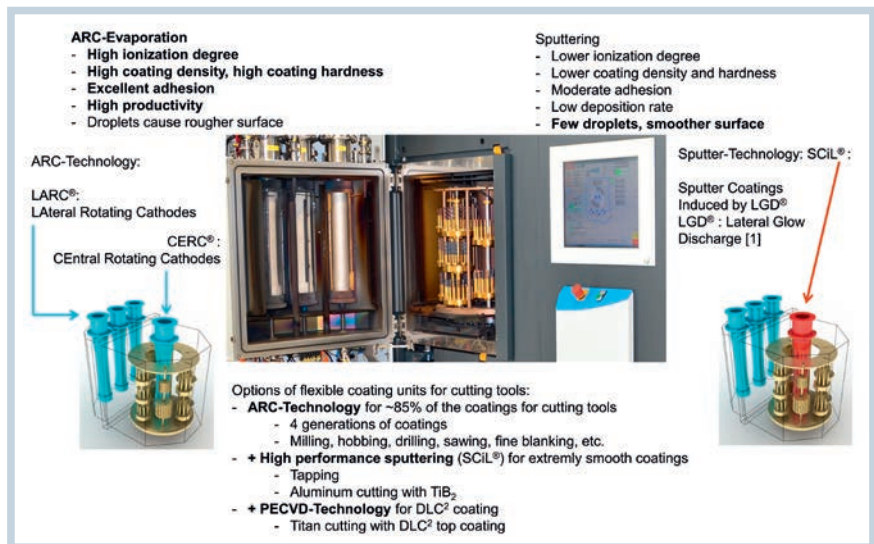
There are three technologies that are widespread for realizing these coating structures: ARC, high performance sputter technology (SCiL® [8]) and PECVD technology. The optimum solution for medium-sized companies is a coating unit which can accomplish the deposition of all of these methods and which can even make combining them all into one process a possibility (Fig. 3 [9]).

The influence of material components on performance

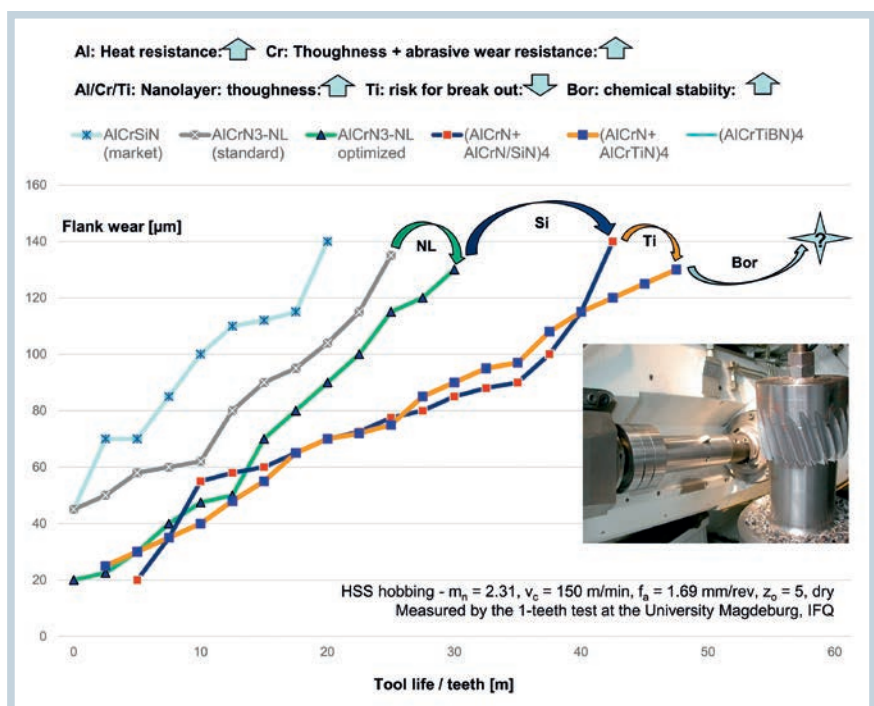
In addition to the structure, the deposited coating materials also have a crucial impact on the performance capacity of the coating. Fig. 4 shows some important coating materials and their impacts on the characteristics of the coating us-



