

FACTS



HIGH-TECH ON SMALLEST CUTTING EDGE

Optimum coating of the smallest tools Page 4/5

CONFIDENCE STRENGTHENED

MI-TECH TOOLING AND CEMECON:
LONG-TERM COOPERATION IN THE USA
Page 6–8

TITANIUM: HIGH-TECH MATERIAL WITH ENORMOUS POTENTIAL

COORDINATED PREMIUM TOOLS
FOR EFFICIENT MACHINING
Page 16–19

“Defects in the coating – known as droplets – are particularly fatal with **MICRO TOOLS**, as they have a much more extreme effect in these tiny dimensions than with larger tools. Consequently, **UNCOMPROMISING SMOOTHNESS** is an absolute requirement and therefore, the **HiPIMS PROCESS** – in which no droplets can occur due to the process – is the key to our **SUCCESS!**”

Ramesh Agarwalla, Director at CTC Praezision Tools, India
(further information on coating micro tools on page 4/5)



IN THIS ISSUE

- 2 **HiPIMS FOR MICRO TOOLS**
Ramesh Agarwalla,
Director at CTC Praezision Tools, India
- 4–5 Cover story:
HIGH-TECH ON THE SMALLEST CUTTING EDGE
Special work processes ensure quality
when coating micro-tools
- 6–8 **CONFIDENCE STRENGTHENED:
FROM COATING SERVICE
TO IN-HOUSE COATING**
Mi-Tech Tooling and CemeCon intensify
longstanding cooperation in the USA
- 9–11 **THE SAME TOP RESULTS EVERY DAY
ACHIEVED WITH CEMECON**
Premium coatings for cutting inserts:
Reliably reproducible performance and quality
- 12–15 **SMOOTH TRANSITION TO
IN-HOUSE COATING PRODUCTION**
With two HiPIMS coating system HORN USA takes
its production to the next level
- 16–19 **FOCUS ON THE “SUPER MATERIAL” TITANIUM**
Mastering the challenges of machining
with premium coatings
- 20 **TEST THE BEST!**

Imprint

Published by

CemeCon AG
Adenauerstraße 20 A4
52146 Würselen
Germany
Phone +49 24 05 44 70 100
Fax +49 24 05 44 70 399
www.cemecon.de
info@cemecon.de

Editor

KSKOMM GmbH & Co. KG
Jahnstraße 13
56235 Ransbach-Baumbach
Germany
Phone +49 2623 79901-60
www.kskomm.de
info@kskomm.de

Circulation of English version: 4,200
Circulation of German version: 4,900

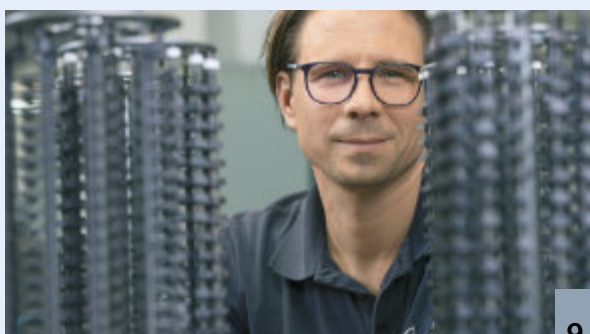
Photographs

Photographs unless otherwise
indicated: CemeCon.
Cover: IDI Precision Machinery Ltd.

All rights reserved. Reprints, including extracts,
only with permission of CemeCon AG.

Data Protection Information

If you have received this newsletter by mail or
electronically, CemeCon AG has stored your ad-
dress data as specified in accordance with Art. 6
Para. 1 f GDPR in order to inform you about our
products and services. If you no longer want to
receive this newsletter or wish to make use of
your data protection rights (rights to informa-
tion, correction, deletion, limitation of process-
ing, data transferability), please contact us:
Phone: +49 24 05 44 70 100 or
e-mail: informed@cemecon.de.



9–11

HiPIMS coatings enable better performance,
faster processing, longer tool life and greater process
reliability – reliably every day

HIGH-TECH ON THE SMALLEST CUTTING EDGE

Miniaturization is setting trends – from dental implants to electronic components and clockworks to micro ball bearings. The demand for ever smaller components leads to ever smaller precision tools and ever tighter tolerances. As a consequence, the coating must also be able to measure up to these developments. What counts here is not only that the coatings combine minimal coating thicknesses with outstanding properties, but also that work processes and handling are adapted to tools that are only a few millimeters or even tenths of a millimeter thick. Tool manufacturers can find this comprehensive know-how from the coating experts at CemeCon.

When tolerances in the micrometer range have to be maintained, there are high demands on process reliability, tool life and precision. Ultra-thin and smooth HiPIMS and diamond coatings ensure that micro tools achieve the required performance in everyday machining. And if you have your tools coated in one of the CemeCon coating centers, you can be sure that your mini tools and micro tools are in good hands.

