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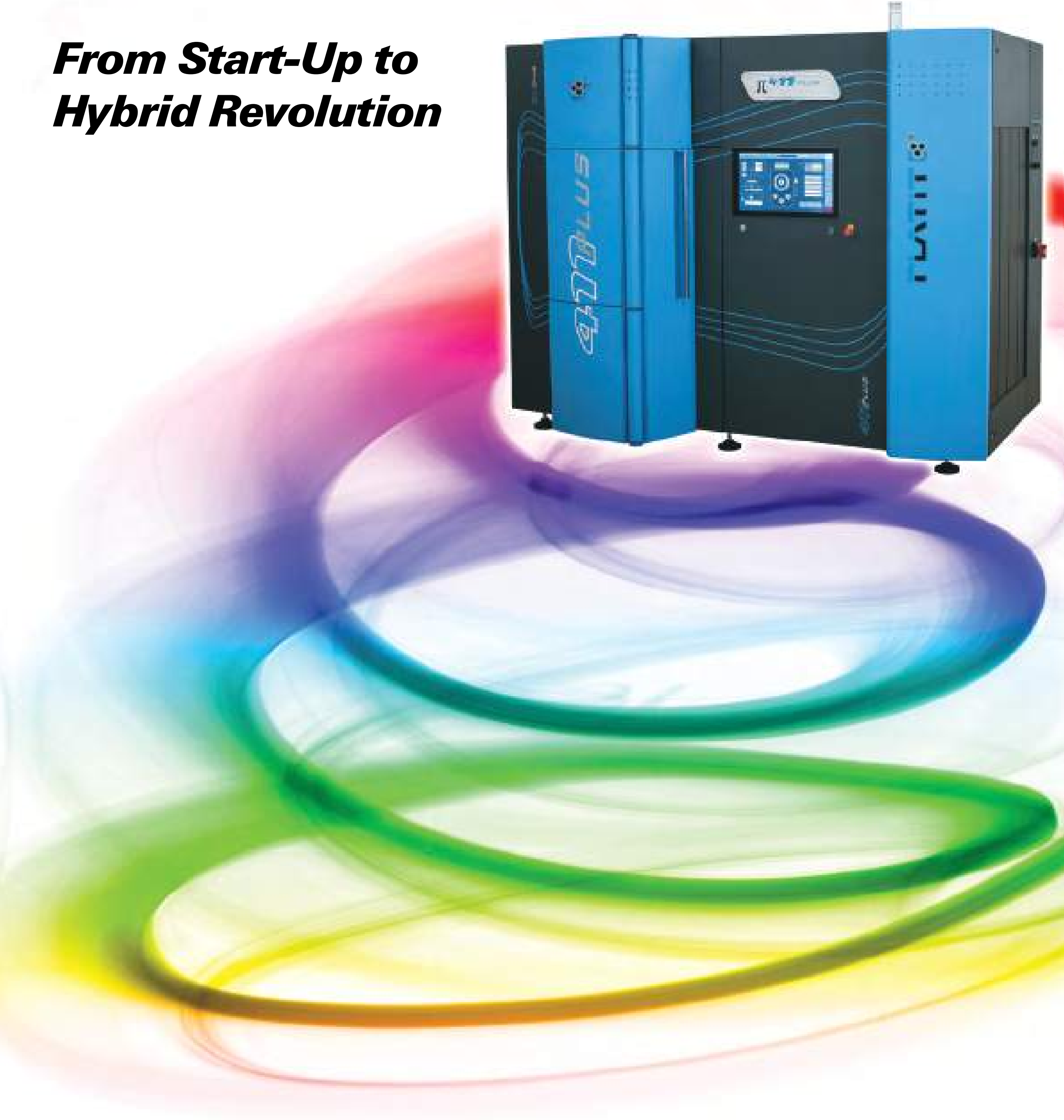

