**Customer magazine** for coating technology



# FACTS





# WERKÖ GmbH: The color is blue for jubilee

Pages 4-5

Diamond Multilayer: µ-precise customer satisfaction

Pages 13-17





**Hardcoating Technologies:**With HiPIMS in the future

# Premium coatings for premium tools ...



Dr. Toni Leyendecker CEO CemeCon AG

#### Dear FACTS reader,

... as a manufacturer of coating solutions for cutting tools, we offer everything from coating services, through equipment, peripherals and measurement equipment to turnkey coating centers. At our headquarters in Würselen we design, manufacture and use revolutionary new coating technologies. At the same location, we coat up to 70,000 cutting tools every day for our customers throughout Europe. For more than 25 years only CemeCon offers consistently the sputter technology for cutting tools. This is the only approach to creating smooth, droplet-free coatings with a unique variety of materials. HiPIMS technology, an evolution of the classic sputtering technology, continues this success story. At EMO we will be presenting the second commercial HiPIMS coating in the form of HARDLOX, a coating for machining of materials up to a hardness of 70HRC. This is also where you will find the CCDia® AeroSpeed®, our latest ultra-smooth multilayer diamond coating, a perfect solution for machining of CFRP in the aviation industry. This unique combination of innovation and experience allows us to produce premium coatings for premium tools.

### Prepare to be inspired! Yours sinceerely,

Dr. Toni Leyendecker

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#### **Editor**

KSKOMM GmbH & Co. KG Pleurtuitstraße 8 56235 Ransbach-Baumbach Phone +49 (0) 26 23 / 900 780 Fax +49 (0) 26 23 / 900 778 www.kskomm.de ks@kskomm.de

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HARDLOX provides optimum tool life for Maier GmbH.

# Success with HPN1 on indexable inserts

# From the drawing board to practical success

For a while now, the coating and tool manufacturing industries have shown a lot of interest in HiPIMS technology. The numerous advantages and expectations have been discussed at conventions and in seminars. The metal cutter's interest, however, does not even begin until he can actually utilize a coated tool, in other words: Once into production – that's how it is with HPN1.

By the time CemeCon decided in 2010 to offer the first coating under the working name HPN1 numerous tests had already been completed. "So we knew from our clients in which fields of applications they expected HPN1 to work. The best ideas often develop in dialog with our clients, and the actual potential of coating materials becomes apparent once one is cutting metal. In the case of HPN1, this also helped us quite a bit in handling the fine-tuning of composition, coating thickness, as well as pre- and post-treatment", explains Inka Harrand, Product Manager of Cutting Inserts at CemeCon.

The working name remained, but HPN1 became the product which is by now successfully deployed on production machines all around the world. And the demand is constantly increasing, which is why CemeCon has already had to expand its capacity. "We can guarantee a standard delivery time of five days", says Inka Harrand. With that kind of success as a foundation, CemeCon is continuously working on soon being able to provide further coatings of the next generation in coating materials: "Power Nitride". The first new product is HARDLOX, which FACTS reviews in detail on pages 6 to 9.

# In a wear-comparison test to a conventional coating based on AlTiN, after 180 minutes of use the HiPIMS coating material HPN1 (see REM picture) clearly has the advantage.

#### Often successful

In the development of coating materials, the list of specifications mostly includes clearly defined characteristics that look promising in terms of solving particular processing issues. Inka Harrand: "A huge challenge in this are the numerous applications for which we must find 'consensus', so to speak. For a successful result, it is important that users are willing to test new coating materials — often in those applications with which they are having difficulty.

## A bright outlook

The coating HPN1 was tested in various milling applications on indexable insert tools: trimming, grooving, slot-milling, thread cutting and recess turning. The overwhelmingly excellent results in comparison to established AlTiN, or coatings from competitors, were persuasive in their performance data, but even more so in actual use.

To fulfill the wishes of indexable insert users for higher coating thickness, and therefore longer service cycles, CemeCon has been for some time now offering the variant HPN1 Plus, with a coating thickness of 6  $\mu$ m.

"We have further coating materials on our agenda, and very soon, we want to convert established coatings such as ALOX SN<sup>2</sup> to the new HiPIMS (High Power Impulse Magnetron Sputtering) technology. We want our customers to always profit from the respective latest technology", says Inka Harrand.

Inka Harrand
Product Manager
Cutting Inserts
Phone:
+49 (0) 24 05 / 44 70 105
inka.harrand@cemecon.de



# WERKÖ GmbH goes for color supernitrides

# The color is blue for the jubilee

To celebrate 75 years of the company's existence, something suitably special was required. That was what WERKÖ GmbH from Königsee in Thuringia decided, developing a 19-part spiral drill bit set with diameters ranging from 1.0 to 10.0 mm – and finished with TINALOX SN<sup>2</sup> BLUE coating.

Königsee is idyllically located in a tributary valley of the Schwarza valley and, in addition to its beautiful scenery, it is home to one particularly special attraction: with a weight of 88 kilograms, a length of 2.20 meters and a diameter of 96 millimeters, possibly the biggest spiral drill bit in the world. It was manufactured by WERKÖ GmbH, a company that has manufactured precision tools and distributed them worldwide from its Königsee base for the last 75 years.

# Special edition with SN<sup>2</sup>

For its 2013 jubilee, the tool experts at WERKÖ wanted something special. Managing Director Jos van Gemert on the subject: "To treat our customers, we have developed a special edition 19-part set for our hugely successful spiral drill bit DIN 338, Type N-HD, HSCo8. It is available in increments from 1.0 to 10.0 mm x 0.5 and is suitable for drilling wear-resistant steels up to a maximum of 1,400 N/mm²." But to round off the tool series, they still required the highend-coating.

