№ 02
2019

world of tools

HORN

SPECIAL FEATURE: COATINGS

COATINGS
New coating increases grooving productivity

PRODUCTS
2019 innovations

MATERIAL
Cobalt-chromium

REVIEW
Technology Days 2019

DEAR READERS,

Gold, mauve, anthracite, copper – coatings are not just about colour, they are also one of the three characteristics that make successful cutting tools. The finished tool is a synergy of coating, substrate and geometry. Just using a new coating on its own often won't achieve the desired result. However, when all three factors work successfully in perfect harmony, you won't just see slight improvements – major advances in tool life are possible. At HORN, we have been coating in-house for many years. Our internally developed coatings have been on the market since 2016. This year, we have added a Hauzer plant to our eleven CemeCon systems to further expand the HORN coatings portfolio and to advance into new areas of application.

4,700 visitors from 35 countries, around 60 exhibiting partner companies and eight technical presentations were the final figures from our seventh Technology Days event. In line with the slogan for the event "Technology. Transparent", we opened our production facilities and provided detailed insights into the development process behind our precision tools. We also celebrated our 50-year company anniversary in conjunction with our biennial customer event. 50 years of HORN – 50 years of tools. We invited customers, employees, partner companies, the technical press and political figures to three evening events where we reflected on the past and looked forward to the future.

2019 is also an EMO year. We are so excited by this major event. Tools, applications, workpieces, live machining, conversations with customers and new prospects and so much more are all on the agenda and of course, we will have lots of our new innovations and product enhancements too.

Come and see us at EMO in Hannover – we can't wait to meet you.

Markus Horn, Lothar Horn and Matthias Rommel

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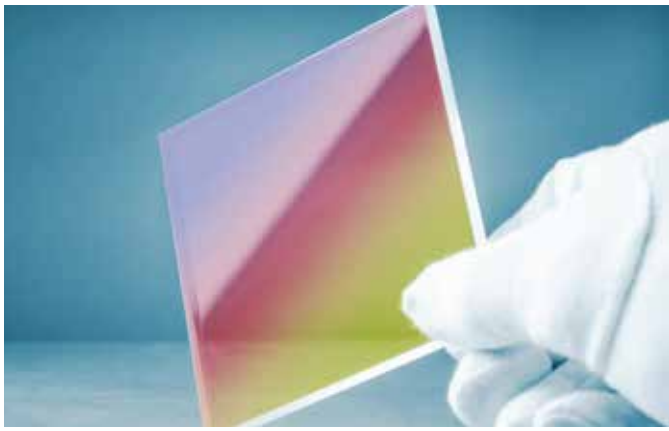
COATINGS

We come into contact with them every day – coatings. Varnish, electroplating or other technical coatings. They inspire passion and recognition in automotive brands; in technical applications they increase performance and durability.



A COATING MODIFIES THE SURFACE PROPERTIES OF A COMPONENT

No matter where they are going to be used, coatings all have one thing in common: a coating modifies the surface properties of a component. Way back in ancient times, people already understood the benefits of using coating products to protect against corrosion. For example, coatings like shellac were used on wood.

Protection against external influences
One of the most important purposes of a coating is to protect the material from external influences. This includes oxidation and corrosion protection coatings, wear protection coatings, thermal insulation coatings and decorative coatings. Coatings are applied by varnishing, electroplating, hot-dipping, sintering, using the PVD/CVD method or thermal spraying. Technical and economic factors need to be taken into account when it comes to selecting the right process.

According to DIN 8580, coating is one of the main groups of manufacturing processes in production technology. It defines the application of a substance to the surface of a workpiece. This process is referred to as coating. Coatings can be thin or thick and can also consist of several cohesive layers.

However, coating techniques differ significantly in terms of how the coatings are applied. The initial state of the coating material is a way to distinguish between the methods, including gaseous, liquid, dissolved and solid.

Gaseous processes
Gaseous processes are used to coat precision tools. In this case, there is a difference between physical and chemical vapour deposition. HORN uses the PVD technique (physical vapour deposition) for its tool coatings. PVD is a process which involves the coating material being vaporised by electrons, laser beams or arc discharges. The vaporised material covers the workpieces that need to be coated, which results in a layer being formed. The coating composition can be influenced by the supply of reactive process gases. This results in nitrides

or carbides or mixtures of the two being deposited during the coating process. PVD coatings significantly increase the service life of cutting tools.

Diamond coatings

Chemical vapour deposition (CVD) also comes into play in tool coating. This method, for example, allows diamond coatings to be applied to carbide tools and it can even produce monocrystalline diamonds. Gases such as methane are used as the carbon source (diamond is 99.99 percent carbon).

PVD COATINGS SIGNIFICANTLY INCREASE TOOL LIFE.

COATINGS

NEW COATING INCREASES GROOVING PRODUCTIVITY

For contract manufacturers, continuously reviewing their production processes is essential to maintaining their competitiveness. Such optimisation can achieve impressive results when manufacturers of cutting tools apply their expertise and incorporate advanced machining strategies.

Successful suppliers of turned parts utilise the latest production equipment and technologies and impress their customers with top performance in terms of their production methods and cost-effectiveness. By consistently implementing this strategy, in just a few years TecVo Zerspanungstechnik has transformed into an in-demand supplier of turned parts up to 380 mm (14.961") in diameter. This company, which is based in Bühl on the edge of the Black Forest, focuses on supplying components for the hydraulics, fittings and construction industries as well as for rail vehicles and mechanical engineering. The service based around the core business of turning ranges from customer consultation during product development to additional machining tasks such as milling, surface finishing, precision machining and heat treatment, sometimes in collaboration with predominantly local companies.

R_z values for internal grooves require new machining strategies

The large proportion of turned parts with many kinds of internal grooves is constantly presenting Production Manager Sven Vollmer and his team with new challenges. An example of this is the introduction of various recesses with an average roughness of R_z ⩽ 6.3 µm (248.0315 µin) in three geometrically similar turned parts. To fulfil orders for batches of 50 to 200 pieces, a future-proof solution was required to machine the workpieces reliably and cost effectively within the given time frame.

The first tests with carbide grooving inserts from HORN and other tool suppliers did not reliably produce the R_z specifications, which resulted in some of the workpieces needing to be polished manually.

THE CERMET CUTTING MATERIAL RESOLVED THE PROBLEM.

The next trial used ground cermet indexable inserts which produced significantly better results, but they were still unsatisfactory in terms of the tool life and surface quality. However, the tools recommended by Thomas Schnurr, Technical Consultant at HORN, encouraged the machining specialists to continue down this path and in the next trial they used type 229 cermet indexable inserts with the new EG3 coating.

3D model of toolholder 213.

Toolholder 213 and cutting insert S229.

Tried-and-tested coatings for diverse applications
A coating of a few thousandths of a millimetre in thickness decisively influences tool wear along with its associated effects on the machine, energy consumption, cutting fluids and consumables. To adapt this coating to the HORN product range in line with application requirements, the company is continually investing in coating processes such as PVD sputter technology and the new coating technology HiPIMS (high-power impulse magnetron sputtering). HiPIMS produces an even more homogeneous and significantly more durable coating with a hardness and toughness that demonstrate its strengths, particularly when it comes to steel machining and machining small and miniature parts. This technology made it possible to coat various grooving and milling tools with the new EG3 and EG5 titanium aluminium nitride (TiAlN) coatings developed by HORN. EG3 is predominantly used for the Supermini boring tools (hole diameters ≥ 0.2 mm (0.00787")) and ground indexable inserts. Both tool types are particularly well suited to the EG3 coating thanks to their smooth, highly adhesive surface. The EG5 coating is primarily used on indexable inserts with an edge radius of 0.01 (0.000394") – 0.03 mm (0.00118") used for circular interpolation milling.