From Start-Up to Hybrid Revolution

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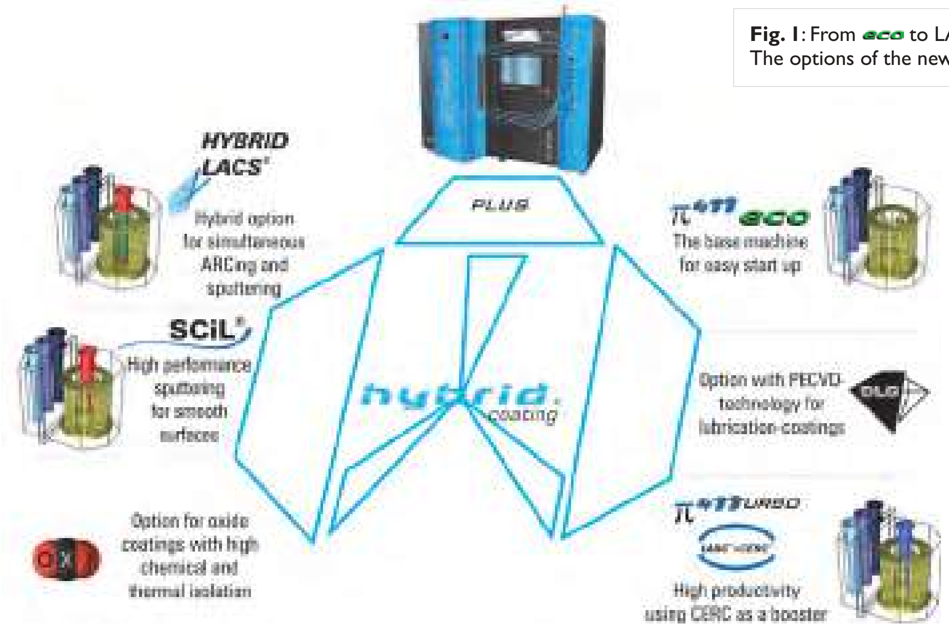


Fig. 1: From eco to LACS® – The options of the new coating unit π411PLUS.

The highest dangers for the big corporations (you must not necessarily think of the Apples and Googles) come from two different directions:

- From the central administrations (governments, EU, IRS, OECD, etc.), which pay attention to tax breaks, data protection and monopoly proceedings, as well as
- From the small, innovative start-ups they "steal" smaller and larger market segments with dedicated products and endanger the monopoly of the giants.

Platit would like to support the start-ups, to equip them with tools (i.e. coating systems), so that they can fight against the big tool manufacturers and job coaters [1].

The new coating plant the π411PLUS is such a tool (**Fig. 1**).

- The basic machine, the π411eco, allows the start of the own production with 3 lateral rotating door cathodes (LARC®: LAteral Rotating Cathodes).

Despite the manageable costs, the machine is an excellent start with practically all market coating grades.

After the EMO 2017 the machines are delivered with the new pulsed, lateral cathodes LARC®PLUS (Cr&Ti with 10 Hz [1]). The new cathode system increases the deposition rate and extends the lifetime of the targets!

Even for the future, the entry level π411eco is not a dead end, it can be gradually expanded with the following high-performance machine options adapted to the applications.

- The **DLC option** deposits a: C: H: Si layers using PECVD technology.
- The change in of a central ARC cathode (**CERC® option**, CEntral Rotating Cathode) in principle speeds up the deposition process since all four cathodes can coat at the same time. The name π411TURBO says that the high productivity of this machine is at the forefront. All elements of the turbo upgrade [2] are aimed at shortening the door-to-door time:
  - The preheater additionally avoids the condensation on the chamber walls.
  - The lightweight carousels reduce the body masses to be heated respectively cooled.
  - The new LGD® (Lateral Glow Discharge) shields reduce the etching time.
  - The new software upgrade "Turbo" is gaining further production time by overlapping the etching and heating.
- After the EMO 2017 these 4 new features will be built in all machines by default, hence in the eco-versions too.

Fig. 2: Ring Cathodes for SCiL® and LACS®.

Options	Coatings / Machines	Conventional Coatings	Nanocomposite Coatings	TripleCoatings$^{3®}$	QUAD Coatings$^{4®}$
	π411 eco	TiN, TiCN, CrN, CrTiN, ZrN, AlTiN, AlCrN	nACo^{2*}, nACRo^{2*}	AlCrN^{3*}, TiXCo^{3*}, AlTiCrN^{3*}	ALL^{4*} eco, nACRo^{4*} eco
	π411 DLC	cVic*, CROMVic^{2*}, CROMTiVic^{2*}	nACVic^{2*}		
	π411 TURBO	TiN, TiCN, CrN, CrTiN, ZrN, AlTiN, AlCrN	nACo^{2*}, nACRo^{2*}	nACo^{3*}, nACRo^{3*}, AlCrN^{3*}, TiXCo^{3*}, AlTiCrN^{3*}	nACo^{4*}, nACRo^{4*}, TiXCo^{4*}, AlTiCrN^{4*}, AlCrTiN*=ALL^{4*}+Tribo
	π411 OXI				nACoX^{4*}
	π411 SCiL	TiN, TiB_2		TiCC	
	π411 LACS	AlTiN-LACS, AlCrN-LACS		BorAC*=AlCrN/BN BorAT*=AlTiN/BN	

Fig. 3: Typical Coatings of the Options of the π411PLUS.