With this is mind, WERKÖ turned to CemeCon, with whom the company had been collaborating in the area of tool coating for years. "With our coating material TINALOX® SN² BLUE, from the very successful class of supernitrides, we had found the ideal way to provide the jubilee edition with corporate colors. In technological terms, the coating also provides extra bite for use with steel materials," says Helmut Schauenberg sales manager with CemeCon.

With the 19-part set, WERKÖ GmbH offers a special edition of its successful spiral drill bit set. The coating TINALOX®SN² BLUE provides outstanding and distinctive anti-wear protection.

# Full performance due to supernitrides

Supernitrides are coating materials that thanks to their nanocomposite structure, provide high degrees of hardness as well as maximum ductility. And like all CemeCon PVD coatings, they are manufactured using Sputter technology and are therefore extremely smooth. TINALOX® SN2 can be described as a multirange coating material, as it successfully covers a wide range of applications from steel processing to the processing of stainless steels and cast iron. Accurately constructed TINALOX® SN2 is not only ideal for finish milling, it is also an outstanding solution for HSS and Mini-VHM spiral drill bits and reamers.

And the blue surface provided by the CemeCon coating material makes it much easier to detect wear. "We have often been asked whether a blue coating would make it easier to identify wear on our tools,", says Jos van Gemert. And WERKÖ has now duly obliged with TINALOX®SN² BLUE.

# **Record-breaking**

"Whether or not our spiral drill bit gets a place in the Guinness Book of Records is for the committee to decide. But how good our special edition is - that is for our customers to decide. The first 500 cases were sold within a few days, and more than 300 re-orders suggest that we got it right in terms of quality and style!" Jos van Gemert is happy to report.



Felmut Schauenberg
Sales Manager
CemeCon AG
Phone:
+49 (0) 170 / 63 10 744
helmut.schauenberg
@cemecon.de



# **WERKÖ GmbH in detail**

WERKÖ GmbH is a leading provider of catalog and special edition precision machining tools for the automotive and aeronautics industry and for machinery and plant engineering. With 75 years of experience in the manufacture of sharpened solid-carbide precision tools and cobalt and powder-alloy, high-performance, high-speed steels, WERKÖ GmbH is Europe's expert supplier in the areas of drilling, countersinking, reaming and thread production. Werkö is an independent company within the global TDC group, which operates state-of-the-art production and distribution sites in China, the U.S., Mexico and Brazil, among others.

#### **WERKÖ GmbH**

Jos van Gemert Managing Director

Industrie- und Gewerbepark 30b

07426 Königsee

Germany

Phone: +49 3 67 38 - 77 0 Fax: +49 3 67 38 - 4 34 28 E-mail: vertrieb@werkoe.de

www.werkoe.de

# (WERKÖ)







# The new HARDLOX coating

# Increased performance in hard machining

HSN<sup>2</sup> has established itself on the market as a high-performance hard machining solution. With the enhanced solution HARDLOX, CemeCon is now offering a new premium product for materials over the 50 HRC limit. This coating combines the best of both worlds: a smooth surface thanks to sputter technology and a adhesion stronger than every other technology.

Hard machining is a discipline for specialists, in terms of both the operators and the tools employed. Drills and end mills that have to work through materials with a hardness of HRC 50 and over are exposed to extreme wear. And manufacturers know: Without a suitable coating, they won't achieve much - certainly not in the long term in any case.

# Simply switch to new coatings

Up until now, HSN<sup>2</sup> has set the standard for hard machining and has been suc-

cessfully deployed by many. "With our new coating, we're demonstrating that time does not stand still for layer development either. The name HARDLOX is not coincidental: It is set to make hard machining significantly easier," explains Manfred Weigand, round tools product manager at CemeCon.

#### Hard, harder, HARDLOX

HARDLOX is the second HiPIMS product that is silicon-doped and "it is similar to our established HSN<sup>2</sup> in terms of its composition, but it also benefits

from a new adhesion technology," continues Manfred Weigand. "On the one hand, the adhesion provided by this new coating has been improved once again, while the percentage of individual alloying elements has changed, meaning its level of performance in general has increased."

# Strong adhesion means high performance

Not least in die and mold construction, the demands placed on the cutting tools in use are constantly increasing: The processing industries focus just as much on corrosion-resistant steels of medium strength as steels with 60 HRC and more. These materials are both tough and hard, and their alloying components for



Powerhouse for hard machining: Thanks to its extreme hardness, mechanical resilience, outstanding coating adhesion and high ductility, HARDLOX is the first choice for materials harder than 50 HRC.

corrosion resistance also make cutting tasks difficult.

Here are required high performance tools. Manfred Weigand on the subject: "Our HARDLOX solution is precisely tailored towards the machining of extremely hard materials. With a layer thickness from I  $\mu$ m to 3  $\mu$ m on end mills, drills and indexable inserts, the metal removal specialist can cover a wide range of machining tasks."

#### **Smoother and harder**

In addition to the denser layer structure, the material assembly is responsible for the high thermal stability of HARDLOX. Manfred Weigand: "Among others, the multilayer coating contains silicon, which allowed us to further optimize the morphology." This also allows the new HiPIMS technology to bind the layer to the substrate more effectively, which greatly improves the adhesion in comparison to previous layers. At the same time, HARDLOX provides much better ductility when used with harder materials, which significantly improves its performance.