This is made possible by a passion for perfection and attention to detail, which is reflected in the sophisticated work plans. Quality is the sum of many building blocks and so every work step is documented. "We have developed coordinated workflows, processes and devices for handling the delicate micro-tools to

enable our employees to work reliably. Examples include special holders for the micro tools during charging or the specially developed cleaning system for evaporating cooling channels. No system available on the market convinced us. That is why CemeCon Production Engineering has built a system that is perfectly suited to micro-tools. To avoid direct contact with fingers, our colleagues also use tweezers and wear gloves during handling," says Manfred Weigand, Product Manager Round Tools at CemeCon, explaining some of the adaptations in CemeCon production specifically for micro tools.

Absolute cleanliness is particularly important when coating micro-tools. Even the smallest particles on the tools affect the coating and

therefore the quality. This is why CemeCon places a special focus on cleaning: This applies not only to the tools, but also to cladding, charging material and, quite simply, the entire production process. Particularly gentle cleaning of the micro-tools during pre-treatment ensures an excellent coating result. CemeCon's diamond coating department also has another special feature: tools are processed in the clean room – protected from external influences.

Why is CemeCon so good at coating micro-tools? CemeCon has over 35 years of experience in the coating of cutting tools and has specialized exclusively in this field. This means that all procedures and processes are tailored to precision tools – whether HiPIMS or diamond coat-



© tashatuwango/AdobeStock



© IKS/IMM GmbH & Co.KG



© NorGal/iStock

ings. This comprehensive expertise in dealing with tools makes it easier to adapt the processes to the “minis”. “We also started coating small tools very early on – when micro tools were still rather exotic. Sputtering is our technology of choice and – just like HiPIMS as its further development – is perfect for coating miniature tools. The traditional arc process is out of the question here. We have been able to gain experience in this field over many years,” adds Manfred Weigand.

HiPIMS AND DIAMOND – CUSTOMISED COATINGS FOR MICRO TOOLS

“HiPIMS is perfect for micro tools”, says Ramesh Agarwalla, Director at CTC Praezision Tools, India – an expert in micro tools for PCB production or micro metal cutting tools for dental and medical technology. “Defects in the coating – known as droplets – are particularly fatal with micro tools, as they have a much more extreme effect in these tiny dimensions than with larger tools. Consequently, uncompromising smoothness is an absolute requirement and therefore, the HiPIMS process – in which no droplets can occur due to the process – is the key to our success!”

The ultra-thin HiPIMS coatings reproduce complex tool geometries one-

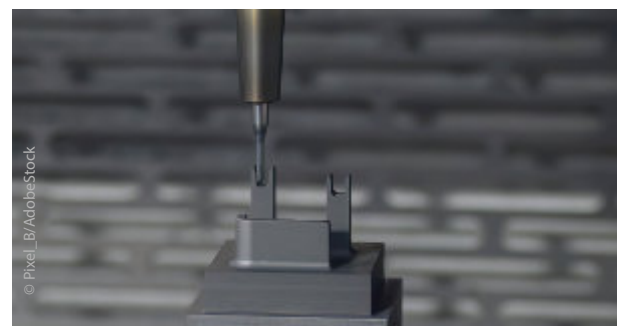


Processes specially adapted to the handling of micro-tools ensure quality at CemeCon

to-one. Christoph Schiffrers, Product Manager Technology at CemeCon: “If you want to apply coatings to the filigree geometry of a micro-tool in an adhesive and process-reliable manner, you need adapted residual stresses. This is the only way to homogeneously coat fine cutting edge geometries. With our HiPIMS technology, the residual stresses can be controlled and significantly reduced – perfect for sharp cutting edges on micro tools.”

The high-precision multilayer CCDia® coatings are ideal for high-end micro

tools, for example for the production of highly complex graphite electrodes or dental implants. Production using the hot filament process ensures thin layers with a homogeneous layer thickness distribution within narrow tolerances – even with complex, delicate geometries. “To ensure that the high accuracy of the tools is also guaranteed after coating, we coat precision tools to the desired final dimensions on request – and this can be reproduced at any time, including documentation,” adds Manfred Weigand.





**MI-TECH TOOLING AND CEMECON:
LONG-TERM COOPERATION IN THE USA**

CONFIDENCE STRENGTHENED

Mi-Tech Tooling, Inc., a cutting insert expert for the oil and gas industry in the USA, and the coating experts from CemeCon, Inc. in Horseheads, N.Y. have been working together for many years. This has led to a strong trust in CemeCon technology at the family-owned company from Cass City, MI. Mi-Tech has been able to secure an unbeatable advantage for its cutting inserts using CemeCon coatings in various thicknesses. Now the tooling experts are taking the next step and are raising their production to the next level with their own CC800® HiPIMS coating system. Thanks to training and support from CemeCon, Inc., in-house coating production was up and running within days of installation.

Since the first wells were drilled in Texas at the beginning of the 20th century, oil has been the lubricant of the economy and the basis of the American way of life. Mi-Tech sup-

ports the American lifeline with carbide cutting inserts to produce internal and external pipe threads. Reliability, reproducibility, and trust are essential elements of Mi-Tech's

mission and have helped the family-owned company to operate profitably and successfully for 20 years. "The energy sector requires tools that reliably achieve high cut-

ting volumes with good surface quality. Short cycle times and long tool life are also essential from an economic point of view," says Joseph Langenburg, President and company founder of Mi-Tech Tooling, describing the requirements for the cutting inserts.