2 Structure of a triple coating (© Platit)



3 The most important PVD processes and their features, realized in one unit (© Platit)



4 Influence of material components in coatings for hobbing (© Platit)

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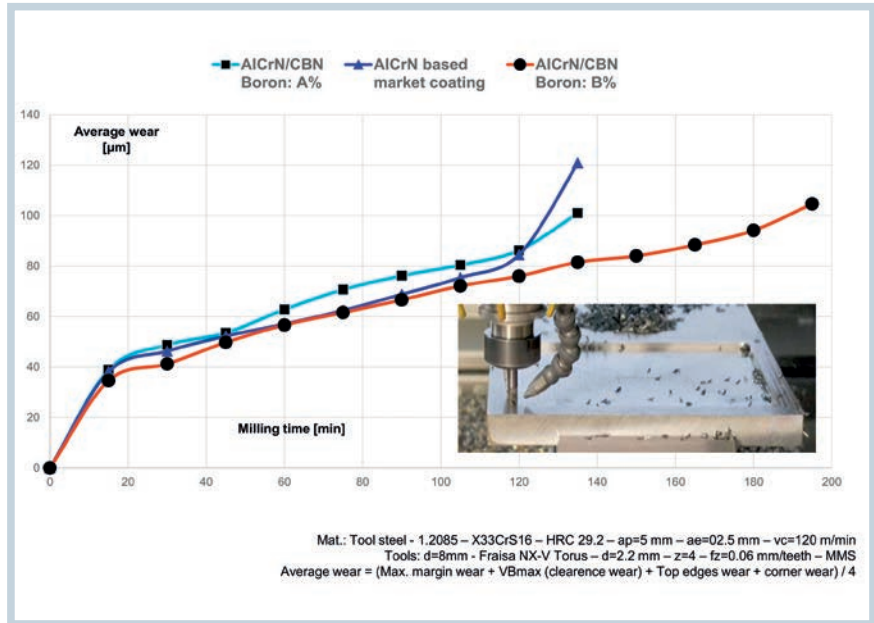
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ing an industrial example for hobbing [5]. Boron, the ›new‹ element, primarily promises even more improvements in performance due to its chemical stability. The hybrid coating AlCrN/BN is deposited by the LACS® technology (Lateral ARC & Central Sputtering). It works as a combination of ARC and High Performance Sputter technologies from non-alloy targets [10], [11]. The pure Al and Cr cathodes sit in the door (LARC®; lateral rotating cathodes), B(X) sputtered cathodes (SCiL®: Sputtered Coatings induced by LGD®) are mounted in the central position of the coating chamber (Fig. 3). In contrast to solutions with expensive alloyed targets, this configuration facilitates the simple variation – and therefore optimization – of the BN portion using software (Fig. 5). The positive results of this extremely innovative development, however, still have to be confirmed with more encompassing tests and industrial applications.

Influence of the ›pre-set parameters on the performance of the tools‹

In addition to the structure and the material components, many other parameters influence the behavior of coatings. Some of these include

- the roughness of the coating,



5 Tool life comparison at pocket milling with shank end mills at variation of the cBN ratio by software (© Platit)

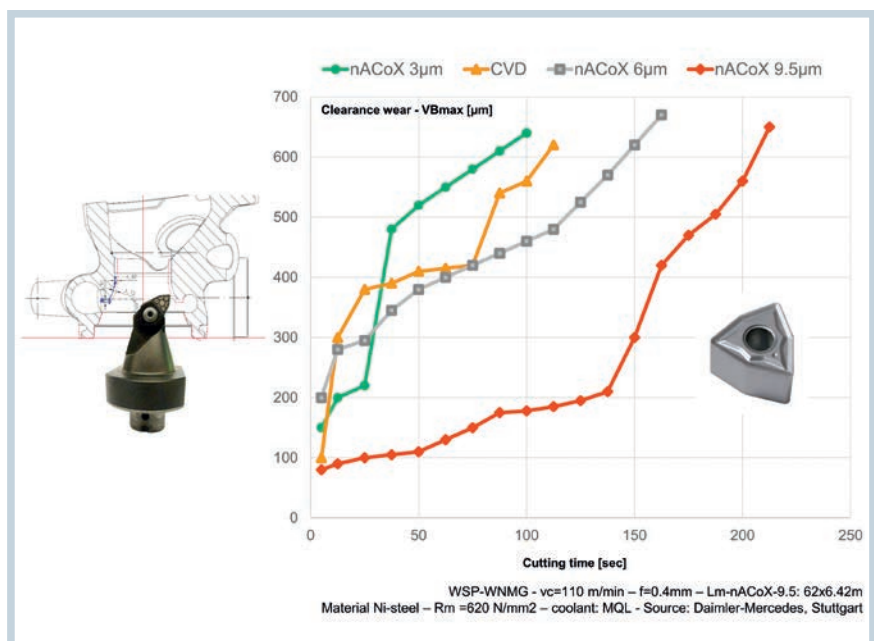
- the cooling of the cutting process,
- the decoating of reground tools [12] and
- the ›simple mechanical‹ pre-set parameters
- such as cutting edge preparation and last but absolutely not least
- the thickness of the coating.

As an example, we will take turning an extremely ductile material where CVD coatings usually have explicit advantages. With the right selection of coating thickness, an oxide PVD coating (nACoX®) can surpass the performance of CVD coatings considerably (Fig. 6 [13]).

The values of the optimum edge rounding (honing) and the correct coating thickness depend primarily on the type of tool and on the material to be processed. Fig. 7 summarizes long-term industrial experience

- with solid carbide end mills with heat-treated steels and
- with solid carbide ball nose mills with hardened steels [1] [14].