"HARDLOX is also extremely smooth, as no droplets can form on the layer thanks to the sputter process. This means that you are no longer hindered by having to remove chips and release heat. It is precisely these attributes that allow the tools used on hard materials that are difficult to machine to keep a 'cool head'," stresses Manfred Weigand.

However, wear resistance is not the only topic here. Reliable and precise machining also requires the strictest manufacturing tolerances on the part of the cutting tools. In this case, the goal must be, for example, to use an end mill to manufacture reflective surfaces thanks to its smooth coatings. This usually saves the user from having to carry out subsequent work such as polishing the work piece.

## Success based on hard facts

Tools coated with HARDLOX now provide security even for companies involved in hard machining: Shorter processing times, reduced installation and handling process and higher quality allows customers to significantly reduce their costs. "We can achieve these benefits thanks to the extreme hardness, mechanical resilience, outstanding layer adhesion and the high ductility of HARD-

LOX. If you have been using HSN<sup>2</sup> up until now, you should not hesitate to go for a performance upgrade and switch to our new coating," concludes Manfred Weigand.



HARDLOX is also an extremely effective solution for micro-tools.





# **HiPIMS-technology shortly:**

PVD (Physical Vapor Deposition) coating have offered high performance for many years in the challenging fields of hard, high-speed and dry machining. Major improvements have been achieved compared with standard PVD coatings using HiPIMS (High Power Impulse Magnetron Sputtering) technology. HiPIMS-coated tools handle materials that are hard to cut such as nickel-base alloys and stainless austenitic steels in a more economical way, with significantly increased cutting parameters and a

much lower level of wear.

A high level of ionization is achieved in the sputtered metals with the HiPIMS process. The target is exposed to highenergy pulses in the megawatt range resulting in the formation of plasma with a high charge carrier density (1019 m<sup>-3</sup>) in front of the target. The energy and direction of motion of the positively charged particles that hit the substrate are favorably influenced by exposure to negative voltage (bias voltage). The high ionization of the vaporized metals in the HiPIMS process improves the layer structure and characteristics.

With the conventional DC sputtering process, the ionization is increased by increasing target power. The limits to this are determined by the increased thermal loads on the targets and substrates to be coated. HiPIMS is applied at this point: The average target power remains low (I-I0 kW) since the pulses only act on the target material for a very short time followed by a long subsequent "down time". This allows the targets to cool down in downtimes and process stability is assured.

# Steel processing on a new tempo level

Barely officially released and already a major success: After just one test run, HARDLOX has already pushed other coatings to the back of the queue. For Maier GmbH in the Bavarian town of Salching, first class results in everyday production are the key to passing the test of time.

HARDLOX combines the best of two worlds: smooth surfaces thanks to top class Sputter technology, and a perfect adhesion stronger than every other technology. CemeCon AG achieves these results thanks to a HiPIMS (High Power Impulse Magnetron Sputtering) process, which produces, among others, a much denser coating structure. But this new development is not just impressive on paper; it provides results under the toughest working conditions – as is the case with the company Maier GmbH, based in Salching in Bavaria.

# Wanted: Tuning for hard machining

Maier GmbH is a renowned manufacturer of milling, countersinking, chamfering, turning and recessing tools, which are sold under the brand name "Head-Master". These tool specialists are also experienced as partners for a range of application-optimized special solutions. Specialists in hard machining and the cutting of extremely high-tensile steels, the company was searching for ways to make its products even more

efficient, and it turned to CemeCon to do so. "They provided us with a new coating material made using the HiPIMS process to test. The performance data provided by HARDLOX had already given us high expectations, promising precisely what we needed to significantly improve our cutting processes", said Andreas Kraus, Sales Manager with Maier GmbH.

Among others, HARDLOX was used on a milling cutter with a diameter of 16 mm, z=4, and unequal helix angles of  $35^{\circ}/38^{\circ}$  with a coating thickness of  $3 \mu m$  in 42CrMo4, a heat treatable steel (1.7225) with a hardness of 1,300 N/ mm<sup>2</sup> (approx. 40 HRC), water-cooled  $(a_0 = 14.8 \text{ mm}, a_0 = 12.4 \text{ mm}, v_0 = 60 \text{ m/}$ min, f = 0.06 mm). "We were very curious: Our previous tool produced 50 components in a 90 minute cycle, requiring I minute and 48 seconds per part. The HARDLOX-coated milling cutter got through the work much more efficiently, and had already finished one component after 31 seconds. After 90 minutes, we had produced 170 milled parts!" exclaims Andreas Kraus, clearly impressed with the enormous level of productivity achieved by the milling cutter.



