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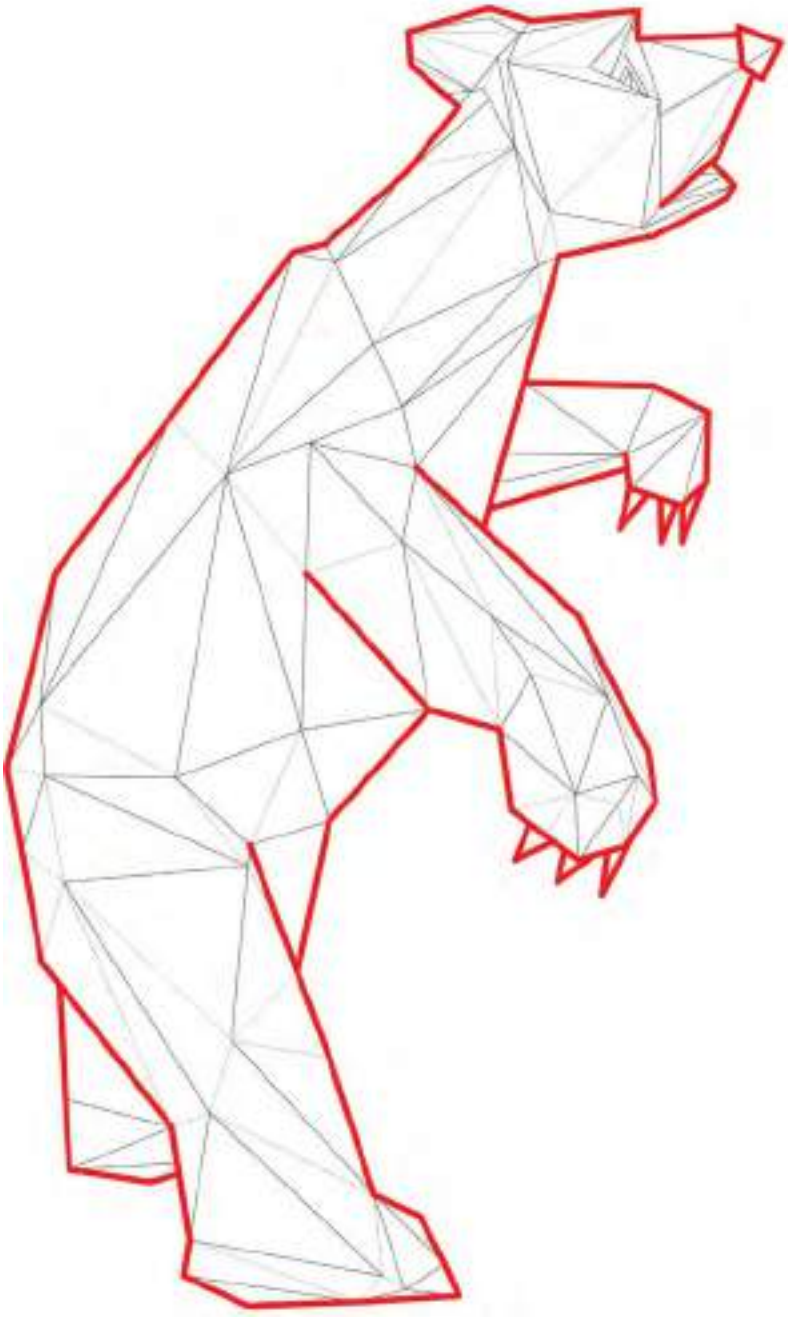
New QuadCoatings$^{4®}$ for Milling - 2015



New QuadCoatings4® for Milling – 2015

PLATIT AG, Selzach, Switzerland

With no false modesty, we can confirm that in recent years PLATIT has introduced numerous new coatings and even new generations of coatings. The overview on pages 4 and 5 [1] shows a representative selection of those that we worked out for the series 11 coating machines [2]. Some of them have already been developed to market standards (e.g. the addition of silicon or the creation of triple structures). This process is also continuing in 2015, which can be seen with the current market launches of milling coatings. This article already covers industrial experiences and the continued advancement of PLATIT QuadCoatings4® from three chosen fields of application: end milling, hobbing and hard milling.