TAKING PRODUCTION TO THE NEXT LEVEL

Mi-Tech has been working closely with CemeCon for over 15 years, relying on their experts to determine the best coating solutions to protect the cutting inserts against wear and improve performance. Joseph Langenburg: "We can always rely on the coatings and advice from CemeCon. This applies both to the tried-and-tested sputter coatings, which we have been using successfully on our indexable inserts for many years, and the new high-performance HiPIMS coatings."

The team at Mi-Tech has now deepened their trust and partnership with CemeCon by purchasing a full turnkey package highlighted by the CC800* HiPIMS. The unit combines all the advantages of classic DC sputtering technology with the possibilities of the latest HiPIMS technology. Regardless of a customer's needs, Mi-Tech can select the best PVD coating solution to quickly react to all requests and requirements. Coating thicknesses of 1–12 µm are possible. Only with HiPIMS technology can "extra-thick layers" be realized. With conventional coating processes, the layer thickness is often limited to just 3 µm due to excessive residual stresses. With CemeCon



"The **TRAINING** at CemeCon and also at our production facility enabled us to quickly get started with **REAL COATING PRODUCTION**. We were able to coat the first batch immediately following installation. We are delighted with how **QUICKLY AND EFFICIENTLY** the system was implemented."

Brad Langenburg, Vice President of Mi-tech (right), pictured with Joseph Langenburg, President (left), Yarnell Bouverette and Grant Gnagey, both coating center operators

HiPIMS, the residual stresses can be controlled and the layer thicknesses multiplied.

SUPPORT ALL ALONG THE LINE

Working with CemeCon implies the benefit that the coating experts develop a complete package consisting of substrate pre- and post-treatment, coating system and all other necessary peripherals – plus the full-service package. "The decision to use our own coating technology was a very special step. We have thus set the course for the future – especially in view of the upcoming genera-

tional change. It was important for us to have a partner at our side who not only supplies us with the best technology, but also accompanies us from the very first step, trains and supports our employees and supports us in producing our successful coatings ourselves as quickly as possible," says Joseph Langenburg.

CemeCon has a decisive advantage when it comes to integrating the processes and workflows quickly and smoothly into the production of a tool manufacturer: CemeCon uses the same coating and peripheral systems in its own production on a

daily basis. This is why the team knows the customer's in-house coating line, processes and workflows down to the smallest detail and can therefore support them so well. This ensures a seamless transition for Mi-tech's customers, as Mi-Tech produces completely identical coatings with its own coating system as CemeCon previously did through coating service.



Mi-Tech was able to coat the first batch shortly after installing the HiPIMS system

PRODUCE YOUR OWN COATINGS QUICKLY AND EASILY

Ryan Lake, Sales Manager at CemeCon Inc.: "Our experience has shown us that the key to a successful transition from coating service to in-house coating comes down to one

thing – consistency. There cannot be any change in performance once the switch is made. We have optimized our workflows and processes over the years so that they are easy to

learn and understand. Customers go through the same training we put our own staff through when they first start. It is essential that we successfully pass on our knowledge so that tool manufacturers can quickly gain the confidence and ability to master the coating process. In addition, our experienced technicians are always ready to answer any questions a customer may have about their coating system or processes."

Mi-Tech Tooling, Inc.



Founded in 2004 by Joseph Langenburg in a rented shed with three second-hand machines and two employees, Mi-Tech

Tooling Inc. has developed into a leading manufacturer of specialized carbide cutting inserts and solid carbide cutting tools within just a few years. Many years of experience in tool grinding and a commitment to innovation and state-of-the-art technology enable the family-owned company to fulfil the highest quality requirements and provide first-class service.

Today, Mi-Tech Tooling employs 15 people in a 10,000 square foot facility in Cass City, Michigan. The location provides room for further growth to meet the needs of customers in a variety of industries with state-of-the-art technology. All manufacturing is done in-house in accordance with ISO 9001:2015.

<https://mi-techtool.com/>

"The on-site training at CemeCon, Inc. and also at our production facility enabled us to quickly get started with real coating production. We were able to coat the first batch immediately following installation. We are delighted with how quickly and efficiently the system was implemented," says Brad Langenburg, Vice President at Mi-Tech. "The ability to provide premium coatings, improve lead times, and reduce production costs for our cutting tools is a huge advantage for us, and more importantly, our customers. The investment in our own coating line will pay for itself."

HIGHEST QUALITY, FAST RESPONSE TIMES, RELIABLE DELIVERY

BEST PERFORMANCE FOR CUTTING INSERTS EVERY DAY

New high-performance materials, the transition from combustion engines to alternative drive concepts, high innovation and cost pressure – in order to master these and future challenges, machining companies and tool manufacturers must identify and exploit optimization potential. HiPIMS coatings enable better performance, faster machining, longer tool life and greater process reliability. Cutting inserts with CemeCon coatings achieve such top performance reliably and reproducibly every day. Testing is welcome!



If you want to succeed in promising markets such as e-mobility, heavy-duty machining, aerospace and tool and mold making, you have to reliably deliver the best results every day. With CemeCon, tool manufacturers have the right partner by their side.