Maier GmbH figured that, having provided such outstanding results with the heat treatable steel, it could also provide a power boost for their tools for extremely high-strength nitride steels and tool steels. The company then coated other tools with HARDLOX and tested them on a stainless, austenitic, nickel-chromium steel, stabilized with titanium (1.4541). "This material is really difficult to machine, which meant that we were operating under more moderate, but still efficient, machining pa-

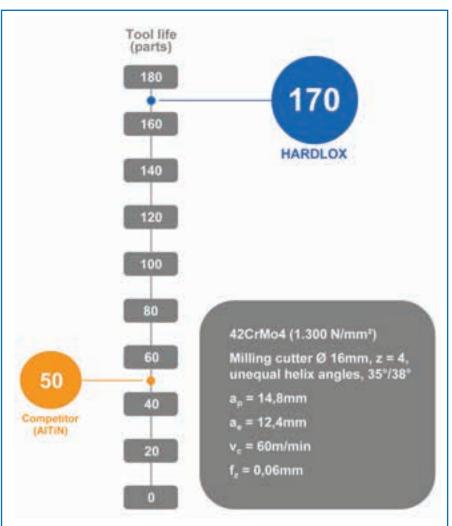


Maier GmbH stands for "Quality made in Germany": The success and innovation of the company is defined by its highly-motivated and qualified employees. Its state-of-the-art machinery also provides the ideal basis for this.

rameters. In this case, we used a milling cutter with a diameter of 12 mm with water cooling. And it ran and ran and ran – until we ran out of components for the test!" Andreas Kraus reports in astonishment. Despite the promising data provided for the coating material, Maier GmbH had not expected such successful results. "Thanks to HARDLOX, our customers now benefit from shorter machining times and higher quality, and the bottom line is that this saves a considerable amount of money," says Andreas Kraus in summary.



HARDLOX optimizes tools for stainless steel.



Thanks to a coating based on HARDLOX, Maier GmbH is one step ahead of the game when it comes to the machining of extremely hard heat treatable steel.

# Maier GmbH in detail

Maier GmbH produces an extensive range of products from its own production facilities under the brand name "Head-Master". Its in-house design and project management ensures innovative and tailor-made solutions, combined with maximum flexibility. All of its tools are produced in a manufacturing facility equipped with the latest in cutting-edge technology. The "Head-Master" products are distributed by sales representatives and sales agencies throughout the world. Maier GmbH produces tools at the highest level and has always placed special emphasis on embracing new machining technology. The technological design and quality of these precision tools play a particularly important role in the efficiency and quality of production. Thanks to its in-house development and tests and the experience of its customers, the company can provide optimized tools for all kinds of operations.

The quality seal "Made in Germany" is based upon a team of highly motivated and highly qualified employees whose know-how and eagerness to overcome challenges forms the cornerstone of the company's success. The innovative drive of the company is clear from the various patents related to cutting technologies for which licensees are already in place. Another cornerstone of its success is its notable cooperative partners – from the areas of solid carbide through to coating.



#### **Contact:**

Maier GmbH
Dipl.-Ing (FH) Harald Maier
Dorfstraße 14
94330 Salching/Germany
Phone: +49 (0)9426/802650
Fax: +49 (0)9426/802651
E-mail: info@maier-tools.de
www.maier-tools.de

Marco Furrer
Sales Manager
CemeCon AG
Phone:
+49 (0) 170 / 6310 718
marco.furrer@cemecon.de



# **Hardcoating Technologies Limited and CemeCon**

# Paving the way to the future with HiPIMS technology

At its inception in January 2012, Hardcoating Technologies Limited (HTL) started operations with the aim of providing a premium coating service to the highest quality standards in Wokingham, England. To achieve this goal, the job coater relies both on outstanding service and premium technology by CemeCon – a CC800®/9 HiPIMS-coating plant.

"Since our aim from the outset was total customer satisfaction, thanks to advanced coating technology and outstanding service, we wanted more than just a partner who would supply us with a turnkey, state-of-art coating line. We were also looking for someone who could offer us the best possible support in every respect. And CemeCon was the perfect match," as Jason Hutt, Business Development Manager at Hardcoating Technologies Limited, recalls.



# **All-round package**

The engineers from CemeCon installed a complete PVD production line at Hardcoating Technologies Limited with the innovative CC800®/9 HiPIMS coating plant as its key component. The turnkey installation included all peripherals, country-specific connections and equipment for substrate preparation, such as cleaning and pretreatment; thanks to this, the first batch of coated workpieces was delivered only a short time later. Additionally, CemeCon helped at the production start-up: "Operation and process control of our system are easy. On-the-job training is the best way to familiarize our customers' employees with the coating technology. Our coating center in Würselen is the ideal place for this" said Andrea Merz, Project Manager Technology Projects at CemeCon. However, there is a lot more to service than just this. On-going technology training, marketing support

CemeCon installed a CC800®/9 HiPIMS coating plant at Hardcoating Technologies Limited.

and advice for end users in case of queries, round off CemeCon's service portfolio. Jason Hutt: "Especially in the initial phase, the 24-hour hotline, for example, was a tremendous help for quickly and competently clarifying any issues that arose in our operations at any time". HTL can also rely on long-term success, after concluding a service agreement.

The PVD (Physical Vapor Deposition) Sputter process gives Hardcoating Technologies Limited the ability to deposit extremely smooth coats without any droplets at all, and with low residual stress. This makes cutting tools perfect for hard, high-speed and dry machining under heavy load. Additionally, the PVD method ensures maximum design freedom: there are many options in terms of the choice and combination of coating materials.