– The **OXI option** builds on the configuration π411TURBO. It was developed primarily for SMEs, which cannot afford CVD plants and which want to deposit oxide films themselves in small series.

– With the **SCiL® option** (Sputtered Coating induced by Lateral Glow Discharge), a sputtering cathode is placed into the central position, which allows a high deposition rate for smooth high-perfomance layers [3]. The technology blows on attacking the conventional, but still so often used, ionitron (eBeam) coatings.

– The **LACS® option** (LAteral Arcing & Central Sputtering) implements the simultaneous combination of ARCing and sputtering [4], [5]! This is done with the simultaneous (not sequential) control of the sputtering and the ARC cathodes in a special pressure range.

The advantages of the SCiL® and LACS® technologies are becoming, in fact revolutionary, by the ring cathodes (**Fig. 2**).

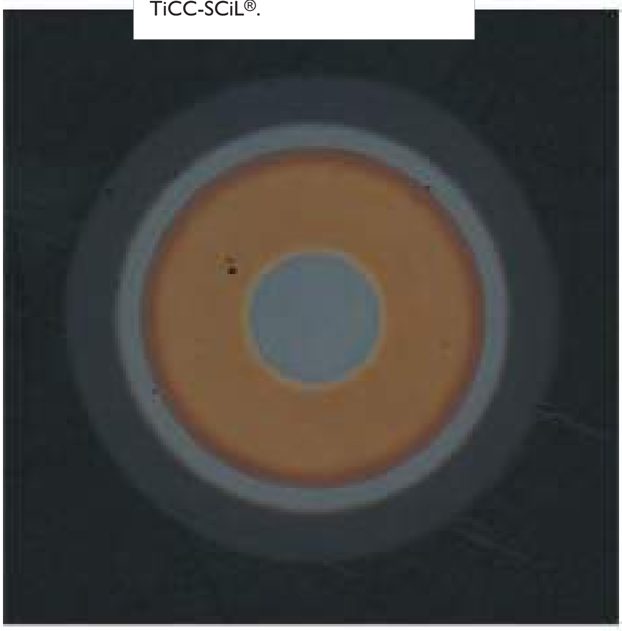
– The cathode body contains the magnets and electronics (**Fig. 2a**).

– The cooling water is let in from the cathode head under the perforated cylinder (**Fig. 2b**).

– The pressure of the cooling water tensions the copper membrane to the inner diameter of the targets (**Fig. 2c**), which ensures an excellent contacting.

The ring cathodes can be readily prepared from the conventional target materials (pure metals such as Al, Ti, Cr, etc. or alloyed metals such as AlTi, AlCr,

Fig. 4: Stoichiometry of TiCC-SCiL Torque and Force Comparison at Thread Forming - TiCN-eBeam <-> TiCC-SCiL®.



	Adhesion layer Ti - TiN	Core Layer TiCN	Top layer TiCC
Total thickness [µm]	1. Thickness [µm]	2. Thickness [µm]	3. Thickness [µm]
2.59	1.16	0.41	1.02