PERFORMANCE, QUALITY,
RELIABILITY,
REPRODUCIBILITY

Excellent chip flow and better surface quality with longer tool life and often higher cutting parameters – HiPIMS coating materials guarantee

the best performance. To ensure that the coated cutting inserts deliver such top performance, the parameters and work steps such as coating material, coating thickness, pre-treatment and finishing are precisely adapted both to the tool and the application.

The quality of the coating is outstanding. Regular checks of the working materials and process steps as well as experienced and well-trained employees reliably guarantee consistently high quality. Inka Harrand, Product Manager Cutting Inserts: "We have also developed processes specifically for cutting inserts that are precisely tailored to the requirements of this tool group. The coating materials are also always



Personal contacts ensure high service quality

adapted to the special requirements."

The excellent quality is reliably reproducible – with short delivery times. Strictly separated batches, individual production processes and precise documentation ensure that the successful formula is always available worldwide in all CemeCon coating centers with equally perfect results. On top of this, individual support and advice from a contact person who is familiar with all the details of a customer is a matter of course for the coating experts.

This combination of performance, quality, reliability and reproducibility opens the way to new markets.

TOOL AND MOLD MAKING: THICK LAYERS FOR MILLING STEEL

In order to maintain a leading global position in tool and mold making, the economical production of molds, punches and dies to the highest quality standards is an absolute must.

One of the most important technologies in tool making is milling. It enables high-quality results to be achieved with high productivity and flexibility. Innovative tool solutions for tool and mold makers are in demand. FerroCon® with 6 µm coating thickness and FerroCon®Quadro with an impressive 12 µm coating thick-



ness are perfect for roughing operations on steel molds. Thanks to the high coating thickness, the cutting inserts achieve a very good metal removal rate, which automatically increases productivity.

HEAVY-DUTY MACHINING: HIGH LAYER THICKNESSES FOR HIGH CUTTING VOLUME

FerroCon® with a coating thickness of 6 µm and FerroCon®Quadro with a coating thickness of 12 µm are the

New for cutting inserts: SteelCon®

The silicon-doped HiPIMS coating material SteelCon® is ideal for machining stainless and hardened steels above 50 HRC. The high silicon content enables economical machining under extreme conditions. SteelCon® is very wear-resistant and has a high thermal stability. The homogeneous wear behavior guarantee maximum process reliability.



Material:
X2CrNiMo17-12-2 (1.4404)

Tool:
**Milling tool
Ø 40 mm with 3 inserts
RPMT1204**

$v_c = 270 \text{ m/min}$

$n = 2,200 \text{ rpm}$

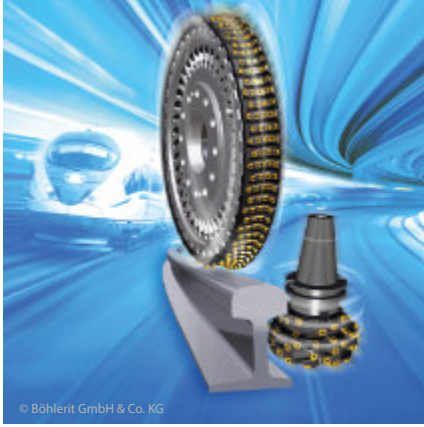
$f_z = 0.45 \text{ mm}$

$a_p = 1-2 \text{ mm}$

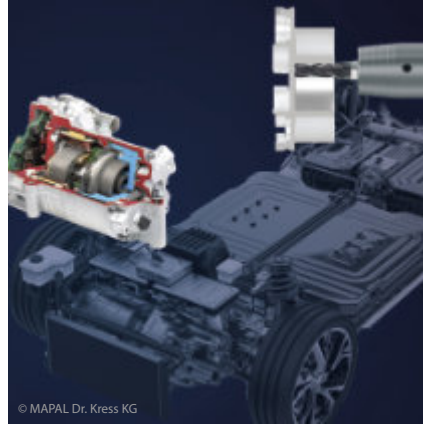
$a_e = 5-15 \text{ mm}$

Tool life: **30 min**





© Bohlerit GmbH & Co. KG



© MAPAL Dr. Kress KG

AluCon®, significant leaps in performance are possible.

E-MOBILITY:
NEW PATHS IN
ALUMINUM MACHINING

There are far fewer machining tasks for e-mobility than in traditional automotive engineering. In addition, mainly aluminum alloys are machined. "Tools tailored to the requirements are the solution to securing market share here. AluCon®-coated cutting inserts can be a good alternative to uncoated carbide," Inka Harrand is convinced. Practical examples show that when milling aluminum with AluCon®, the tendency for built-up edges is significantly reduced and, as a result, the service life of the cutting inserts is extended.

first choice for achieving the required maximum wear volume, particularly in the heavy-duty machining of rails, switches, pipes and crankshafts as well as in the rotary skiving of cast iron and ferrous materials. This is because every micrometer is decisive for the economic efficiency of the process in such roughing operations. Inka Harrand: "Higher coating thicknesses significantly extend the service life of cutting inserts – the key to economic efficiency. The correlation in such applications is almost linear – and this is where FerroCon® with a coating thickness of 6 µm and FerroCon®Quadro with a coating thickness of 12 µm come into play."