Although they have different thicknesses, both coatings have a very dense structure with a particularly smooth top layer and improved adhesion properties. This balances the relationship between the coating adhesion and the residual stress and ensures exceptional hardness of the cutting edge. A gold-coloured layer provides a finish, making it easier to detect wear.

A variety of workpieces requires operation-specific tools

The new EG3 coating now had to demonstrate its strengths to TecVo on three different workpieces. The type 213 toolholder developed for grooving and longitudinal turning could be used for all three workpieces so was the perfect tool carrier. The short version of the holder (length 150 mm (5.906"), shank diameter 32 mm (1.259")) is suitable for machining holes from 38 mm (1.496"). Depending on the cutting insert, groove depths of up to 15 mm (0.591") can be achieved at retraction distances of up to 110 mm (4.331"). The tool system excels at this overhang with a concentricity of 0.05 mm (0.00196"). 0.02 mm (0.000787") is guaranteed for retraction depths of up to 90 mm (3.543").

The holder clamps a double-edged cermet indexable insert coated with EG3 from the S229 product range. With a 3 mm (0.118") cutting width, it enables groove depths of up to 7.5 mm (0.295"). Its free cutting geometry with a small cutting edge radius of 0.01 mm (0.000394") without chip formation has a very stable wedge angle. Its interrupted cutting in high-strength steels is an impressive feature.

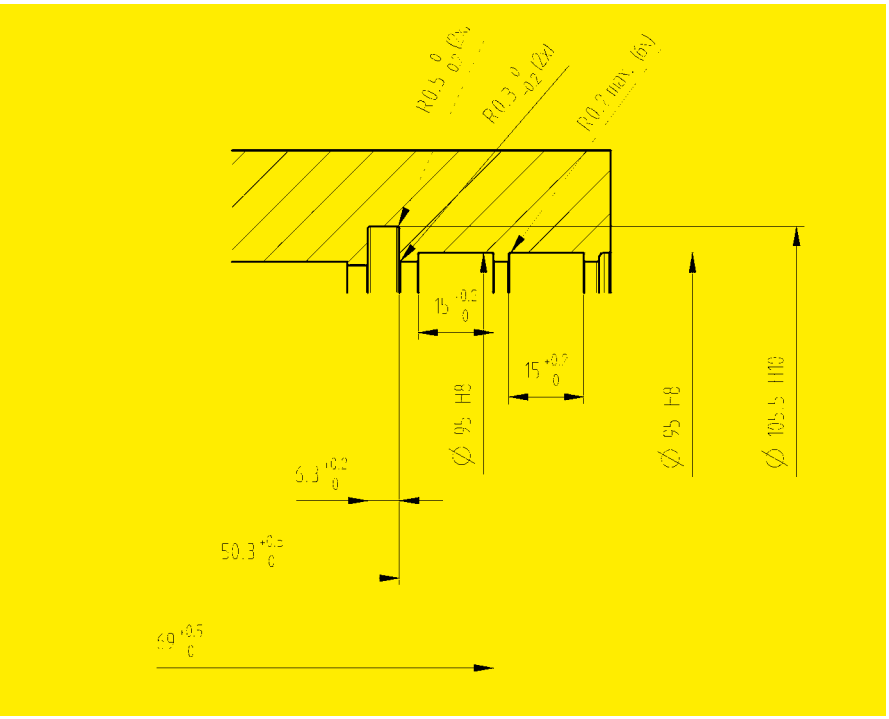
Over the course of the tests, inserts with the chip-breaker geometries .10. and .20. were used without chip formation. Geometry .10. has a rounded cutting surface towards the rear and geometry .20. has a straight cutting surface towards the rear.

Identical cutting parameters reduce programming effort

Production Manager Sven Vollmer and Thomas Schnurr evaluated the performance of the cutting inserts step by step, starting with workpiece no. 1 made of C45E. Three 15.1 mm (0.594") wide internal grooves starting from an initial diameter of 81.3 mm (3.201") up to a final diameter of 85H8 mm had to be machined into this part.

THE CUTTING INSERT STANDS OUT WITH ITS INTERRUPTED CUTTING IN HIGH-STRENGTH STEELS.

The cutting speed of v_c = 250 m/min (820.21 ft/min), the feed rate of f = 0.08 mm (0.00315) and the cutting depth of a_p = 0.2 mm (0.00787") as well as an emulsion coolant of six percent were suitable parameters for machining without vibration or interruptions despite the overhang of 70 mm (2.756") – 80 mm (3.149"). The specified roughness $R_z \leq 6.3$ µm was reliably maintained and the cutting insert achieved a tool life of 50 workpieces with an operating time of 57 minutes per cutting edge. As the first signs of wear on the corner radius became apparent in this application, Sven Vollmer decided to change the insert to ensure the reliability of the production process. He was very satisfied with the result as he could use the uncoated cermet insert to machine up to 15 workpieces.



Simplified production drawing with the relevant data for grooving workpiece no. 3.

New coating excels with a tool life that is up to 3 times longer

Encouraging results were also obtained with workpiece no. 2 made of C45E when grooving three 8.2 mm (0.323") wide internal grooves with an initial diameter of 72.0 mm (2.835") and a final diameter of 82.2 mm (3.236"). With the geometry .20. and the parameters tested with workpiece no. 1, 70 parts could be reliably grooved to the desired accuracy – the figure was max. 25 parts for the uncoated insert. The machining time per workpiece was 1.2 minutes. Again, the reason for insert replacement when grooving this workpiece was apparent wear on the corner radius and on the cutting edge.

The cermet indexable inserts with the new EG3 coating met the expectations of Sven Vollmer, Production Manager, and Tina Vollmer, Managing Director, both from TecVo, which verified the machining strategy elaborated by Thomas Schnurr; Technical Consultant at HORN (from left).

Final confirmation of the chosen strategy was provided by the workpiece no. 3 made of the material S355J2G3 (St52-3N) with three plunge cuts. With the cutting parameters that had already proved effective on the previous parts and the chip shape geometry .10., 44 workpieces (25 with the uncoated cutting insert) were reliably machined to the desired accuracy. The operating time per cutting edge was 40 minutes. The cutting insert was changed at this quantity to prevent tolerance deviations in the surface finish.