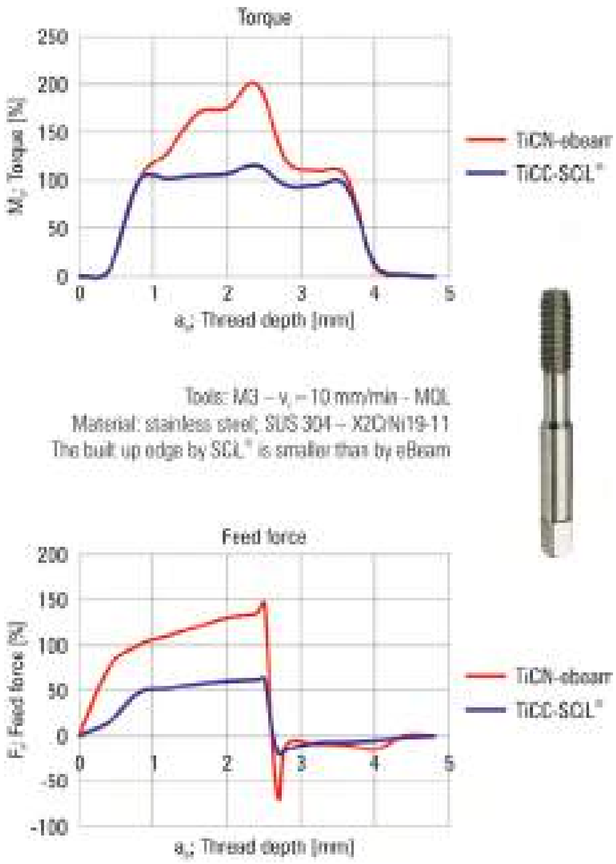
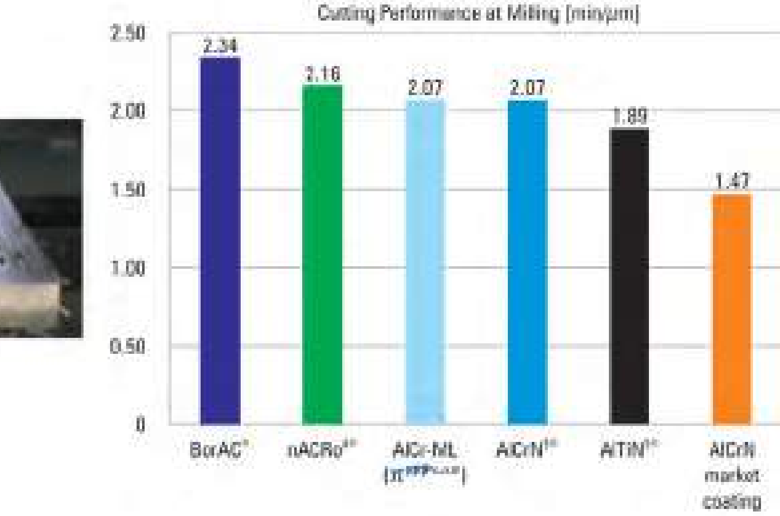


Fig. 5: BorAC® AlCrN/BN: Cutting Performance at Milling.



Mat.: Tool steel – 1.2085 – X33CrS16 – HRC 29.2 – a_e=5 mm – a_p=02.5 mm – v_c=120 m/min
Tools: d=8 mm – Fraisa NX-V Torus – d=2.2 mm – z=4 – f_z=0.06 mm/tooth – MQL
Average wear = (Max. margin wear + VBmax (clearance wear) + Top edge wear + corner wear) / 4

CrTi, etc.). They are used to deposit the LACS® versions of the conventional layers, such as AlTiN-LACS®, AlCrN-LACS®, CrTiN-LACS®. They have ARC qualities with fewer droplets.

However, they can also be constructed from thermally poorly conductive materials (e.g., B_4C, TiB_2, SiC, W). This type of "doping" opens up new ways of coating development, e.g. the purposive influencing of the internal stress of the layers.

The coatings of the πPLUS

The table in **Fig. 3** summarizes the most important standard coatings of each option:

The π eco can deposit practically all common PVD-ARC layers. The new highlight this year is the ALL4eco. It is used mainly for hobbing where the large size of the tools to be coated (d> 143 mm) precludes the use of the central cathode. The industry results clearly show that the ALL4eco is more than able to cope with the current market coatings [6].

The **a:C:H:Si coatings** of the DLC option are mainly lubrication layers. The flag coating is the CROMVIc®2, which is deposited for components and for cutting tools with different stoichiometry. A very interesting application of CROMVIc®2 is machining of titanium alloys [1].

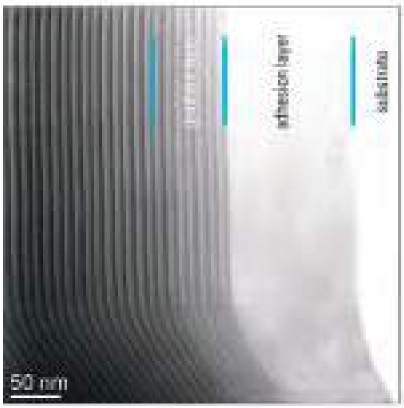
The π offers the broadest layer spectrum [7], making it very difficult to select the most important coatings. Just to give two examples:

- The **TiXCo4®** for hard cutting and
- The **ALL4®+Tribo** for fine blanking [8].