AEROSPACE:
MACHINING TITANIUM ALLOYS
ECONOMICALLY

In aircraft construction, processes are now being put to the test in many areas in order to reduce costs and produce more economically. This is an opportunity for tool manufacturers to gain a foothold in the industry with high-performance solutions. A good example is titanium alloys. However, machining this lightweight material is anything but simple and requires coordinated cutting inserts. With the HiPIMS coating materials InoxaCon® and

HiPIMS coating materials for cutting inserts (CI)

FerroCon®

for unalloyed and alloyed steels and cast iron

Composition:
AlTiN-based

Max. operating temperature:
1,100 °C

Color:
Anthracite

Coating thickness for CI:
3 µm, 6 µm and 12 µm



InoxaCon®

for stainless, high-alloy steels, titanium, nickel-based alloys and difficult to machine materials (CrCo)

Composition:
TiAlSiN-based

Max. operating temperature:
1,100 °C

Color:
Red gold

Coating thickness for CI:
3 µm and 6 µm



AluCon®

for aluminum, titanium, copper and other non-ferrous metals

Composition:
TiB₂-based

Max. operating temperature:
1,000 °C

Color:
Silver

Coating thickness for CI:
2 µm



SteelCon®

for hard machining, stainless steels, titanium and titanium alloys

Composition:
TiAlSiN-based, high silicon content

Max. operating temperature:
1,100 °C

Color:
Red gold

Coating thickness for CI:
3 µm



HORN USA EXPANDS PRODUCTION WITH ITS OWN HiPIMS COATING SYSTEMS

SEAMLESS TRANSITION



© HORN USA

In 70 countries, the top players in automotive, chemical, aerospace, medical technology, and tool and mold making industries trust HORN's precision tools to drive their success. The USA is one of the most significant markets for the cutting tool industry and is becoming increasingly so. In its quest for perfection and enhanced service, HORN USA has now integrated a state-of-the-art coating line with two CC800® HiPIMS systems into its production process. This allows HORN to supply US customers with customized solutions for their individual requirements rapidly. The trust built over years of collaboration between HORN and CemeCon in Europe and North America has paved the way for a seamless transition to in-house coating for HORN USA.

HORN's trademark is delivering high-quality precision tools for demanding machining operations with short delivery times, which is where others struggle. To make this guarantee worldwide, you need high-performance production facilities with cutting-edge technology around the globe – especially in key markets such as the USA. At the main plant in Tübingen, Germany the unique HiPIMS technology from CemeCon has long been one of the cornerstones of HORN's success. Since 2004, HORN USA has had its precision tools coated by the experts at CemeCon, Inc. Now the production in Franklin, TN has been expanded and enhanced with in-house coating expertise to be able to support the US market quickly and efficiently with fully optimized products.

THE PERFECT COMBINATION FOR IN-HOUSE COATING

“It was clear to us that if we were to switch to our own coating production, we had to produce the same coatings ourselves, from day one. We needed to produce the same quality as before using CemeCon's coating service and we needed the new products from Tübingen to be easily duplicated in the US. In other words, we needed the same technological capabilities as in Germany. And the training to not only integrate the coating technology into US production, but also to fully take advantage of its potential,” says Chad King, General Manager at HORN USA.



“For just over a year, we’ve been revolutionizing our **COATING PRODUCTION** in Franklin, thanks to our **DYNAMIC PARTNERSHIP** with CemeCon. By blending cutting-edge technology with unparalleled process expertise and **SYNCHRONIZED TRAINING**, we’ve achieved a flawless transition to in-house coating. From day one, we’ve delivered **EXCEPTIONAL QUALITY** and gained the power to **INNOVATE OUR COATINGS** and tailor them to our exact needs.”

Chad King, General Manager at HORN USA

HORN looked for and found a solution with its long-standing partner CemeCon. HORN invested in a turnkey coating line – consisting of two HiPIMS coating systems, substrate pre- and post-treatment equipment, and all other necessary peripheral systems – with technology “made in Germany” and training “made in the USA”. Chad King comments: “With CemeCon as our technology partner, we have received the all-inclusive turnkey package: First, the technical equipment and sec-

ond, the full customer service package complete with knowledge transfer, training for our employees, and support from the coating experts from Horseheads in collaboration with our German colleagues. This combination is perfect and allows us to do an outstanding job!”

UNIQUE KNOWLEDGE TRANSFER ENSURES A SMOOTH START

When integrating an in-house coating line into the production,

CemeCon has a decisive advantage: The experts use the same technology in their coating service every day – in all coating centers around the globe. As a result, the team at CemeCon, Inc. knows the coating and peripheral systems, processes and workflows down to the smallest detail and provides its customers with optimum support. “HORN and CemeCon have a decades-long partnership – both here in the USA and in Germany. This means we know HORN’s requirements and high-end quality level inside out,” says Ryan Lake, Sales Manager at CemeCon, Inc.

The operation of the HiPIMS coating system is self-explanatory; the key to the success of in-house coating production lies in understanding the workflows and the entire process from start to finish. Over the years, CemeCon has optimized the processes so that they are easy to learn and understand. “We pass on our knowledge and experience during training at our coating center in Horseheads, NY or at the customer’s site. The training is identical for customers and our own employees. We know from our own experience that our training quickly and reliably imparts the know-how needed to master the coating process successfully.