Objective achieved: Reliable, ultra-smooth R_z values for increased tool life

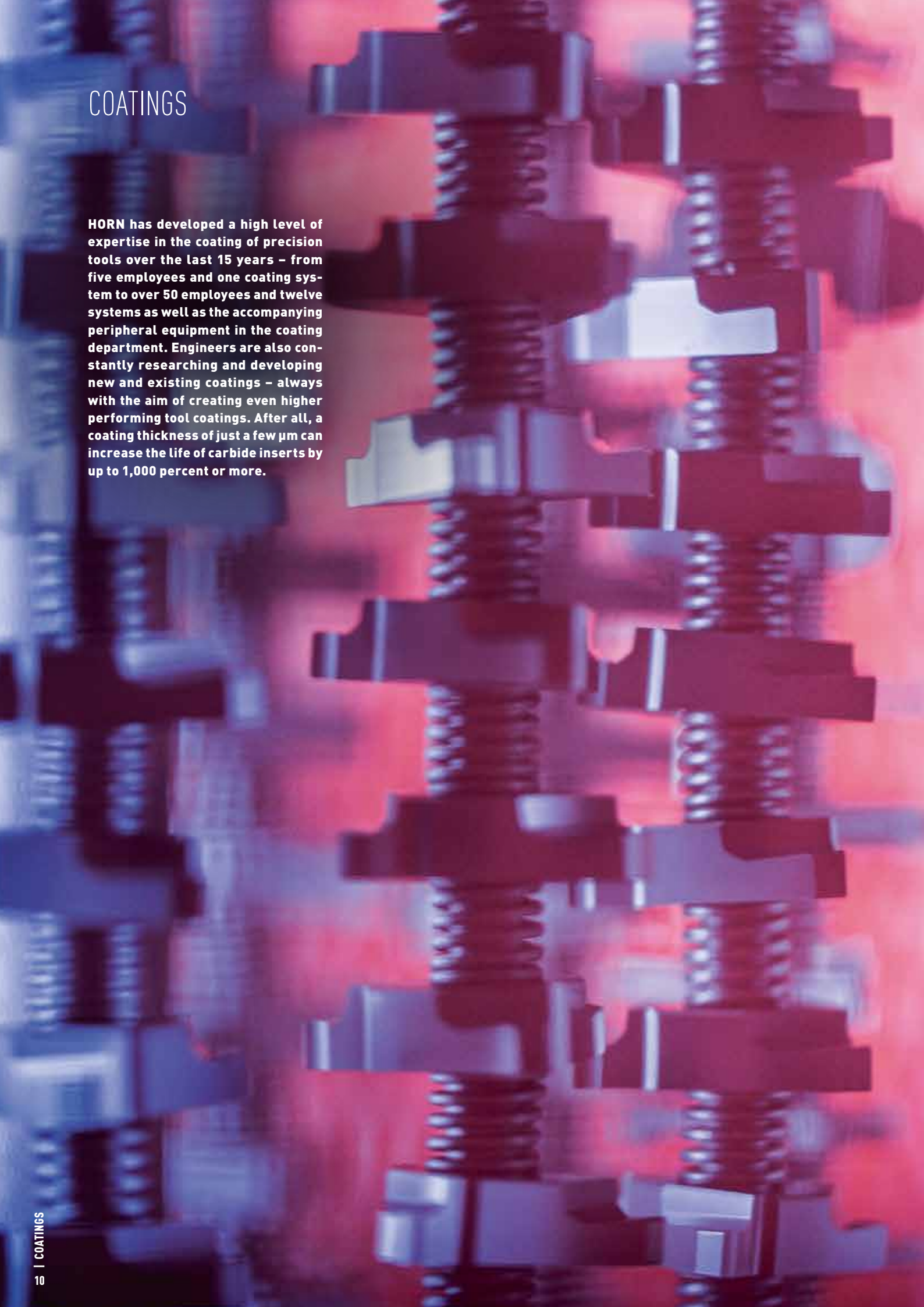
The tests with the EG3 coating also impressed Managing Director Tina Vollmer. Like Production Manager Sven Vollmer, she also sees great potential in these grooving tools. This is why, after the tests had been completed, TecVo now uses the geometry .20. with the coating EG3 for all workpieces of this order package – there are currently eight pieces with up to six plunge cuts each. The significantly longer tool lives compared with the previously used cutting inserts and adherence to the specified roughness values were crucial factors in this decision. The S229 cutting inserts produced ultra-smooth surfaces for almost all workpieces until shortly before the end of their tool life with R_z values well below the specifications. The universal geometry .20. has also really proved its worth with other orders. These product features are extremely important for safeguarding the future of the service provider, which is constantly needing to meet individual customer requirements.

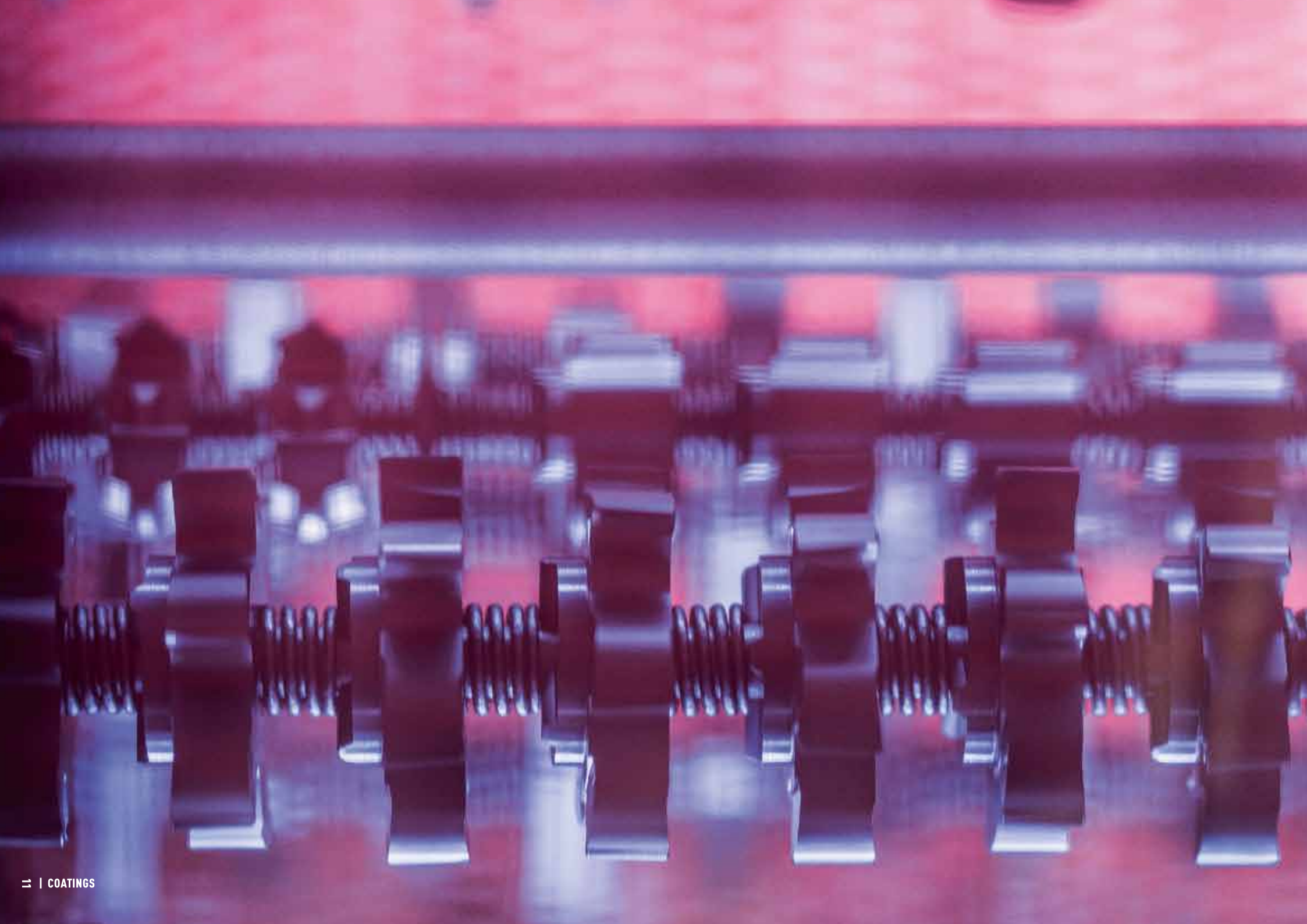
TOOL LIFE INCREASED, SURFACE FINISH AND PROCESS RELIABILITY IMPROVED.

This is firstly because the responsible HORN Technical Consultant is on hand as a highly competent expert in machining and process optimisation, and secondly because HORN supplies standard and special tools in a very short time frame thanks to its in-house production – from carbide powders to ready-to-use inserts – which can ultimately be a decisive competitive advantage for a service provider.

COATINGS

HORN has developed a high level of expertise in the coating of precision tools over the last 15 years – from five employees and one coating system to over 50 employees and twelve systems as well as the accompanying peripheral equipment in the coating department. Engineers are also constantly researching and developing new and existing coatings – always with the aim of creating even higher performing tool coatings. After all, a coating thickness of just a few µm can increase the life of carbide inserts by up to 1,000 percent or more.





COATINGS

FROM ZERO TO A HUNDRED

ALL UNDER ONE ROOF

In-house coating at HORN started in 2004. The company invested large sums of money in the project. HORN had previously had its tools coated by external service providers. "We wanted all production steps in tool manufacturing to be carried out internally. Coating was the last missing element," says Managing Director Lothar Horn. HORN installed its second coating system at the end of 2004 and in 2005, the first coating orders were being reliably fulfilled using the company's own machines. The third system arrived the following year, meaning that in 2006, HORN was able to coat almost half of its tools. Today, over 80 percent of the tools produced are coated in-house.