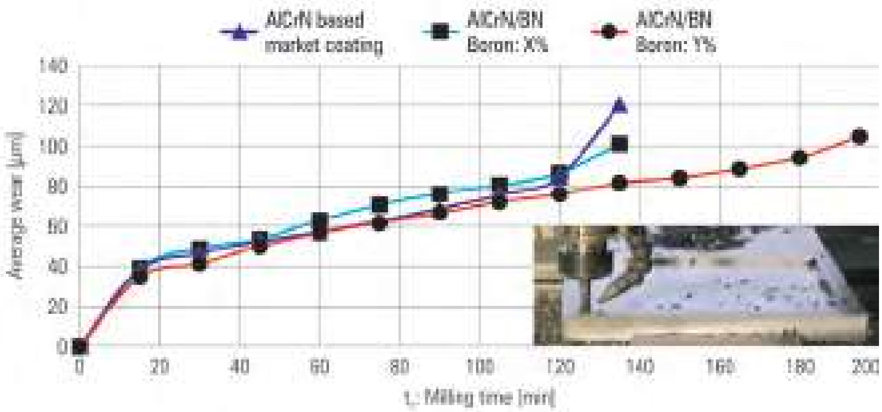
The **nACoX®** coating of the OXI option includes an AlCrON layer, which has a very high hot hardness and is particularly suitable for dry high-performance machining (turning and milling) [9]. It is, in this case, precipitated with high layer thicknesses (~10 um).

Three layers have been established for the SCiL® option:

- The conventional sputtered **TiN-SCiL®** sounds simple, but it was not easy to achieve the performance and reliability of the universally applicable ionitron (eBeam) TiN.
- The **TiCC-SCiL®** used primarily for threading tools has a triple structure. With TiCC, the thread former clearly needs a lower torque and feed force



AlCrN/BN coating with triple structure measured by energy dispersed by X-Ray spectroscopy
Source: University Freiberg, Germany



Mat.: Tool steel – 1.2085 – X33CrS16 – HRC 29.2 – a_e=5 mm – a_p=02.5 mm – v_c=120 m/min
Tools: d=8 mm – Fraisa NX-V Torus – d=2.2 mm – z=4 – f_z=0.06 mm/tooth – MQL
Average wear = (Max. margin wear + VBmax (clearance wear) + Top edge wear + corner wear) / 4

Fig. 6: BorAC® - AlCrN/BN: Coating Stoichiometry and Wear Behavior at Milling Depending on the Boron Content.