From day one, HORN USA was able to deliver the same quality as CemeCon with its own coating line





© HORN USA

The transition to in-house coating production went completely smoothly at HORN USA – thanks to CemeCon training

And if there are still questions, we continuously support our customers whenever it is needed,” says Eli Roberts, Technical Manager at CemeCon, Inc.

SEAMLESS CONTINUATION OF QUALITY

Chad King: “For just over a year, we’ve been revolutionizing our coating production in Franklin, thanks to our dynamic partnership with CemeCon. By blending cutting-edge technology with unparalleled process expertise and synchronized training, we’ve achieved a flawless transition to in-house coating. From day one, we’ve delivered exceptional quality and gained the power to innovate our coatings and tailor them to our exact needs.”

HORN Group



Paul Horn GmbH, based in Tübingen, Germany, has been developing and producing grooving, longitudinal turning and slot milling tools with impressive performance and reliability since 1969. In 70 countries on all continents, companies in the automotive, chemical, aerospace, medical technology and tool and mold making industries produce with precision tools from HORN. The success of the high-performance tools is based on four pillars: an in-house research and development department, in-house coating technology, in-house carbide production and in-house manufacturing technologies. More than 25,000 standard tools and over 150,000 special solutions speak for themselves. Thanks to cooperation with international locations and numerous partners on all continents, HORN can reliably support customers worldwide.

More than 25,000 standard tools and over 150,000 special solutions speak for themselves. Thanks to cooperation with international locations and numerous partners on all continents, HORN can reliably support customers worldwide.

www.horn-group.com

TITANIUM: HIGH-TECH MATERIAL WITH ENORMOUS POTENTIAL

Initially reserved for the engines and airframes of military reconnaissance aircraft, titanium has long since become an integral part of our everyday lives thanks to its outstanding properties. It is primarily used in high-tech applications and luxury products – from components in civilian aircraft to smartphone and laptop housings, sports equipment such as golf clubs, watches and jewelry and even medical implants. However, machining the light metal has its pitfalls. But with the right machining strategies and co-ordinated cutting tools, cost-effective processes are possible here, too.

“Titanium is a kind of ‘super material,’” says Prof. Dr.-Ing. Jan Dege, Professor of Production Engineering at the Institute of Production Management and Technology (IPMT) of Hamburg University of Technology (TUHH). “Titanium alloys are particularly popular for lightweight constructions such as structural components in aviation due to the favorable ratio of strength to specific

weight. The light metal is almost as strong as tempered steel, but over 40 percent lighter. Titanium is also highly heat-resistant and very corrosion-resistant. An oxide layer passivates the metal, giving it high corrosion resistance to aggressive media such as chlorinated gases, seawater, alkaline solutions, alcohol and cold acids. Another invaluable advantage is its biocompatibility. Implants

made of titanium generally do not trigger any immunological rejection reactions.”

Titanium is still a relatively young material. It was discovered in 1791 by the Englishman William Gregor and could only be produced on a larger scale from 1944. Since then, it has begun its triumphal march around the world. Twenty years ago,

Due to the favorable ratio of strength to specific weight, titanium alloys are often used for lightweight constructions in aviation





“All in all, the major challenges involved in **MACHINING TITANIUM** sound daunting at first. However, those who know all the parameters have enormous advantages here. The **FINE TUNING** of carbide substrate, tool geometry, coating and CNC process design to the alloy and machine tool used ensures **ECONOMICAL MACHINING PROCESSES.**”

Prof. Dr.-Ing. Jan Dege,
Professor of Production Engineering at IPMT of TUHH

around 60,000 tons of metallic titanium were processed worldwide, 10 years ago it was 143,000 tons and today it is estimated that almost 300,000 tons are consumed. Furthermore, titanium is not a rare metal: with a share of 0.565 percent, it is the ninth most common element in the earth's crust. This means that it is generally readily available.