# **Advanced options**

Thanks to CemeCon's HiPIMS (High Power Impulse Magnetron Sputter)



Whether new or reground - HTL coats a large number of tools.

coating technology, HTL can now offer an advanced coating service for cutting tools. The spectrum not only includes PVD coats such as aluminum titanium nitride (AlTiN) and titanium diboride ( $TiB_2$ ), but also the latest, nano-struc-

tured power nitrides, which can only be produced using HiPIMS technology. Mark Dixon, Senior Coating Technician at Hardcoating Technologies Limited: "The Power nitrides heralds a new era in terms of performance. The high-

# **Hardcoating Technologies in detail**



Hardcoating Technologies Limited was founded in 2012 as a subsidiary of Hardcoating Technologies of North America in order to support the machining industry with PVD coating for solid carbide tools. Everything started with TiN coating. HTL rounds off its product portfolio with PVD coatings: TiAlN, AlTiN, and TiB<sub>2</sub>. The company coats cutting

tools, stamps, molds and components for mold making with high performance PVD coatings. Hardcoating Technologies Limited's customers include companies from a variety of industries and with a variety of quality requirements, including companies that are approved OEM suppliers to the aerospace industry. This is why HTL is working on achieving NADCAP (National Aerospace and Defense Contractors Accreditation Program) approval.

#### **Hardcoating Technologies Limited**

Jason Hutt

Business Development Manager

I I Ashville Way

Wokingham, Berkshire

United Kingdom

Phone: +44 (0) 11 89 099 720 Mobil: +44 (0) 75 57 10 78 92

Fax: +44 (0) 11 89 099 721

E-mail: JasonH@hardcoatingtech.eu http://www.hardcoatingtech.com

Jason Hutt is Business Development Manager at Hardcoating Technologies.







Thanks to the CC800<sup>®</sup>/9 HiPIMS, its spectrum includes both conventional PVD coating and nano-structured power nitrides.

performance pulse method offers many benefits: stronger adhesion, far higher oxidation temperatures and improved wear resistance. This translates to longer service lives for coated tools."

The major benefits of HiPIMS coatings are the denser layer morphology and the improved hardness-to-toughness ratio compared with standard PVD coatings. The higher thermal stability of the HiPIMS coating is attributable to a new optimized lattice structure of the coating, besides the thicker layer structure.

CC800/9
H:PIMS

Luke Hutt is an expert with the system – not least thanks to the training provided by CemeCon.

Additionally, the innovative coating method means more improvements in film adhesion. This is particularly important for interrupted cuts. The layers are ideal for cutting tools that are used with heat resistant super alloys, hard-to-machine materials for the aerospace industry, and stainless steels. Additionally, they are suitable for applications in the medical and automotive industries. After all, high temperatures, corrosion and wear have significantly less impact on products with HiPIMS coatings.

Marc Dixon: "In addition to this, we naturally also offer premium standard PVD coating, such as titanium diboride (TiB<sub>2</sub>). The very hard and very thin layer, which is only I to 2 microns thick, has very good sliding properties, so that chips are discharged very well, and built-up edges are avoided. This makes it excellent for use with aluminum, magnesium and copper alloys. Its high oxidation resistance means that it can also be used in the machining of titanium alloys." PVD coatings improve the surface hardness and heat resistance of cutting tools, while simultaneously reducing tool wear and breakage. This allows for faster machining and ensures a longer tool life.

#### **Customer service at HTL**

Hardcoating Technologies Limited coats both new tools and reground drills and milling cutters. The British place much emphasis on best-in-class service as well as state-of-the-art technology. Jason

Hutt: "At HTL, the customer always comes first, whether they just want to coat one tool, or a hundred. Because good cooperation is very important to us." Once the tool reaches HTL, the company promises that the tool will be coated and returned to the customer within 48 hours - at no extra cost - again, CemeCon's innovative technology is one of the major factors that makes this possible. "As of a certain order volume, we also include a free pick-up service in cooperation with our logistics partner UPS" says Jason Hutt. "In future, this will be supported by our in-house transport service."



Mark Dixon is Senior Coating Technician at HTL.

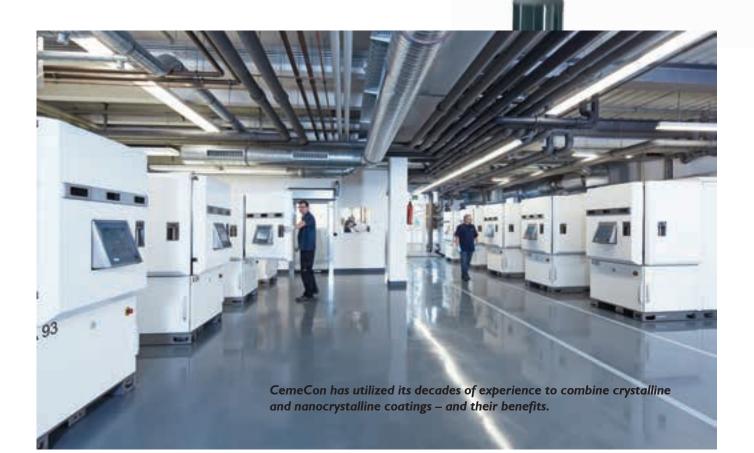
# Diamond Multilayer - the all-rounder coating solution

# Smoothness and adhesion combined

Outstanding layer adhesion or very smooth surfaces - why choose one when you can have both? CemeCon, the pioneer in the area of CVD diamond coating technology, has made this a reality: Thanks to its unique design, the diamond multilayer tool coatings combine the advantages of crystalline and nanocrystalline CVD coatings.

CVD diamond coatings are divided into two structures based on the structure of the crystallite: crystalline and nanocrystalline. The benefits of crystalline coatings lie in an excellent adhesion to the tool, whereas nanocrystalline structures allow for extremely smooth layer surfaces. The diamond multilayer coating developed

and patented by CemeCon consists of both crystalline and nanocrystalline layers, which are alternately applied on top of each other. The result is outstanding mechanical properties for machining due to the extremely smooth surfaces and the reliable adhesion to more than 80 qualified carbide grades.