CONSTANT INVESTMENT IN NEW, MODERN SYSTEM TECHNOLOGIES.

In 2016, the department moved premises to the newly built Factory 2. Twelve coating systems, multiple wet-blasting systems, two fully automatic cleaning systems and manual workstations for loading and unloading are set up across an area covering 1,200 square metres (12,916.693 sq.ft.). The processes and workflows have also been continuously optimised over the last 15 years. For example, multiple monitors display current and planned system processes in live mode. Internal orders arrive at the department every two hours, which employees then process in three-shift operation. HORN is always creative when it comes to using the space available. For example, it has built a second sub-level in the department for a new Hauzer coating system. The peripheral equipment for the new system is housed on this level – with space also available for a second system.

Continuous investment

HORN is constantly investing in new, modern technologies. In 2015, the company CemeCon delivered the first of three HiPIMS systems to HORN, which happened to be the first in the world. High

Work in the lab provides detailed insight into developments.

power impulse magnetron sputtering technology has several advantages and provides new opportunities when it comes to coating precision tools. It enables the formation of very dense and compact coatings, which are very hard and tough at the same time. The coatings have a homogeneous structure and exhibit an even coating thickness, even with complex tool geometries. "New approaches to coating, new approaches to cutting materials, new approaches to geometry. Coating technologies like HiPIMS are showing a huge amount of potential right now in terms of extending the service life of tools," says Lothar Horn.

In-house research and development

Research and development into new and existing coatings and technologies are central pillars to success. HORN employs a team of engineers who work exclusively in this area. "When in-house production first started, we carried out a few research and development projects in cooperation with the system manufacturers. Since the start of coating development in 2014, we have been developing coating solutions and exploring fundamental research findings independent of partners," says the head of research and development at HORN, Matthias Luik. Development projects arise from customer requests. Research projects within the company and, of course, outside the company in collaboration with research centres such as universities and other institutes provide the foundation and pool of experience required for these development projects.

HAZ – HORN Analysis Centre

At the start of 2019, the coating developers moved into a new lab directly next to the coating department. "We need to be able to test the structures of our coatings using X-ray diffraction to gain a thorough insight into the effectiveness of our developments," explains Gaedike. As soon as the project started in August 2018, the XRD (X-ray diffractometer) and other equipment were ordered and work began on the gradual conversion of a storage room into a modern laboratory. The HAZ project was completed in May 2019. As well as the XRDs, the development team has an SEM (scanning electron microscope) and other modern measuring equipment and machines at its disposal for research and development.

Research into and development of modern coatings and coating structures will play an important role in high-performance tool systems in the future. "New materials from aerospace engineering and medical technology will determine the coatings of the future. So far, these include titanium alloys and superalloys. The spectrum of highly complex materials that are extremely difficult to machine will only become more diverse. We have to stay on the ball and continue to develop high-performance coatings," says Gaedike.

QUICK-FIRE ROUND: THREE QUESTIONS FOR MATTHIAS ROMMEL

Mr Rommel, why does HORN carry out its coating in-house?
The performance of a tool's cutting edge is largely defined by its substrate, geometry, edge preparation and coating. These factors always need to working in perfect harmony with one another. It is the duty of high-end tool manufacturers like HORN to be in control of these factors. We provide special tools within a very short time frame. This means that external supply chains are much too slow for us. Many of our tools machine contours to within microns. The influence of coating thickness in the µm range is crucial for our tool cutting edges so we have to ensure they remain within narrow tolerance bands. We have to master this and implement it too. This capability simply does not exist on the open market using external service providers or suppliers.

What do you need to take into account when developing new coatings?
As I already mentioned, coatings need to work in harmony with the system as a whole. For example, there are physical limits for edge preparations and coating thicknesses. Limits like these need to be pushed back again and again by process improvements. New developments are becoming increasingly specific. We clearly define our development goals including the target range and pursue them with determination. The classic conflict between the wear resistance and toughness of a cutting edge must be reduced time and again by coatings.

What future potential do you see in the area of coating?
At the moment we are coating almost all of our inserts, with a few exceptions. Future potential lies in further research into new coating systems and the combination of new elements. We have taken this approach by investing in a new Hauzer system. The additional coating system with its open process technology gives us the opportunity to try out and use completely new methods. In addition to the Hauzer system, eleven CemeCon systems are also still in use. Three of them are equipped with HiPIMS technology which we used to develop and launch our first internally produced coatings.

WE PROVIDE SPECIAL TOOLS WITHIN A VERY SHORT TIME FRAME.

MARKUS HORN, THE NEW ECTA PRESIDENT

European manufacturers of cutting tools and workholding equipment and their national associations are all united in the European association ECTA – European Cutting Tools Association. Getting to know each other, sharing experiences, collaborating – there are numerous topics that European companies in the industry urgently want to discuss with each other as well as with their customers, suppliers and cooperation partners. ECTA is the optimum platform for this.

The main aim of ECTA is to act as the central organisation to promote the interests of the entire European cutting tool industry and to initiate measures that are deemed necessary in the interests of the industry and members. The ECTA organises world conferences in a different location every three years.

"We need to work together to shape our future," said Markus Horn, the new President of the European Cutting Tools Association (ECTA). Horn is the Managing Director of Paul Horn GmbH in Tübingen and was elected as ECTA President at the World Cutting Tools Conference 2019 at Tegernsee. In his inaugural speech, he thanked the ECTA members for the trust they have placed in him and his predecessor Marc Schuler from the Swiss company Dixi Polytool SA for his commitment to the association.

"WE NEED TO WORK TOGETHER TO SHAPE OUR FUTURE".

Horn: "The ECTA offers our industry many opportunities to shape the future and to promote our industry in Europe and around the world. And this is precisely what I will be doing during my term."

TOP INNOVATION

HORN is expanding its gear manufacturing portfolio to include gear skiving tools with indexable inserts for the production of large modules. The tool system can be used from module size 3 where solid carbide gear skiving tools are no longer economically viable. This tool enables large gears that previously required special gear cutting machines to be produced on universal machines. The user can fully machine the components in a single clamping, which reduces cycle times while achieving higher accuracy.

GEAR SKIVING FOR LARGE MODULES

This method for producing larger modules offers the benefit of a shorter machining time, especially for internal gear teeth. When it comes to gear skiving of larger modules, large and rigid milling and turning centres are required that facilitate accurate synchronisation between workpiece rotation and cutting tool movement. Thanks to its experience with small solid carbide gear skiving tools, HORN can now apply this expertise to cover larger modules.

The tool system is based on the cutting insert type S117. The patented insert seat of the single-edged tool ensures precise clamping and positioning for high rigidity of the system as a whole with precise repeatability. The ground chipbreaker form and the direct threaded connection of the inserts enable very effective chip removal from the machining zone. All cutting edges are cooled directly by an internal coolant supply.

HORN gear skiving tools are specially designed and manufactured for every application. The feasibility of each application is verified by HORN engineers prior to implementation and the tool design and recommendations for the process are discussed with the user.

HORN's product portfolio comprises a wide range of tools for the production of various gear tooth geometries from module 0.5 to module 30. Whether this involves gear teeth for spur gears, shaft/hub connections, worm shafts, bevel gears, pinions or customised profiles, all these tooth profiles can be manufactured extremely cost-effectively with milling or broaching tools. The gear skiving range is yet more testament to the company's gear tooth machining expertise. It is a process that has been in use for over a century – but has only been incorporated into a wider range of applications since machining centres and universal turning machines with fully synchronised spindles and process-optimised software have been able to accommodate the highly complex technology.