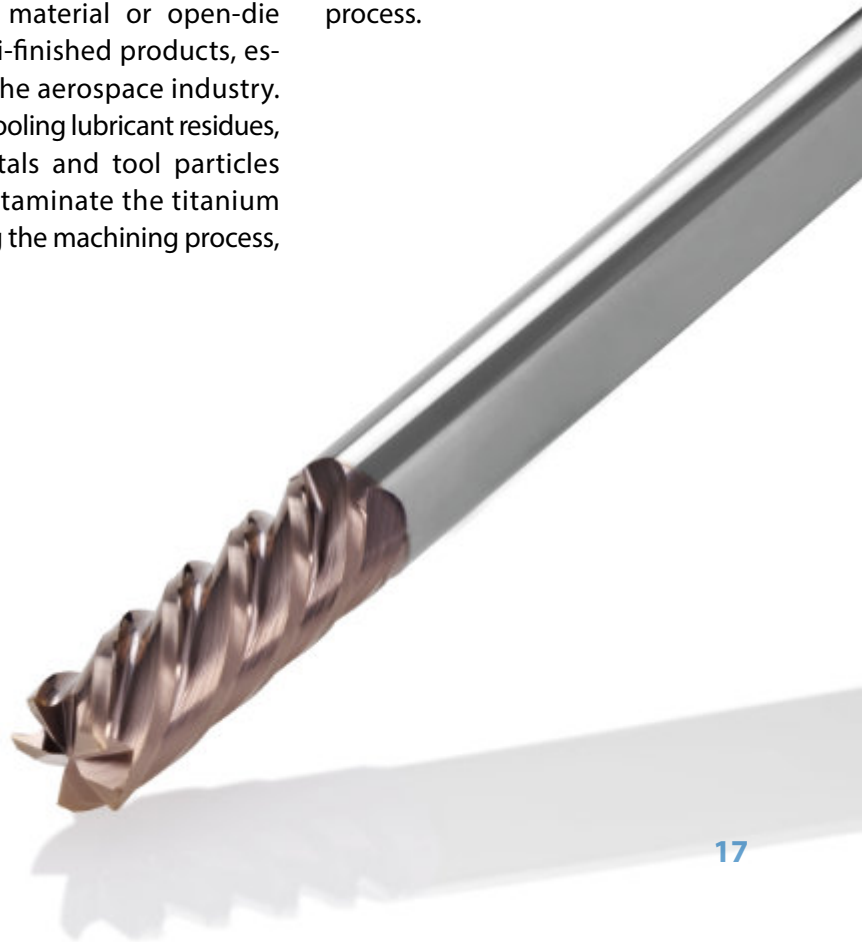
ENERGY-INTENSIVE PRODUCTION

So why is it often only used in high-tech and luxury applications? “Titanium is very expensive. This is due to the complex manufacturing process,” explains Jan Dege. “The material is rarely found in its pure, metallic form. It has to be extracted from the minerals ilmenite or rutile using the energy-intensive Kroll process and further processed into a technically usable metal through repeated remelting. This means that the production of the titanium alloy Ti-6Al-4V requires around 108 kWh per kg. This is six times as much energy as is needed for the production of aluminum alloys (17 kWh/kg). Not

only is the raw material price correspondingly high, but also the CO₂ footprint of titanium.”

This makes the recycling of titanium both economically and ecologically extremely sensible. However, there are problems here: Today, numerous titanium components are milled from plate material or open-die forged semi-finished products, especially in the aerospace industry. Oxidation, cooling lubricant residues, foreign metals and tool particles heavily contaminate the titanium chips during the machining process,

which makes recycling difficult. This is why the chips are often used as an additive in steel production instead of being recycled to a high standard. Pure titanium, on the other hand, can be completely returned to the material cycle. Recycling is carried out by remelting, often together with original titanium from the Kroll process.



SOPHISTICATED MACHINING

Another reason for the limited use of titanium lies in its challenging machining requirements: titanium is one of the materials that are diffi-

cult to machine. The first hurdle in machining is a combination of high tensile strength and low thermal conductivity. The former leads to high mechanical stresses on the tool cutting edge, the latter to a pro-

nounced thermal load on the tool. This is because, unlike with steel, very little heat is dissipated via the workpiece and chips. At the same cutting speeds, the temperatures when machining titanium are sometimes twice as high as when machining steel. "In order to reduce the thermal load on the cutting wedge, the cutting speeds are usually reduced to $v_c = 60\text{--}90$ m/min. In addition, the relatively low modulus of elasticity leads to springback on the flank face and thus to additional frictional heat. This significantly limits the productivity of the cutting processes," says Jan Dege.

Manfred Weigand, Product Manager Round Tools at CemeCon, adds: "The tendency of titanium to adhere, especially at high temperatures, makes machining even more difficult. Cold welded-on titanium sticks to the tool cutting edges. If it is torn off with the next chip, not only does the adhesion come loose, but a piece of the coating and substrate may also come off. This results in micro-chipping on the cutting edge, which in the worst case can lead to tool failure, but at least means increased wear."

Furthermore, not all titanium is alike: In addition to the widely used α - β alloy Ti-6Al-4V, near- β alloys such as Ti-5Al-5Mo-5V-3Cr or Ti-10V-2Fe-3Al are increasingly being used in the aerospace industry. Due to their high strength and hot hardness, these lead to even higher tool wear compared to Ti-6Al-4V and result in a further reduction in cutting speed and feed rate. Other titanium alloys are used in medical technology and implantology, for example.

IPMT of TUHH



The Institute of Production Management and Technology (IPMT) of Hamburg University of Technology is dedicated to researching fundamental production challenges and

developing models, methods and processes for industrial application. The two departments of the institute work closely together. The Production Management department focuses in particular on the organization of production processes. Innovative processes for the machining of modern industrial materials, such as CFRP and titanium, are researched in the Production Technology department, whereby the institute stands out in particular for its capacity for machining large workpieces.

Prof. Dr.-Ing. Jan Dege has held the Chair of Production Engineering since 2022. Previously, he held various management positions at Premium AEROTEC GmbH, where he was responsible for the development and design of tools, processes and machines for the high-performance machining of structural components for aviation – and often acted as an interface between university research and industrial application. His current areas of research include machining production processes, particularly for the aerospace industry, such as manual and semi-automatic drilling in composite materials (CFRP, aluminum, titanium), trimming and grinding of components made of fiber-reinforced plastics and high-performance milling of aluminum and titanium alloys. He is also a member of the board of the Manufacturing Innovations Network (MIN) and an expert for the German Research Foundation (DFG) and the Industrial Collective Research (IGF).