Figure 1: End milling – Hobbing – Hard milling.

Open Source as a Principle

PLATIT works according to the Open Source principle [3]. Consequently, new coatings are described and publicized in great detail. This "excessive candor" clearly doesn't just win friends:

- It means constant new challenges for the market competitor.
- Job coaters focus on conventional coatings until the market forces them to be innovative, i.e. the customer threatens to switch to a competitor.
- We face the fear of our solutions being copied with a certain amount of composure. Good ideas should be passed on.

Basic Development at PLATIT with End Milling

Every serious coater is always carrying out cutting tests which serve as a basis for their own developments. **Fig. 2** shows the parameters and actual results of the basic PLATIT tests for the end milling of high-strength, hot-working steel.

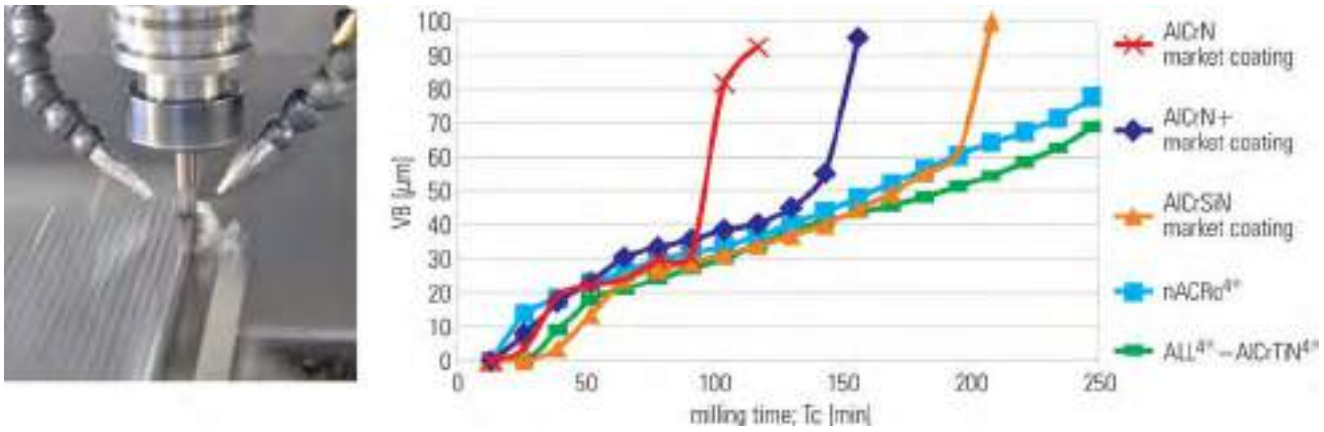


Figure 2: End milling with QuadCoatings
Tools: Solid carbide end mills - d=8 mm - z=4 - a_p=5 mm - a_e=3.5 mm - v_c=110 m/min - f=0.24 mm/rev
Work piece material: DIN 1.2085 - X33CrS16 - 31 HRC - External minimum lubrication.

Alongside the market competitor's conventional AlCrN coatings, the test results also show the comparison with a "new" AlCrSi-based market coating [1], [3], [4].

Our two QuadCoatings4® nACRo4® and ALL4® are the best coatings for the application of milling abrasive steel with minimal lubrication. Both coatings display very consistent wear without break outs at the cutting edges until the end of the tool's life.

nACRo4®: ([1] page 9, [3] page 30)

Was designed to process extremely abrasive and highly alloyed materials. It features a quad stoichiometry:
CrN – AlCrN gradient – AlCrN nanolayer – nanocomposite; AlCrN/SiN
- CrN ensures optimal adhesion
- The gradient layer provides very good cohesion
- The nanolayer allows for highly dynamic resilience, i.e. flexibility
- The nanocomposite top layer features high hardness, which gives the coating a high wear resistance.