# The right layer thickness for any application

The diamond multilayer is available with a layer thickness ranging from 3 to 15  $\mu$ m, which means it is suitable for use with a large range of tools and applications. Thin layers are mainly applied for extremely sharp cutting edges, while thick layers increase the durability of tools in the manufacturing process. Above all, the CemeCon multilayer coating is ideal for machining hard materials, including fiber-reinforced plastics and non-ferrous metals. Due to their exceptional hardness thanks to the multilayer coatings, the tools are capable of machining abrasive materials and the level of wear is reduced. Due to their exceptional hardness, multilayer-tools are capable of machining abrasive materials, while reducing the wear. This means that the service life of drills, end mills, reamers and indexable inserts increases noticeably.

# Multilayer coatings for multi-layered tools

The very high level of thermal conductivity of the diamond multilayer coatings



Efficient and precise machining with long tool life are possible with the CCDia® tool coatings of CemeCon.

approaches the level of natural diamonds. This represents especially good value for the machining of composites such as carbon fiber-reinforced plastics (CFRP). This material consists of a carbon fiber matrix that is immersed in reaction resin. If the frictional heat gets too high during

processing, the thermal stress of the resin can lead to the displacement of individual layers or delamination in the boreholes. CemeCon multilayers do not only divert chips and dust excellently, they also dissipate out the heat from the contact zone and ensure optimal machining results.

### CCDia® FiberSpeed - Multilayer diamond coating



Our multilayer CCDia® FiberSpeed diamond coatings for the aviation industry feature multiple layers.

The coating used on these types of tools has anti-tear properties, which significantly increases the service life of tools working with fibre-reinforced materials (e.g. CFRP, GFRP).





# **Interview with COO Dr Oliver Lemmer**

Dr Lemmer, CemeCon is a pioneer in the area of CVD diamond technologies. How long has the company been working with this process?

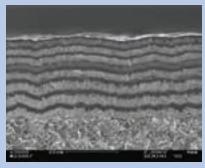
We have been coating tools using CVD diamond technologies since the 1980s, and in that time we have really driven the development of this process. Thanks to our experience over the decades, we have succeeded in producing unique multilayer diamond coatings for the market.

#### How hard are the multilayers?

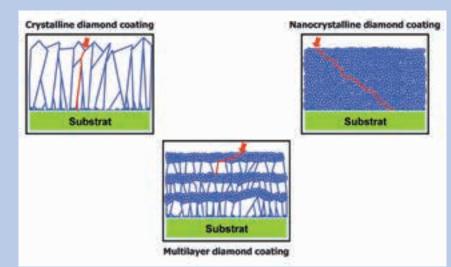
The coatings have a micro hardness of up to 10,000 Vickers. That is roughly as hard as a natural diamond.

As we already know, the multilayers are ideal for the machining of carbon-fiber reinforced plastics thanks to their high level of thermal conductivity. What other benefits does it offer in terms of the machining of this material?

When drilling CFRP, the carbon fibers must be cut cleanly. If this does not happen, they may break away from the matrix, which weakens the structure of the material considerably. There is then the danger when bolts are inserted into the boreholes, fiber residues are pushed



Crystalline and nanocrystalline layers are deposited on top of each other.



Multilayer diamond coatings have numerous benefits, one of which is their crack stability: Whereas a crack may reach the hard metal below a purely crystalline or purely nanocrystalline structure, a crack in the multilayer is "absorbed" by the next layer and cannot expand.

in with them, which could compromise the hold of the bolts. The multilayer coatings counteract these problems, as they make the tools extremely hard, allowing them to separate the carbon fibers cleanly. The required tolerances and quality standards are also complied without any trouble.

Furthermore, the diamond multilayer would also be more efficient at preventing cracks than other coatings available on the market. Why is that?

In purely crystalline or purely nanocrystalline structures, a crack in the coating caused by tensile residual stress, which develops during the machining, may overcome the crystal boundaries and reach the carbide below it. In the worst-case scenario, this can result in the tool failure. By contrast, in the case of diamond multilayer coatings, this problem does not occur, as any crack that develops is immediately "absorbed" by the next layer and can therefore no longer expand. No damage is caused to the tool.

# For which particular applications are the diamond multilayers suited then?

For a whole range of applications! Since the multilayers have proved themselves so impressively up to this point, they are now used exclusively in our CCDia® range. CCDia®CarbonSpeed is ideal for machining graphite and green compacts, CCDia®AeroSpeed® and CCDia®FiberSpeed are ideal for high-tech composites and CCDia®MultiSpeed is ideal for fibre materials with non-ferrous content. high silicon-content aluminum and metal matrix composites. It thus provides a solution for all kinds of applications and the multilayer coatings have already enabled many users to achieve more efficient and economical machining results.

Dr Oliver Lemmer COO Phone: +49 (0) 24 05 / 44 70 100 oliver.lemmer@cemecon.de





In the manufacture of electrodes for the production of tools and molds, graphite is being used more and more in place of copper. The positive qualities of graphite are self-explanatory. For this reason, Zecha Hartmetall-Werkzeugfabrikation GmbH, based in Königsbach-Stein, has launched special micro mills for graphite processing – and CemeCon applies the appropriate coatings.

The growing popularity of graphite is based not only on its high degree of toughness and wear-resistance, but due also to the fine-grained structure of some types of graphite, which are particularly well-suited to the manufacture of electrodes. This property allows for burr-free machining and also enables the milling of filigree forms.