<https://www.tuhh.de/ipmt/das-ipmt>



Titanium is now an integral part of our everyday lives, for example in medical and dental technology. However, machining is anything but simple and requires customised premium tools

ALL PARAMETERS PRECISELY IN TUNE

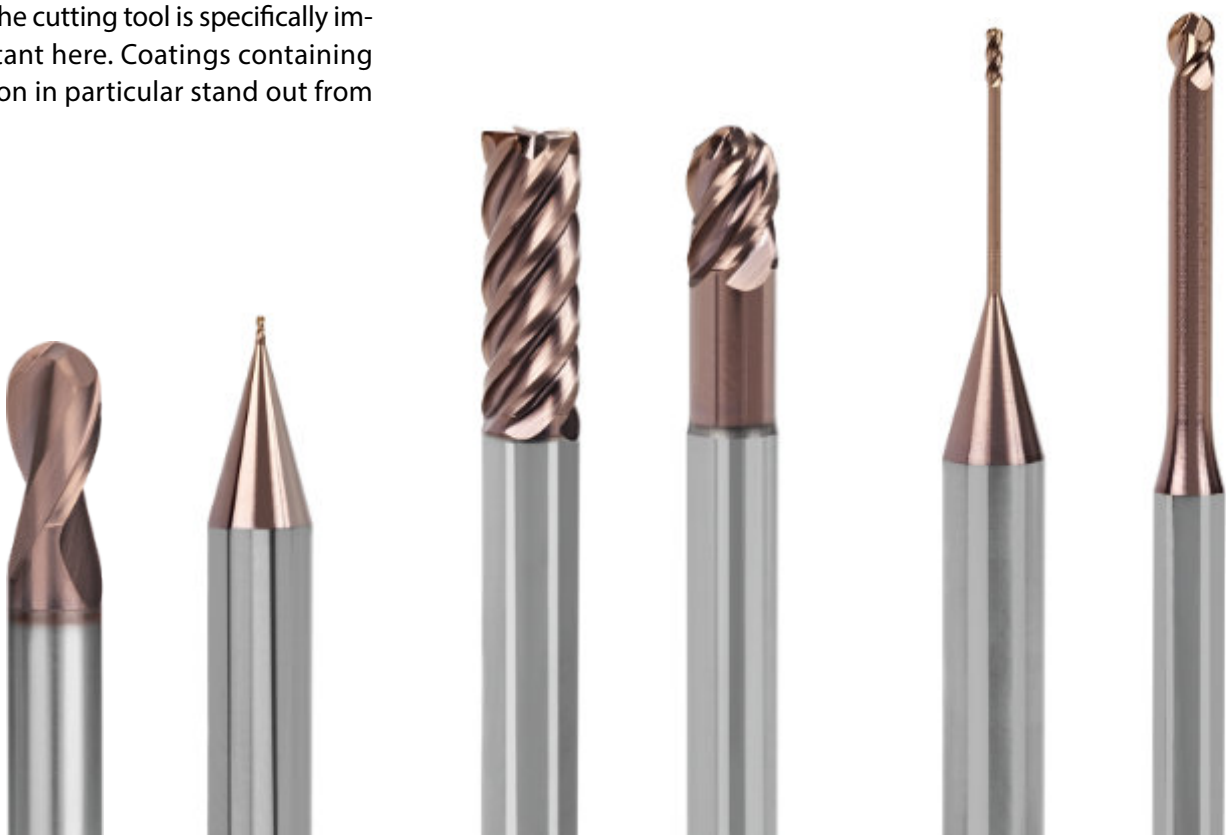
“All in all, the major challenges involved in machining titanium sound daunting at first. However, those who know all the parameters have enormous advantages here. The fine tuning of carbide substrate, tool geometry, coating and CNC process design to the alloy and machine tool used ensures economical machining processes,” says Jan Dege.

The coating as a “protective cover” for the cutting tool is specifically important here. Coatings containing silicon in particular stand out from

other solutions when machining titanium. One example are coatings based on the HiPIMS coating material SteelCon®. Manfred Weigand explains: “SteelCon® provides excellent insulation against heat and hardly lets any heat into the tool. This is particularly advantageous for materials that are themselves very poor heat conductors, such as titanium. Without SteelCon®, the high temperatures that inevitably arise when machining hard materials would embrittle the carbide and thus damage the tool.”

OUTLOOK: OPTIMIZING PRODUCTION

In order to reduce the CO₂ footprint in the production of titanium components, conserve resources and produce more economically, the aerospace industry in particular is increasingly using near-net-shape semi-finished products. These are both precision forged parts and, increasingly, additively manufactured semi-finished products.



TEST THE BEST!

We are convinced that we offer the best HiPIMS and Diamond Coatings in the world. This turns excellent tools into perfect products.

Find out!

Our coating experts look forward to meeting your requirements.

coatingservice@cemecon.de



WOULD YOU LIKE TO READ FACTS STORIES REGULARLY AND FIND OUT MORE ABOUT OUR COATINGS?

Simply subscribe to the digital edition of FACTS or to our newsletter. This way you keep up to date with the latest information! We are just a click away!