ALL4®: ([1] page 9, [3] page 31)

Originally designed for hobbing, this coating has been established as a job coater's dream, an all-rounder. It isn't just "the girl", but is even "the queen for everything".

The stoichiometry is similar to that of the nACRo4®, but the role of the additive is assumed by titanium instead of silicon:
CrTiN – AlCrTiN-G - Al/CrN – AlCrTiN (CrCN optional as a Tribo top layer).

The Eternal Project on Coatings for Hobbing

The hob is one of the most complicated tools with geometrically defined cutting edges. Because of this, the projects on developing coatings for hobs are very "multi-layered" and time-consuming (**Fig. 3** [5]). PLATIT has been driving this development with its partners for over 10 years, producing new hob coatings every other year (e.g. Nanosphere, Nanosphere-2 [6], AlTiCrN3 [7], nACRo4® and ALL4®).

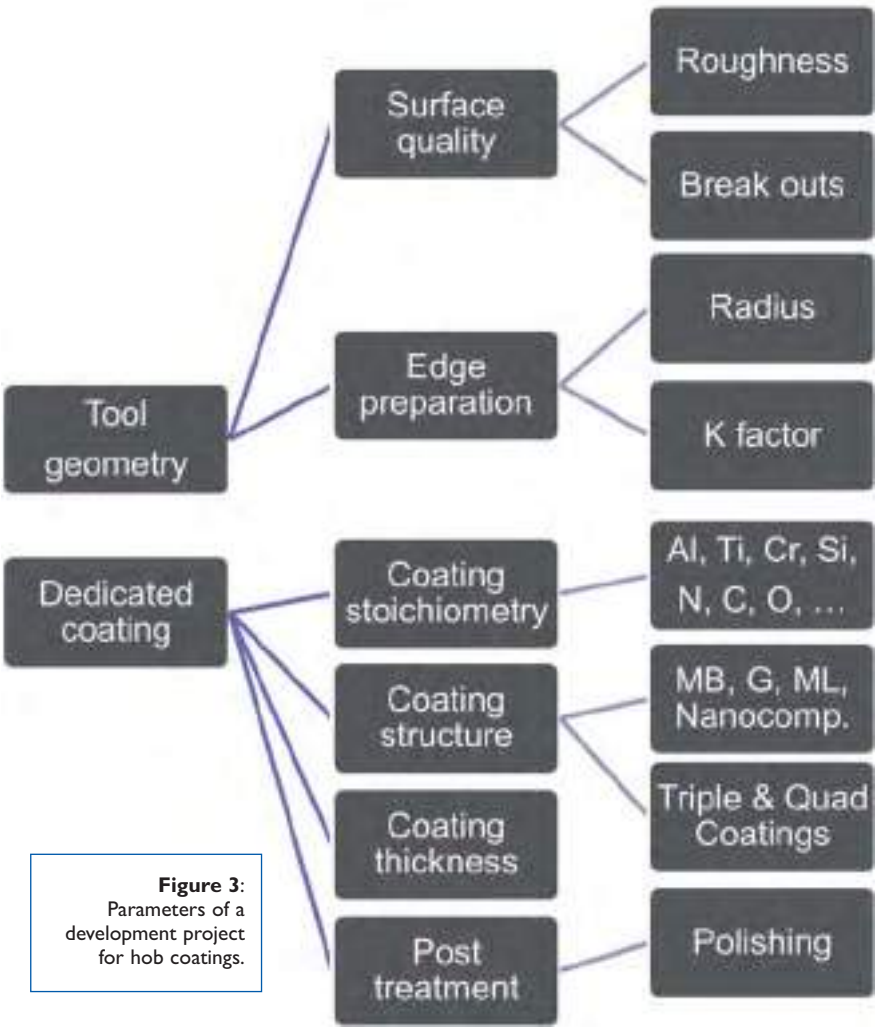


Figure 3: Parameters of a development project for hob coatings.