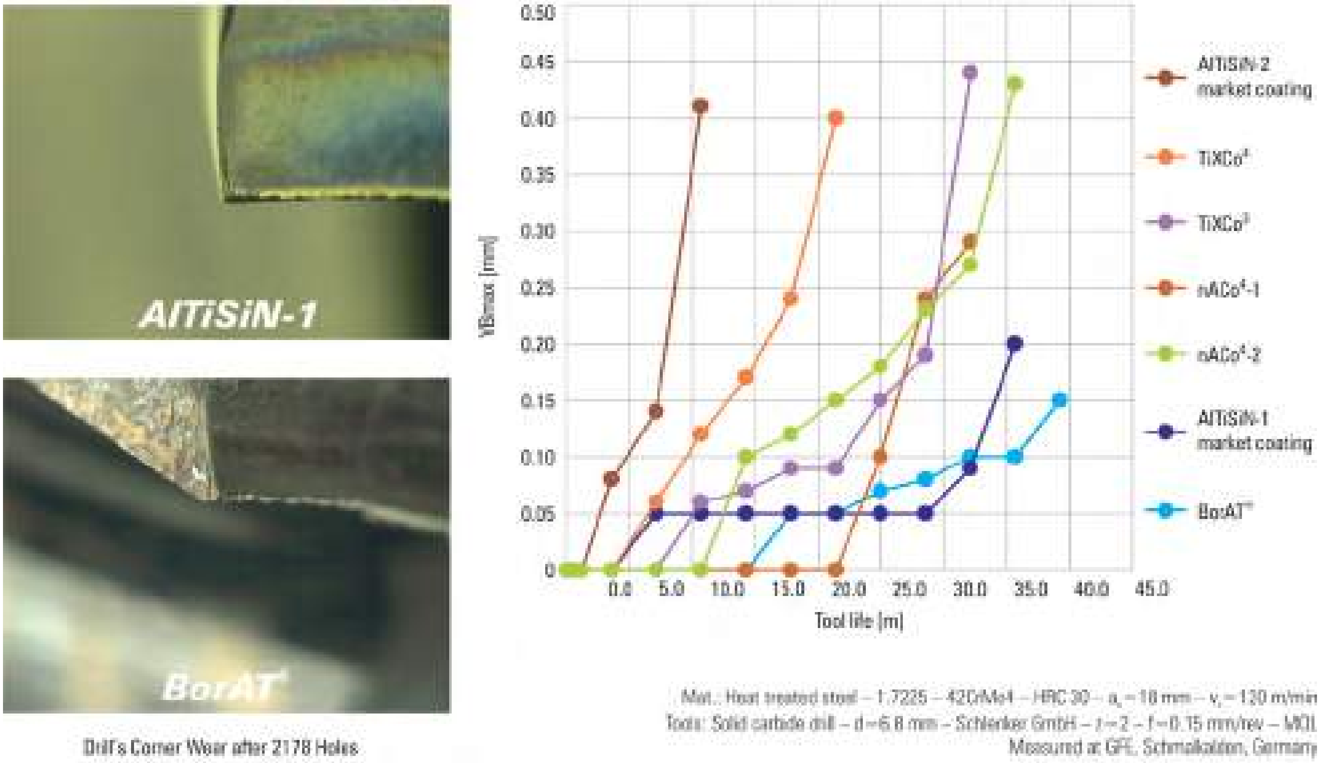


Fig. 7: BorAT® – AlTiN/BN: Wear Behavior at Drilling.

[1], and thus achieves a higher tool life than the TiCN, produced by the ionitron process (**Fig. 4**)

– Due to the good avoidance of built up edges, **TiB_2** is the classic layer for aluminum machining.

What is the goal of the LACS® option with the simultaneous combination of ARCing and sputtering? Of course, the using of their advantages:

- ARCing: perfect layer-adhesion, -density, -hardness, -structure and
- Sputtering: fewer droplets.

– The use the SCiL® cathode made of B_4C rings reduced the internal stress of the layer, which makes the new **BorAC®** (AlCrN/BN) coating outstanding at milling (**Fig. 5**) and hobbing. This coating also builds on the triple principle with a nanolayer structure [1], which is made possible by the rotating cathodes (**Fig. 6**). The programmability of the boron content is the most exciting information of this figure. You can find the optimum percentage of boron (or other "doping" materials) for your application without buying and changing of different and expensive targets and cathodes.

– Without changing the cathode configuration, the layer **BorAT®**-(AlTiN/BN) can be produced too. Due to the higher thickness the coating is excellent for drilling (**Fig. 7**).

In the next step, the classical layers, AlTiN and AlCrN were prepared in combination of the two methods. As the next LACS® advantage, the Al content of AlCrN-LACS and AlTiN-LACS can be increased.

Outlook

It is extremely important that the stoichiometry of the coatings, as well as the percentages of the individual material components (for example boron), be freely programmable by this machine configuration and by the LACS® technology. As a result, the π411PLUS is not only the ideal machine for small and medium-sized enterprises, but it is also an excellent, flexible tool for coating development in greater enterprises.

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References

[1] Compendium – 58th edition, PLATIT, Selzach, 2017.

[2] Cselle, T., Lümkemann, A.: Turbos for the Flagship Werkzeug-Technik, No.156, Sept/2016.

[3] Jilek, M. sen.: The cylindrical cathode for deposition of layers by PVD method Patent application, PV 2015-837, 27.11.2015, Prag, 2015.

[4] Jilek, M. sen.: Method of deposition of boron based wear resistant layers Patent application, PV 2016-61, 5.2.2017, Prag, 2016.

[5] Jilek, M. jun., Zindulka, O. u.a.: High-Rate Deposition by Central Cylindrical Magnetron Sputtering, ICMCTF, San Diego, 5/2014.

[6] Beutner, M., Lümkemann, A., u.a.: Stress optimized hard nitride coatings for high-performance gear hobbing, ICMCTF, BP-42, San Diego, 4/2017.

[7] Cselle, T., Lümkemann, A. Jilek, M. sen&jun: My Tool, My Coating Werkstatt und Betrieb, Hanser Verlag, 11/2016.

[8] Morstein, M, u.a.: Nanolayered coatings for Advanced Fine Blanking Applications ICMCTF, G3-2, San Diego, 4/2017.

[9] Habermeier, J., u.a.: Challenges in the mechanical processing of turbine housings in the large series, Hanser Verlag, Nürtingen, March/2014.

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