GEAR TEETH FROM MODULE 3 WITHOUT THE NEED FOR A SPECIAL GEAR CUTTING MACHINE.

TOP-PERFORMANCE GROOVING WITH HIGH CUTTING PARAMETERS

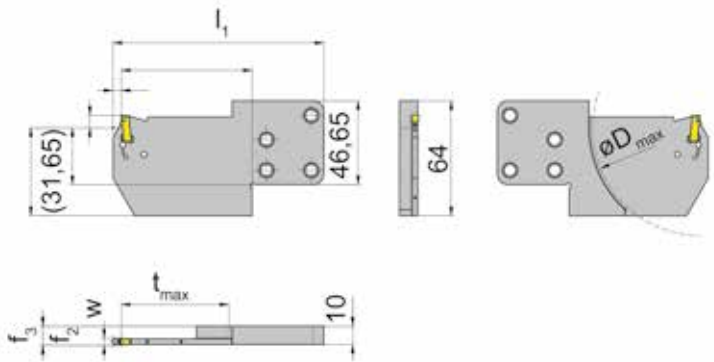
Parting off along the Y axis

Paul Horn GmbH is offering new tool holder variants for the S100 system for parting off with the feed movement along the Y axis on turning/milling centres. This method enables a very effective grooving process with high cutting parameters, resulting in shorter machining times. Furthermore, there is the option to part off large diameters with a compact grooving tool holder as well as parting off with narrower groove widths.

Large moments of force occur, particularly when parting off workpieces with larger diameters. The space available in the machine often does not allow the use of tools with larger cross sections. With the new arrangement of the cutting edge in the tool carrier, the cutting forces are diverted to the main cross section of the grooving tool holder. This results in increased rigidity of the system as a whole with the same cross sections for the grooving tool holder. It allows higher feed rates for the same groove width. The force in the longitudinal direction of the tool means narrower holders can be used to achieve the same system rigidity. In modern generations of turning and milling centres, parting off with the new grooving tools causes the cutting force to be diverted in the direction of the spindle, meaning a higher rigidity of the system as a whole.

HIGH CUTTING VALUES AND SHORTER MACHINING TIMES.

HORN is offering two holder variants for the parting off process. For the 842 and 845 modular grooving system, there is a cartridge with cutting widths of 3 mm (0.118") and 4 mm (0.157"). There is also a reinforced grooving blade, also with widths of 3 mm (0.118") and 4 mm (0.157"). Both variants are equipped with an internal coolant supply via the clamp and through the support. In addition, the S100 system provides an option for direct cooling through the cutting insert. The maximum groove depth (T_{max}) is 60 mm (2.362"). The tried-and-tested grooving insert of the S100 system is used, which is available in various substrates and geometries.



MCD-TIPPED BALL NOSE END MILLS

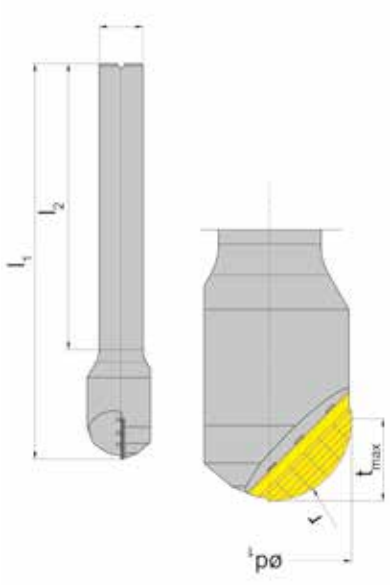
Milling instead of polishing

HORN is expanding its tool range for brilliant-finish milling. The monocrystalline diamond-tipped (MCD) ball nose end mills are geared towards use non-ferrous materials in the tool and mould-making industries. Milling with MCD-tipped tools saves polishing when producing free-form surfaces. The new, larger diameter variants reduce machining time, guarantee compliance with the strictest tolerances and produce surface qualities to within nanometres.

SURFACE QUALITIES IN THE NANOMETRE RANGE.

HORN offers the expanded portfolio of MCD ball nose end mills from stock. Diameters of 6 mm (0.236"), 8 mm (0.315"), 10 mm (0.394"), 12 mm (0.472") and 16 mm (0.629") allow a broader range of applications to be undertaken. All variants are single-edged and feature an internal coolant supply. The solid carbide tool shanks enable vibration and oscillation-free machining.

The range of applications for brilliant-finish milling is huge. In the tool and mould-making industry in particular, the method saves polishing, while also increasing quality, precision, contour accuracy and surface finish. It is therefore used in applications where the high surface quality of the mould is reflected in the parts being produced. For instance, these include PET blow moulds and chocolate moulds as well as applications in the medical technology sector. In addition to brilliant-finish milling, HORN includes solutions for brilliant-finish turning with MCD tools.



IG35 – NEW COATING

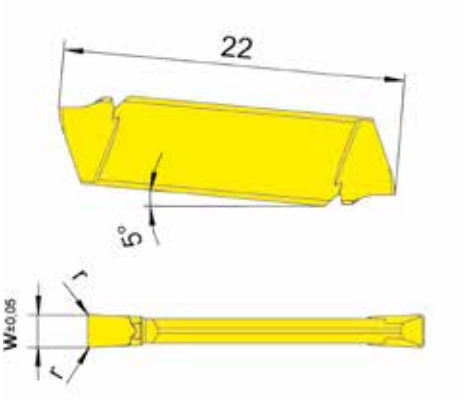
HIGH PERFORMANCE FOR STAINLESS STEELS AND SUPERALLOYS.

High heat resistance

The new IG35 insert coating allows HORN tool systems to offer high performance and long tool life when machining stainless steels, titanium alloys and superalloys. In combination with the 3V and FY geometries, the aluminium titanium silicon nitride coating prevents the formation of built-up edges due to the low coefficient of friction. Thanks to HiPIMS coating technology, the coating exhibits very smooth properties and a high heat resistance. Furthermore, the tool coating is free from defects such as inclusions or other coating faults at the cutting edge.

HORN adapts the coating system, the chipbreaker geometries and the micro-geometries to applications such as internal and external grooving, longitudinal turning and circular interpolation milling and solid carbide milling. The user can achieve higher cutting parameters, enabling a shorter cycle time, which in turn has a positive impact on unit production costs. The use of the new coating also leads to higher surface qualities.

The IG35 coating is available for the S100, S101, S224, S229, S274 grooving systems as well as for the circular interpolation milling and solid carbide milling systems.



PRODUCTS

SUPERMINI HP AND NEW HOLDER VARIANTS

Versatile application

HORN will be showcasing a new variant of the successful precision tool system at EMO 2019. The new HP geometry is suitable for drilling, boring, face turning and skimming. With this, HORN is offering a multi-functional tool for multiple applications. The new cutting geometry enables higher cutting parameters including infeed rates. When boring, this results in an accurate 90-degree shoulder at the base. The trailing cutting edge (wiper geometry) produces high surface qualities, even at high feed rates.

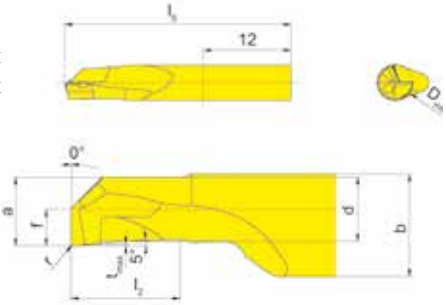
Alongside the turning operations, the system is also suitable for drilling into solid material in diameters ranging from 3 mm (0.118") to 7 mm (0.276"). The performance data of the tool cannot compete with normal drills, but there is often a lack of space for tools in the machine. The Supermini HP offers the option of directly boring the inner contour after drilling – without needing to change the tool. With the single-edged version, various bore diameters can also be produced using a single tool.

HORN provides tools for optimum chip control with and without a chipbreaker. For turning operations, we recommend the variant with a chipbreaker. The chipbreaker is not used for drilling. The slightly twisted flute removes the chip from the machining zone. The EG35 tool coating allows versatile machining of both normal and stainless steels.