TripleCoatings$^{3®}$ & QUADCoatings$^{4®}$

Extended Coating Recipe Set

AlTiCrN$^{3®}$
π^{111} - π^{311} eco - π^{311} - π^{411}

TiXCo$^{3®}$
π^{111} - π^{311} eco - π^{311} - π^{411}

nACRo$^{3®}$
π^{311} - π^{411}

PLATIT® openSource

SCiL®

DLC-VIc®

nACo$^{3®}$

nACRo$^{3®}$

TiXCo$^{3®}$

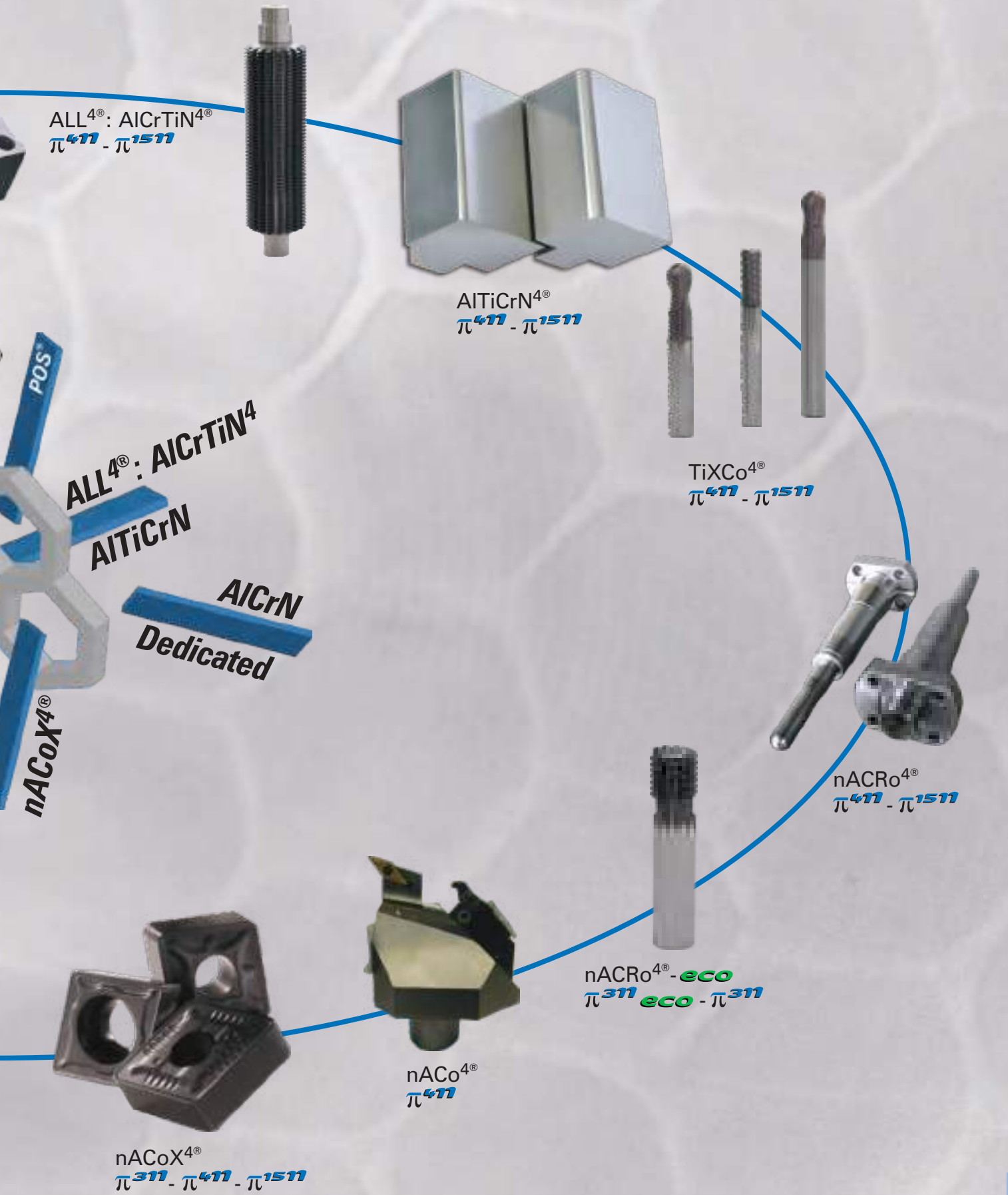
nACo$^{3®}$
π^{311} eco - π^{311}
π^{411} - π^{1511}