# Innovative Coatings for Miniature Mills

Today, even graphite electrodes with 3D contours in the  $\mu$ m-range can be reali-

zed. The small cutting tools that provide such stellar performance do not only have to be highly precise to guarantee the required narrow tolerances: Electrode graphite is highly abrasive, which is why it is important to protect the tools from wear with suitable coatings. Thin and uniform coatings are essential in this, so as not to compromise the tolerances. The companies Zecha and CemeCon are meeting this challenge together: Zecha produces the micro mills, which are specifically geared towards graphite processing, while CemeCon applies the related diamond coatings - with

precisely specification for the various product lines.

Thomas Schaaff, Sales Europe, CemeCon: "Our diamond coatings are perfectly suited to the geometries of mills by Zecha, which uses a specially adapted hard metal in the production of their tools. We are especially proud of the fact that we can guarantee our clients a precise tolerance of  $10 \mu m$  after coating. This works very well with our technologies." CemeCon systems apply a multitude of CVD diamond coatings to different tools and applications, to meet the highest possible quality standards. The coatings for the Zecha micro mills are also designed especially for the user requirements in the processing of abrasive materials like graphite.

# Smaller diameter, longer service life

"Our mill program for graphite is divided into three product lines", explains Arndt Fielen, Director of Sales at Zecha, "The

'Quality' line with optimum price-performance ratio for standard applications, the 'Premium' line as an all-rounder for roughing jobs in small and large series production runs, and the 'High-End' line, when the narrowest tolerances and long service life are essential." Other variants in a diverse spectrum of applications also include editions with shorter necks, for more stability and even longer service life cycles. "The radius and torus mills of the 'High-End' line guarantee the highest precision", states Arndt Fielen, with a sense of pride. "For these, the very fine, filigree forms in electrodes are no problem at all." Mills of the 'High End' line are available from diameters of 0.1 mm, thus fulfilling the industry's requirement for ever smaller and finer tools.

An ID number at the shank end also ensures exact reproducibility of the tools - even after many years. Arndt Fielen: "Our standard for quality is not just  $\mu$ -precise tolerance, but also the  $\mu$ precise satisfaction of our customers." CemeCon's pick-up and delivery service also ensures Zecha of optimum delivery times: Several times a week, CemeCon's own delivery department stops by the Zecha site to pick up tools for coating, or to deliver tools that have been coated.

"Such stellar performance in terms of precision and true-running accuracy is of course more than just a promise", says Thomas Schaaf. At CemeCon as well as Zecha, the most modern measuring instruments are used for quality assurance. The micro mills are precisely measured with computer-controlled instruments, and the results are documented - fully automated, and touchless! In this, the precise dimensional check of the effective diameters is absolutely essential.

## Close cooperation

When it comes to high-quality solid carbide tools with extremely precise coatings for micro-processing, CemeCon and Zecha have now been partners for more than ten years. This cooperation is not limited to the production of tools, but also includes a lively exchange of information. Arndt Fielen: "Whenever there is another tricky application to solve, technicians from

and CemeCon meet either in Königsbach-Stein or in Würselen, to coordinate important parameters for tools and coatings - and to continuously keep each other appraised of the latest developments in the technology."





Ball nose end mills from the High-End line of the Zecha Hartmetall-Werkzeugfabrikation GmbH are optimized for use in graphite. An especially adjusted diamond coating solution on the basis of the CCDia® line provides the tools with some additional bite.

# **Zecha Hartmetall-**Werkzeugfabrikation GmbH in detail

Since 1964, Zecha Hartmetall-Werkzeugfabrikation GmbH from Königsbach-Stein has been manufacturing solid carbide micro tools for the punch, mold and metal cutting industry. For graphite processing in mold making, as well as for medical and dental technology, the company offers the right tool solutions for the processing of titanium, stainless steel and special materials. A versatile standard range of products ensures short delivery times. Special tools, customized for particular applications, provide the user with an edge in performance, quality and service life.

## Zecha Hartmetall-Werkzeugfabrikation GmbH Arndt Fielen Sales Director Benzstraße 2 75203 Königsbach-Stein Germany

Phone: +49 (0) 72 32 / 30 22-16 Fax: +49 (0) 72 32 / 30 22-25 E-mail: arndt.fielen@zecha.de

www.zecha.de



**Arndt Fielen is Sales Director** at Zecha.

# High-precision coatings for tough situations

To ensure a maximum level of precision and the lowest tolerances in machining, everything must be just right for the tool. Both cutting edge geometry and coating play a major role in this. CemeCon provides diamond precision coatings with a tolerance difference of  $0 \mu m$  – and determines these values with the latest in measuring technology.

In electrical and medical technology, micro parts are playing as central a role as ever and they constantly require smaller and smaller tools. Maintaining tolerances in the  $\mu$  range does not just require expert know-how in tool manufacturing, but also high-precision measuring technology. But each measuring device is as good as its operator. This is why people work exclusively specialized in the specially air-conditioned measuring room. All this means quality assurance on the highest level.