As well as the new geometries, HORN developed a new holder system for the Supermini type 105.
In the new design, the clamping process uses a tensioning wedge on the face rather than on the circumference, as was previously the case. This enables the cutting insert to be held in place with more force, which in turn makes the entire system more rigid. As well as this, the new clamping design results in a higher level of repeatability when changing inserts and allows better use to be made of the available installation space thanks to the face-clamping concept.

MULTI-FUNCTIONAL TOOL FOR HIGH CUTTING PARAMETERS.

This is a significant advantage when working with Swiss-type lathes, as it enables users to change the cutting insert without removing the tool holder.



PRODUCTS

117 FORM BORING TOOL

Advantages in series production

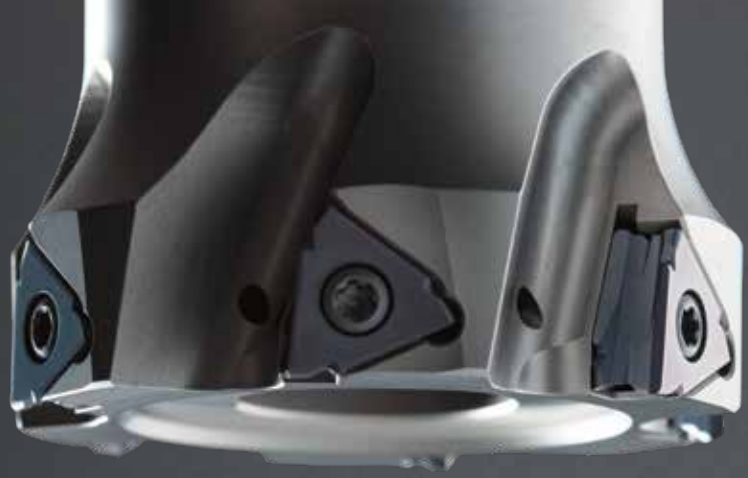
Boring with profiled tools provides economic advantages in series production. HORN provides profiled cutting inserts based on the 117 tool system to customer specification for use on turning and milling centres from a diameter of 16 mm (0.629"). The patented precision insert seat of the 117 system guarantees high concentricity and axial run-out accuracies as well as highly precise exchange to within microns. The ground cutting edges achieve high precision and surface quality. Cost savings arise due to the option to exchange the insert, the lower tool costs and the reduced machine downtime. The internal coolant supply to both cutting edges through the round shank ensures cooling in the contact zone and efficient removal of chips.

ECONOMIC ADVANTAGES IN SERIES PRODUCTION.

HORN offers the tools in widths (w) 16 mm (0.629"), 20 mm (0.787") and 26 mm (1.0236"). The desired special form is precision-ground to suit the application. The maximum profile depth is t_{max} = 17 mm (0.669"). The maximum profile width is w = 26 mm (1.0236"). The tool coating is specially selected for each application and is available for the material groups P, M, K and N. The round shanks are available in the diameters 16 mm (0.629"), 20 mm (0.787") and 25 mm (0.984") in designs A and E as standard. All variants are fitted with an internal coolant supply.

PRODUCTS

M610 TANGENTIAL MILLING SYSTEM

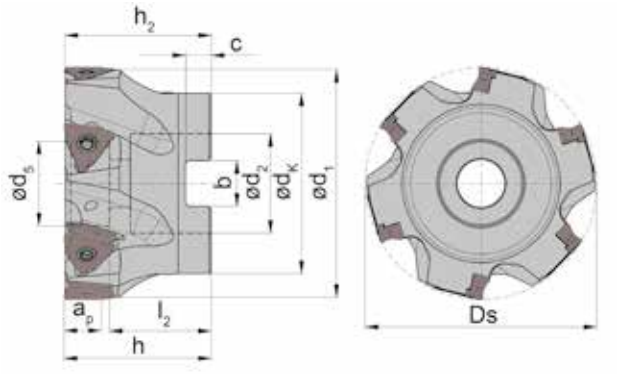


High accuracy and surface quality

HORN is continually developing the M610 tangential milling system concept. In addition to the side milling cutter, the range is being extended to include a 90-degree shoulder mill and new cutting material grades. The patented tool system ensures a soft cut with positive radial and axial rake angles. The precision-ground indexable inserts provide six usable cutting edges for high accuracy and high surface quality. The additional flank chamfer ensures a stable wedge angle and very smooth milling. The milling body is protected against abrasive chips by a special surface coating.

SIX CUTTING EDGES OFFER A LOW COST PER EDGE.

The six cutting edges per indexable insert mean low cost per edge. HORN provides inserts in the substrates AS46, IG35 and NE2B in right and left hand versions as well as with corner radii of 0.4 mm (0.0157") or 0.8 mm (0.0315") to machine different materials. The maximum cutting depth is a_p = 9.9 mm (0.389"). The main bodies are available in the following cutting edge diameters: 50 mm (1.969") (z = 5), 63 mm (= 2.480") (z = 6), 80 mm (3.149") (z = 8), 100 mm (3.149") (z = 10) and 125 mm (4.921") (z = 12).



PRODUCTS

NEW GROOVING GEOMETRY FOR TITANIUM MONITORED WITH SENSORS

HORN and Kistler combine their expertise to ensure efficient turning

HORN presents the newly developed grooving geometry for parting off titanium. This WT geometry designed specifically for titanium was developed based on extensive simulations. It proved its practical value straight away for parting off bone screws made from this challenging material. In addition to reliable chipbreaking, the adapted geometry ensures a soft cut. This means that higher feed rates are possible, resulting in faster machining. What's more, service life is increased – tests have shown that it can be boosted by up to 60 percent. Type 224 inserts with the new WT geometry are available in increments of 2 mm or 2.5 (0.0984") and 3 mm (0.118") in the IG35 grade. They are designed for H224 holders.

Kistler is the global market leader in dynamic measurement technology for measuring pressure, force, torque and acceleration. Working closely with HORN, the Kistler Group has developed a solution – the only one of its kind in the world – for the real-time monitoring of tools used in micro turning applications. The Piezo Tool System (PTS) consists of a force sensor which is inserted into the turning tool and provides information on the condition of the tool during machining. The small piezo sensor can measure even the smallest cutting forces to a high resolution. The machine operator is therefore able to identify defective (workpiece) materials or a tool breakage immediately, resulting in minimum waste and maximum quality.

The new system is suitable for use in turning, particularly in the micro range, and can be used when machining any material. In such cases, alternative measurement methods, such as monitoring the drive power of the main spindle motor, are not practical as they cannot detect minute deviations. Measuring acoustic emissions would also not deliver satisfactory results on a consistent basis when small workpieces are machined. Visual monitoring also has to be ruled out due to the use of coolant and high rotational speeds during machining. The new solution is compatible with selected standard turning tool holders offered by HORN. It does not require any adjustments to be made in the CNC system and can be used on any machine. The sensors can be replaced quickly and easily and using PTS results in lower production costs as well as increased production capacity.

HIGHER FEED RATES AND MONITORED PROCESSES.

SNEAK PREVIEW

COUNTDOWN TO EMO HANNOVER 2019

International manufacturers of production solutions will be presenting smart technologies at EMO Hannover 2019 from 16th to 21st September 2019.

Under the slogan "Smart technologies driving tomorrow's production", the world's leading trade fair for metalworking will showcase a comprehensive range of today's metalworking technologies – which form the beating heart of all industrial production. On show will be state-of-the-art machines and efficient technical solutions, product-related services, sustainable production solutions and much more besides. The focus at EMO Hannover will be machine tools for cutting and forming, as well as production systems, precision tools, automated material handling, computer technology, industrial electronics, and accessories. EMO draws specialists from every key sector of industry, including mechanical engineering and machine construction, the automotive industry and its suppliers, aviation and aerospace, precision engineering and optics, shipbuilding, medical technology, tool-making and mould-making, plus steel and lightweight construction. It represents the world's most important international meeting point in the field of production technology. EMO Hannover 2017 drew almost 2,230 exhibitors from 44 countries as well as around 130,000 specialist visitors from 160 countries.