AlCrN$^{3®}$
π^{111} - π^{311} eco - π^{311} - π^{411} - π^{1511}

AlTiN$^{3®}$
π^{111} - π^{311} eco - π^{311} - π^{411} - π^{1511}

CrTiN$^{3®}$
π^{111} - π^{311} eco - π^{311} - π^{411} - π^{1511}

CROMVIc$^{3®}$
π^{211}


ALL4®: AlCrTiN4®
π411 - π1511
AlTiCrN4®
π411 - π1511
TiXCo4®
π411 - π1511
nACRo4®
π411 - π1511
nACRo4®-eco
π311 eco - π311
nACo4®
π411
nACoX4®
π311 - π411 - π1511
POS
ALL4®: AlCrTiN4
AlTiCrN
AlCrN
Dedicated
nACoX4®

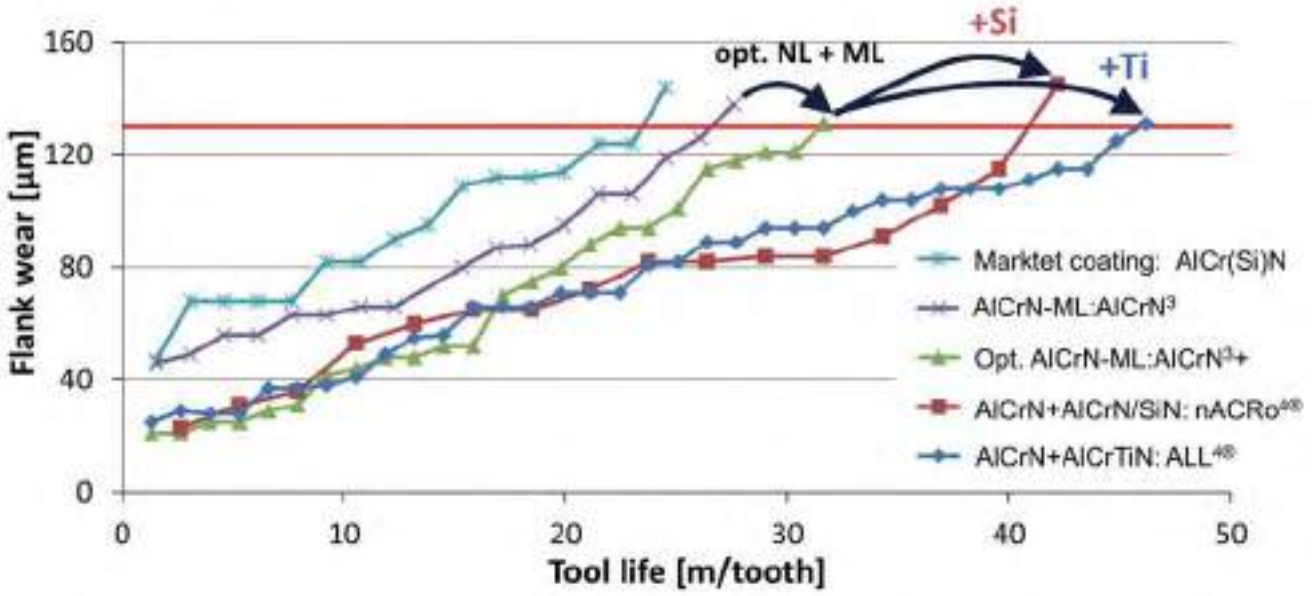


Figure 4: Development of the coating ALL4® in 4 steps
Tools: PM-HSS - mn = 2.31, v_c = 150 m/min, f_a = 1.7 mm/work piece rev. - z_o = 5 - Mat. : 20 MnCrB5 - dry
Tested by the University of Magdeburg, Germany.

As shown in **Fig. 4**, the ALL4® coating (as needed for a QuadCoating4®) was designed in 4 steps:

- After the Nanosphere project, new coatings appeared on the Japanese market, which were beaten (AlCrN3).
- The optimization of the nanolayer-multilayer structure yielded another advantage (AlCrN3+).
- The addition of silicon in the nanocomposite top layer boosted the tool life (nACRo4®).
- Replacing the silicon with titanium reduced the brittleness and the break outs. Performance is particularly increased during cutting with coolant (ALL4®).