These and similarly open guidelines provide enormously important information for medium-sized grinders to achieve optimum performance with their own deposited coatings.



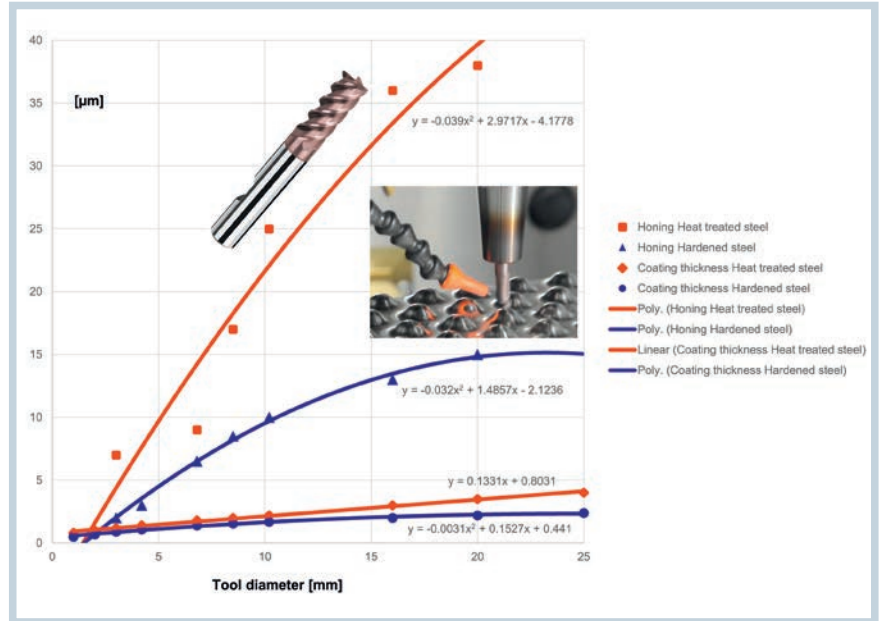
6 Influence of the coating thickness at turning of ductile nickel alloyed steel. (© Platit)

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7 Typical pre-set parameters at coating of solid carbide end mills (© Platit)

Outlook

More and more tool manufacturers and grinders (already over ~1000 today) avoid dependence on contract coating by integrating their own coating system into their manufacturing process [15]. For this, they need the following

- flexible coating systems with various technologies (ARC, high-performance sputtering and PECVD)
- open-source technologies in order to stay up to date in all areas (coating,

cleaning, cutting edge preparation and de-coating).

With the help of the integrated systems, they will be capable of setting up the right parameters (coating thicknesses, cutting edges, etc.) for all types of tools minimizing delivery times and operations expenses and offering their own brands as dedicated coatings [16], [17]. ■

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8 HSC tools with QuadCoating ALL4 (© Platit)


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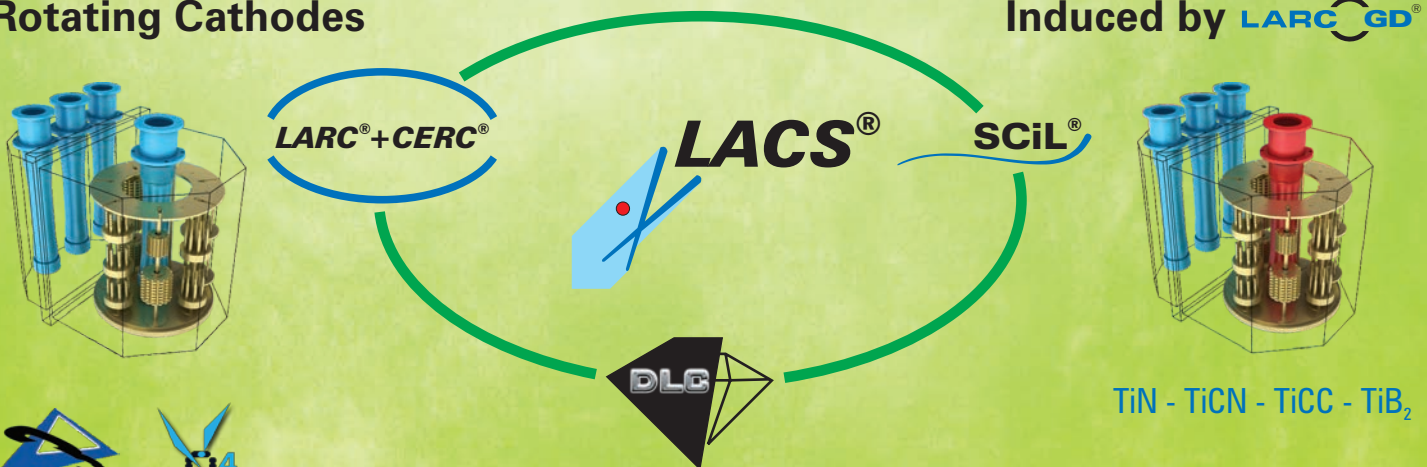
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