"SMART TECHNOLOGIES DRIVING TOMORROW'S PRODUCTION"

HORN in Hannover

HORN will be presenting numerous new products and product enhancements on Stand A54 in Hall 5. Lothar Horn, Managing Director of Paul Horn GmbH: "EMO is the most important international platform for us to present our product innovations, enhancements and solutions to a specialist audience. In 2019, we are focusing on topics such as gear teeth. For example, we are widening our gear skiving options by offering our customers tools with indexable inserts. Grooving of stainless materials and digitisation in grooving applications will also be highlighted. Come and see us in Hannover and talk us through your challenges, tasks and requirements. I am sure that our discussions will be the start of a journey towards solutions and improvements."

Graphic of the HORN trade fair stand at EMO 2019.

The exhibition areas at EMO Hannover:

- **Machine tools**
- **Additive technologies**
- **Other machines**
- **Precision tools**
- **Components, assemblies, accessories**
- **Software, production and process automation**
- **Measurement technology and quality assurance**
- **Services**

Trainee programme at EMO

Employee training and recruitment for the smart factory is another primary focus at EMO Hannover. The special youth exhibition is a classic feature at trade fairs held by EMO organiser VDW (German Machine Tool Builders' Association). This exhibition will provide information on metalworking professions, requirements, training and career opportunities in the machine tool industry in Hall 25 throughout the duration of the trade fair. Around 7,000 young people are being invited together with trainers and teachers from technical and vocational schools. The training department from HORN will also be in Hall 25 on Stand No. A01 together with the company's trainees and will be providing an insight into various career profiles and educational projects.

REVIEW

HORN TECHNOLOGY DAYS 2019

TECHNOLOGY. TRANSPARENT.

The slogan for the HORN Technology Days 2019 was "Technology. Transparent". "We gave our visitors the opportunity to see our facilities first-hand and talk directly with us," says Managing Director Markus Horn. To this end, Paul Horn GmbH opened its doors to its customers and business partners for the seventh time from 5th to 7th June and this year, HORN had a particular reason to celebrate. HORN is 50 years old. "It was amazing to celebrate this anniversary together with our customers, partners and employees at the Technology Days and at the three evening events," says Lothar Horn. Politicians also wanted to express their congratulations. Minister for Economic Affairs Hoffmeister-Kraut: "Medium-sized businesses like Paul Horn are the backbone of our economy. The company is deeply rooted in the region – but it has also made a name for itself across all continents. For 50 years now Paul Horn has been a unique combination of global player, local mainstay, innovative spirit and social responsibility." The mayor of the city of Tübingen, Boris Palmer, also had a few kind words to say: "At 50 years old, Paul Horn GmbH is still relatively young, but it can look back on a very successful company history. In my opinion, the Swabian creative energy is one of the keys to their success. And when the city, companies and society work together, they can achieve things that would otherwise not be possible."

The programme also included eight exciting lectures with accompanying practical demonstrations for the 4,700 visitors over the course of the Technology Days.

An overview of the individual technical presentations:

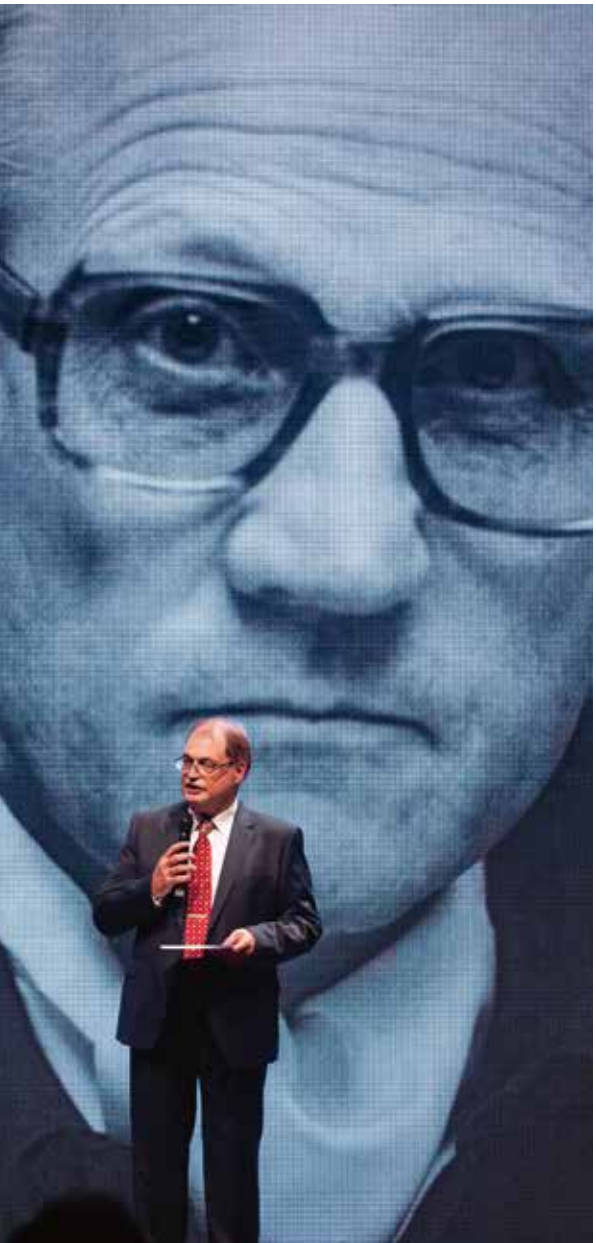
- **From powder to a finished component**
- **Getting right down to the atomic level**
- **Trends and outlook for the precision tool industry**
- **Machining sintered carbide**
- **Gear cutting taken to the next level**
- **Thinking outside the box**
- **Milling at the highest level**
- **Grooving and parting off with success**

The HORN Technology Days 2019 were rounded off by various exhibitions from an exceptionally wide range of customer industries and more than 50 partner companies.

THE NEXT HORN TECHNOLOGY DAYS WILL TAKE PLACE IN 2021.

Various exhibits from different customer industries were on show.

50 partner companies gave presentations over the course of the HORN Technology Days.



A total of 4,700 visitors had the opportunity to view the three HORN factories in Tübingen over the three days.

Managing directors Lothar and Markus Horn spoke about HORN's 50th anniversary. Over three evenings, around 750 guests were greeted.

A variety of entertainers were a highlight of the evening events celebrating the anniversary.

MATERIAL

SCREWS FOR ENDOPROSTHETICS

"When machining cobalt-chromium alloys, we demand very high performance from the tool due to the high material costs," explains Tibor Veres. The Managing Director of Hymec Fertigungstechnik GmbH from Norderstedt near Hamburg relies on tools from Paul Horn GmbH to machine superalloys. The precision tools from the Tübingen-based company are also used for shaping the hexagon socket of an implant screw made of cobalt-chromium. Together with HORN Technical Consultant, Thomas Wassersleben, they transformed this demanding machining task into a reliable process.

Medical screw made from cobalt-chromium.

"We see ourselves as a manufacturer that is able to accomplish high-precision machining to the highest quality," says Veres.

The company specialises in medical products, custom-made solutions and demanding low-volume production. Machining high-tech materials such as high-strength aluminium and titanium alloys, implant steels and superalloys like cobalt-chromium (CoCr) are part of Hymec's day-to-day tasks. The range of activities includes the production of precision-engineered components and complete assemblies as well as providing technical advice from concept and design to quality audits.