Among the many influencing factors, the thickness of the layer plays a very important role. Its influence is huge, as shown clearly in **Fig. 5**. Has your contract coater attributed this huge significance to the thickness of the layer? If not, please consider getting an in-house coating system [8].

Another critical process for hob coatings is decoating. A hob can be reground and recoated up to 20 times. With modern-day conventional methods, you have to wait up to 12 or even 24 hours for a hob to be completely decoated. For this reason, "productive decoating" [9] in a few minutes is of huge commercial importance.

Hard Milling

What level of hardness constitutes hard milling? It is a matter of definition which is not universally accepted. We consider it to be hard milling when the work piece has a hardness of 50 HRC or above.

- Usually hard materials will be finished dry or with minimal lubrication.
- The depths of the cuts are therefore low, in the range of 0.1–0.5 mm.
- The tool's edges must almost be sharp, with minimal cutting edge radius of 3–7 µm.

These conditions demand coatings with

- small layer thickness (0.7–2 µm),
- high hardness (up to and above 40 GPa), and
- high temperature hardness (up to 1200 °C).

Due to these requirements, nanocomposite coatings with silicon are favored for hard milling.

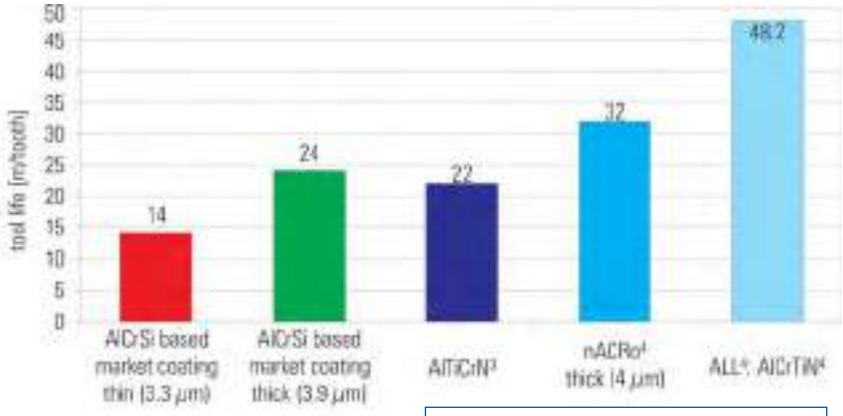


Figure 5: Hobbing with QuadCoatings4®
See parameters at Figure 4.