Measuring technologies with high levels of precision are constantly being developed for the manufacture of micro tools. "Maintaining the tolerances at  $\mu$  level

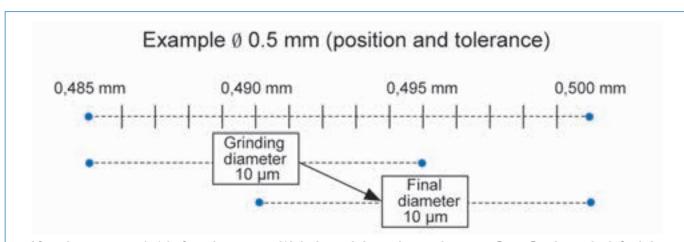
is not just required in micro-machining but also has to be documented through measurement logs", says Manfred Weigand, round tools product manager at CemeCon AG, "Smooth surfaces and the highest level of contour precision are also an absolute must for premium tools on the market. We play our part with our premium precision coatings."

# **Maximum precision** with CCDia®

In addition to high abrasion-resistance for aluminum alloys containing silicon, the multilayer sandwiches in the CCDia® family ensure reliable machining even for micro tools, as thin layers are also pos-

sible in the CVD process. Alternately applied crystalline and nanocrystalline layers ensure excellent adhesion properties and extremely smooth surfaces, allowing the coated tools to benefit from outstanding hardness, wear resistance, high performance and thermal conductivity. This has meant that tools coated in CCDia® have mastered the machining of CFRP, GFRP and composites with titanium and/or aluminum. CemeCon uses its years of experience to refine highprecision diamond coatings using the CVD process - even achieving precision coatings with a tolerance difference of  $0 \, \mu m$ .

"The outstanding feature of the precision coating is that the tolerance position is shifted only once," explains Manfred Weigand. "For example, if the tolerance of an uncoated tool is between 0.485 mm and 0.495 mm, the threshold values after the coating are 0.490 mm and 0.500 mm. The tolerance of 10  $\mu$ m is therefore retained." In micro-machining in particular, the lowest levels of tolerance are vitally important, as even minimal deviations can lead to the workpieces being wasted. Despite this, a tolerance



After the coating is (as) before the coating: With the multilayer diamond coating CemeCon has only shifted the tolerance position, the tolerance value remains unchanged.

difference of  $0 \mu m$  after coating is usually not standard! Incidentally: The lowest final dimension tolerance technically achievable is 4  $\mu$ m with a grinding tolerance of  $2 \mu m$ .

# **High-precision** Measuring technology

Manfred Weigand: "The increasing demands placed on tools - in the aircraft industry, for example - call for highprecision measurements to ensure that the finished parts are flawless." And this does not just concern reliability, but also environmental conditions such as temperature and humidity which must





CemeCon ensures the precision of coatings using the latest measuring technology. Naturally CemeCon customers receive also the appropriate measurement log.

also be considered to ensure precise and unbiased results. For this reason. CemeCon has further modernized its measuring processes and takes measurements in a special acclimatized space with tool exchange doors. The diameter and run out of the tools is determined using three laser measuring devices that have a repetitive accuracy of less than I  $\mu$ m. A 3D-CNC multi-sensor coordination measuring device with a precision of roughly I  $\mu$ m takes measurements from edge rounding and geometry.

Customers also receive a measurement log with their precision-coated tools in which the diameter and rotation are documented in both the ground and the coated state. "This allows the tool

manufacturer to check that we are delivering what we promise," says Manfred Weigand. "And since in many sectors quick availability is vital, the tools with CCDia® precision coating can also be supplied quickly."

**Manfred Weigand** Product Manager **Round Tools** Phone: +49 (0) 24 05 / 44 70 135 manfred.weigand@cemecon.de



# CemeCon Events Calendar 2013

16. - 21. September 2013

**EMO 2013** 

Hannover

22. October 2013

3. IfW-Tagung Bearbeitung von

Verbundwerkstoffen – Spanende Bearbeitung

von CFK

Stuttgart (Germany) 12. - 13. November 2013

14. November 2013

19. - 21. November 2013

3. VDI-Fachtagung Stahl- und Gusszerspanung 2013 Kassel (Germany)

IAK Werkzeugbeschichtugnen und Schneidstoffe Braunschweig (Germany)

Moderne **Beschichtungsverfahren** Dortmund (Germany)

### CCDia® - Ultra-hard diamond coatings



Our CCDia® series multilayer diamond coatings boast Vickers-standard levels of hardness.

Coated tools can be used up to 20 times longer whilst still delivering the highest surface quality when it comes to the machining of graphite, CFRP, GFRP or aluminium.





Tel.: +49 (0)2405 4470100

# Here you can reach CemeCon:

#### **Germany:**

CemeCon AG

Phone: +49 2405 4470 100 www.cemecon.de

#### China:

Baoding CemeCon
Coating Technology Co. Ltd.

#### Suzhou

Phone: +86 512 891 74919 www.cemecon.cn

## **Peking**

Phone: +86 10 873 983 00 www.cemecon.cn

#### USA

CemeCon Inc.

Phone: + I 607 562 2363 www.cemecon.com

## **Czech Republic:**

CemeCon s.r.o.

Phone: +420 539 003 501 www.cemecon.cz

#### Denmark:

CemeCon Scandinavia

Phone: +45 7022 1161 www.cemecon.dk

#### India:

M+V

Marketing & Sales Pvt. Ltd. Manish Adwani

Phone: +91 9158 99 99 56 www.cemecon.com

#### Japan:

Correns Corporation
Shigeru Kuroda

Phone: +81 3 5114 0795 www.cemecon.com

#### Korea:

JetztKorea Ltd. Hong-Silk Cho

Phone.: +82 2 792 2430 www.cemecon.com

#### Taiwan:

DKSH Taiwan Ltd. Vincent Chu

Phone: +886 963 495 396 www.cemecon.com