Close collaboration

Hymec has been working closely with HORN for 30 years. "The cooperation has been outstanding because they are always able to provide a cost-effective solution for our applications," explains Veres. The Managing Director attaches great importance to the selection of tools on offer and is always looking for the best tool solution for his machining tasks. He approached Wassersleben for technical support in the production of a hexagon socket in a screw made of CoCr.

MACHINING SUPERALLOYS IS PART OF EVERYDAY WORK AT HYMEC.

The screw is an implant and forms part of an artificial knee joint. Hymec manufactures the screws in various widths across the hex flats of 2.5 mm (0.0984"), 3.5 mm (0.118") and 5 mm (0.197"). The hexagon socket is machined to a tight tolerance so that the screw sits firmly on the hexagon key during insertion. The surface finish also needs to be of high quality as even small grooves and ridges can be a breeding ground for germs. The company produces around 5,000 screws like this every year.

Broaching is virtually impossible in series production

"Machining a hexagon in titanium is relatively easy by profile broaching. Broaching in series production in cobalt-chromium is virtually impossible, however, due to its high strength and the tool wear is significant," says Veres. Due to this, Wassersleben proposed producing the hexagon socket using the shaping process. The method offers high precision and high process reliability as the cutting geometry and the carbide substrate can be easily adapted to the material being machined. The first tests quickly discovered the required solution. "The shaping tool makes it possible to produce precise fits and the surface quality is very good," says Veres.

TIBOR VERES REPRESENTS THE SECOND GENERATION TO MANAGE HYMEC

Following its establishment by his father in 1972, the company quickly acquired a good reputation as a manufacturer that was able to accomplish high-precision tasks. Hymec is now a top supplier of orthopaedic implants as well as the instruments associated with them. The company's global customer base benefits not only from the high-quality turning, milling and erosion work it carries out, but also from the numerous services that guide customers through the product development process – from technical consultations to manufacture, all the way through to quality certification.

Shaping the hexagon socket with the N105 Supermini system.

HEXAGON SHAPING USING THE SUPERMINI SYSTEM.

The shaping process works as follows: A solid carbide tool from the HORN DD system drills a hole of 4.9 mm (0.193") diameter into the screw head. The drill with internal coolant supply is from the standard range with a geometry designed for stainless steels. The conical base of the blind hole is used as clearance for the shaping tool during machining. Due to the shallow height of the screw head, it was not possible to use an undercut as clearance. The tool moves along a programmed path to break the chips at the end of the flat. A Supermini N105 performs the shaping of the hexagon socket with a width across the flats of 5 mm (0.197"). The infeed of the individual strokes is 0.02 mm (0.000787"). After completing a surface, the chuck indexes to position the component for machining of the next surface. The process time of the shaping operation is around two minutes. A CNC lathe from Mori Seiki is used. The shaping process is performed using the movement of the tool turret.

100 screws per cutting edge

Veres is pleased with the performance: "The cutters are very precise and barely any correction is required after a tool change. We are also very happy with the tool life of 100 screws per cutting edge." The surface quality of the hexagon socket is so high that no further surface treatment is required.

The hardness and toughness of the cobalt-chromium required modifications to the cutting edge geometry, the carbide substrate, the coating, the machining conditions and the coolant. The hard particles in the alloy tend to form abrasive and crater wear and work hardening of the surface also presents a problem during machining. The tool cutting edge is sharp and not rounded as it is for titanium machining, but unlike titanium machining, the wedge angle is of more stable design. A tough micro-grain grade is used as the carbide substrate. The tool coating must be hard and heat resistant. Correct coolant delivery to the contact zone between the tool and the workpiece is another prerequisite for successful machining of the superalloy. The high material price also places stringent demands on the process reliability of the tools used.

Material for medical technology

Depending on the manufacturer, cobalt-chromium generally consists of 50–90 percent cobalt, 10–30 percent chromium and additional alloying components such as molybdenum, tungsten, niobium, manganese or silicon. CoCr is one of the highest performing materials for endoprosthetics. The material is particularly suitable for artificial knee joints and hip replacements. CoCr is also widely used in dental prosthetics. Due to its high biocompatibility with human tissue and its total corrosion resistance, CoCr alloys are predominantly used in medical technology despite its high price.

HORN has once again proved its expertise in the precision machining of superalloys with the implementation of the shaping process. Through its own research and development, the tool manufacturer is constantly designing new substrates, geometries and coatings for cost-effective processing of difficult-to-machine materials. The extensive vertical integration means that HORN has complete control over all process steps in tool production, from the powder to the coating.

THE WORKPIECE MATERIAL REQUIRED CUSTOMISATION OF THE CUTTING TOOL GEOMETRY.

A successful partnership for 30 years: The Managing Director of Hymec, Tibor Veres (middle) talking to an employee and HORN Technical Consultant, Thomas Wassersleben (right).

Drilling the screw head using the HORN DD system.

MATERIAL

COBALT-CHROMIUM – THE AMBITIOUS ALL-ROUNDER

Cobalt-chromium is considered a superalloy for good reason: it is hard, tough and has a low thermal conductivity. This makes it one of the highest performing alloys, particularly in the field of medical technology. However, machining subjects the tools to the most stringent requirements, both in terms of the result and the tool life.

All around the body, from a dental implant to an artificial knee joint – modern medical technology relies on endoprostheses made from cobalt-chromium alloys.

MEDICAL TECHNOLOGY SYSTEMATICALLY RELIES ON ENDOPROSTHESES MADE FROM COBALT-CHROMIUM ALLOYS.

Non-precious metal alloys are composed of about 50–90 percent cobalt and 10–30 percent chromium. Other additives include molybdenum, tungsten or silicon. The corrosion-free material excels in terms of its resistance under load and its biocompatibility. It has a lower thermal conductivity compared to precious metal alloys. Expert machining of the components is another essential factor to achieve maximum performance in the final product. This is because a perfect synergy of material, milling or turning strategy and the tool can create complex, robust and very delicate parts from this material.

A tough nut to crack

The positive properties of cobalt-chromium alloys are also the biggest hurdle when it comes to efficient machining. When machining the material (hardnesses between 35 and 45 HRC), high temperatures can occur at the point of cutting. In combination with the feed rate and cutting speed, work hardening can quickly occur on the surface. The tool becomes blunt more quickly and the scrap rate increases. At the same time, surface finish is a decisive quality for the abrasion and frictional properties of the implant. The demands on the process reliability of the cutting tools, their performance and precision and, last but not least, tool life are correspondingly high.

Tool: sharp, cool and durable

The tools used therefore need to be true all-rounders – just like the material itself. Firstly, it is important to keep heat generation during machining as low as possible. This can be achieved through efficient internal cooling of the most frequently used tools or by reducing the cutting forces with optimum synergy of substrate, geometry and coating. This is because particularly sharp cutting edges, as might be used for optimum machining at a low feed rate, are at risk of breaking due to the hardness of the material. And even the smallest irregularities of the cutting edge can be disastrous for the machining result. This should be counteracted by an appropriate coating that is thin enough that the cutting edge remains sharp and thick enough that fine cracks and tool breakage are prevented even during demanding milling operations. Negative rake angles also stabilise the tool.

Solutions for a smooth result

HORN offers a particularly wide range of products for machining cobalt-chromium with the solid carbide milling cutters in its DS system range. The shank and toroidal milling cutters with a cutting edge diameter from 1.5 mm (0.0591") are exceptional due to their temperature resistance and low thermal conductivity of the substrate. The special geometry with different helix angles and a variable pitch ensures a smooth cut and low vibrations. This ensures precise machining of the workpiece and protects the tool and machine. The coating also plays an important role when it comes to tool life. HORN opts for fine, precise, semi-rounded finishing of the cutting edge. In order to minimise reworking of the finished implant or joint, HORN's solid carbide milling cutters are absolutely precise and have achieved a particularly good surface quality in recent tests: The finish of the machined cobalt-chromium alloy was between 0.2 and 0.3 Ra. Subsequent polishing is therefore kept to a minimum.

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