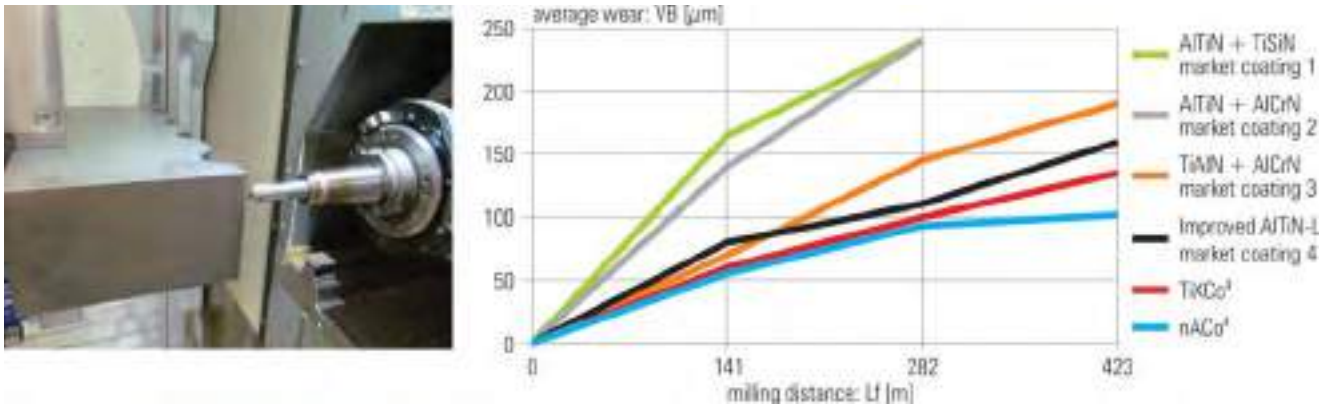


Figure 6: Hard milling with QuadCoatings4®
Work piece - Wave profilewl: X155CrVMo12 - 1.2379 - hardened to 55 HRC
Coolant: Internal air
Tool: WPR 16-SF - v_c=240 m/min - f_z=0.2mm - v_f=1910 mm/min - a_p=0.2mm - a_e=0.3mm
Tested by LMT-Kieninger, Lahr, Germany.

nACo4®: ([1] page 9, [3] page 30)

This is the 4th generation of the most world-renowned PLATIT coating. Its quad stoichiometry:
TiN – AlTiN – AlTiN nanolayer – AlTiN/SiN is based on the well-known nanolayer and nanocomposite structures. With a hardness range of 50 to 56 HRC, it surpasses the market coatings, which usually have a dual structure, regardless whether they have a titanium, chromium or silicon base (**Fig. 6**).

TiXCo4®: ([1] page 9, [3] page 30)

Optimal use with a higher hardness range of 56 to 62 HRC. Its stoichiometry:
TiN – AlTiN/SiN nanocomposite – AlTiCrN/SiN nanocomposite – TiSiN is based on nanocomposite structures immediately after the adhesive layer in order to reach the highest level of hardness.

Outlook

An article as compact as this one can only give a narrow view on the 4 most important coatings for the end milling, hobbing and hard milling fields of application. PLATIT is constantly working on various other coatings for milling. Here are just a few examples:

- nACoX4®, with which, SMEs will be able to produce oxide and oxinitride coatings (primarily for cutting inserts) themselves with PVD technology [10].
- The tribo top layers, such as DLC2 (a-C:H:Si) or CrCN, support our TripleCoatings4® and QuadCoatings4® during titanium milling for a better chip removal [11].
- For aluminum milling, we developed the hard, hydrogen-free DLC3 coatings (ta:C [3]), which provide a commercial alternative to CVD diamond coatings.
- The sputtered TiB2 coatings induced by LGD with SCiL technology [3] are also primarily used for aluminum work.

The variety of coatings is the basis of and an absolute requirement for tackling all kinds of processing functions presented by the user. The coating projects are initiated by our best development staff with samples completed in our support center. They are continued on site, where coatings are dedicated to the particular conditions, special requests and circumstances set forth by the customer. The key to success is flexibility. This way, the project engineers' work is decisive, and we consider them to be particularly important.

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