GUHRING

Coatings

in-house coating system engineering

development and service under one roof

in excess of 50 service centres world-wide

Application of Guhring coatings

		DRILLING			MILLING		
		CARBIDE		HSS	CARBIDE		HSS
		conv.	MQL		conv.	MQL	
C-steels, Free-cutting steels, Mn-steels	P	Endurum Raptor Fire	Endurum Raptor Fire	Fire – –	Endurum Fire Raptor	Fire Endurum Raptor	Fire – –
Steel, low-alloyed	P	Fire Endurum Raptor	Fire Endurum Raptor	Fire TiN –	Fire Signum nanoA	Fire Signum nanoA	Fire TiCN –
Steel, alloyed	P	Fire Signum nanoA	Fire Signum nanoA	Fire TiN –	Fire nanoA Signum	Fire nanoA Signum	Fire TiCN –
Steel, hardened, <55 HRC	P	Signum Fire TiAlN	Signum Fire TiAlN	– – –	Signum nanoA TiAlN	Signum nanoA TiAlN	– – –
Steel, hardened, 55–65 HRC	P	Signum Fire TiAlN	Signum Fire TiAlN	– – bright –	Signum SuperA nanoA	Signum SuperA nanoA	– – –
Steel, stainless and acid-resistant	M	nanoA Sirius Endurum	nanoA Sirius Endurum	Sirius Fire TiN	nanoA Sirius Fire	nanoA Sirius Fire	Fire – –
Cast iron	K	Signum Fire nanoA	Signum Fire nanoA	Fire – –	Signum Fire nanoA	Signum Fire nanoA	Fire TiCN –
Nickel-based alloys (i.e. Inconel)	S	nanoA Signum Fire	nanoA Signum Fire	Fire – –	nanoA Signum Zenit	nanoA Signum –	Fire – –
Titanium/titanium-alloys	S	Zenit nanoA	Zenit nanoA	Fire –	Zenit SuperA	Zenit SuperA	Fire –
Cobalt-chromium-alloys	S	nanoA Signum Fire	nanoA Signum Fire	– – –	nanoA Signum Fire	nanoA Signum Fire	– – –
Precious metals	S	nanoA	nanoA	–	nanoA	nanoA	–
Aluminium-wrought-alloys	N	bright Carbo Cristall	bright Carbo Cristall	bright Carbo –	bright Carbo Zenit	bright Carbo Zenit	bright Carbo –
Aluminium-cast-alloys (<12% Silizium)	N	bright Zenit Carbo	bright Zenit Carbo	bright Zenit Carbo	Zenit Carbo Cristall	Zenit Carbo Cristall	bright Carbo –
Aluminium-cast-alloys (≥12% Silizium)	N	Cristall – –	Cristall – –	– – –	Cristall – –	Cristall – –	– – –
Copper/bronze/brass	N	ICE Carbo	ICE Carbo	TiN –	ICE Carbo	ICE Carbo	TiN –
Ceramics	N	Cristall	Cristall	–	Cristall	Cristall	–
Plastics, not reinforced	N	Carbo	–	–	Carbo	–	–
Plastics, fibre-reinforced	N	Cristall Signum	Cristall Signum	– –	Cristall Signum	Cristall Signum	– –
Graphite	N	–	Cristall	–	–	Cristall	–

Note: *The overview shows the general application recommendations for Guhring coatings. Prioritisation is from top to bottom.*

TAPPING			THREAD MILLING		FLUTELESS TAPPING			REAMING			
CARBIDE		HSS	CARBIDE		CARBIDE		HSS	CARBIDE		HSS	
conv.	MQL		conv.	MQL	conv.	MQL		conv.	MQL		
– – –	– – –	TiCN TiAlN TiN	TiCN – –	TiCN – –	TICN TiN –	TICN TiN –	TiCN TiN –	Endurum nanoA –	Endurum nanoA –	TiN – –	P
– – –	– – –	TiCN TiAlN TiN	TiCN – –	TiCN – –	TICN TiN –	TICN TiN –	TiCN TiN AlCrN	nanoA Endurum –	nanoA Endurum –	TiN – –	P
– – –	– – –	TiCN TiAlN TiN	TiCN – –	TiCN – –	TICN TiN –	TICN TiN –	TiCN TiN AlCrN	nanoA Endurum –	– – –	TiN – –	P
– – –	– – –	TiCN – –	TiAlN – –	TiAlN – –	– – –	– – –	– – –	nanoA – –	nanoA – –	– – –	P
TiCN – –	– – –	– – –	TiAlN – –	TiAlN – –	– – –	– – –	– – –	Signum – –	– – –	– – –	P
– – –	– – –	Sirius[1] / TiAlN[2] TiN –	TiCN – –	TiCN – –	TICN TiN –	TiCN TiN –	TiCN TiN –	nanoA – –	nanoA – –	TiN – –	M
TiAlN TiCN –	TiAlN – –	TiAlN TiCN TiN	TiCN – –	TiCN – –	TICN TiN –	TiCN TiN –	TiCN TiN –	Signum – –	Signum – –	TiN – –	K
– – –	– – –	TiCN TiAlN –	TiCN – –	TiCN – –	TiCN – –	TiCN – –	TiCN – –	nanoA – –	– – –	TiN – –	S
– –	– –	TiCN TiAlN	TiCN –	TiCN –	TiCN –	TiCN –	TiCN –	Zenit nanoA	– –	TiN –	S
bright – –	– – –	bright – –	TiCN – –	TiCN – –	– – –	– – –	– – –	nanoA – –	– – –	TiN – –	S
–	–	–	–	–	–	–	–	nanoA	nanoA	TiN	S
bright Carbo –	bright Carbo –	bright Carbo –	bright – –	bright – –	Carbo – –	Carbo – –	Carbo – –	Carbo – –	– – –	– – –	N
TiCN Carbo –	TiCN Carbo –	TiCN Carbo –	TiCN bright –	TiCN bright –	TiCN Carbo –	TiCN Carbo –	TiCN Carbo –	Carbo – –	Carbo – –	– – –	N
TiCN Cristall –	TiCN – –	TiCN – –	TiCN Cristall –	TiCN – –	– – –	– – –	– – –	– – –	– – –	– – –	N
bright Carbo	bright Carbo	bright Carbo	bright –	– –	Carbo –	Carbo –	Carbo –	bright –	– –	– –	N
–	–	–	–	–	–	–	–	–	–	–	N
bright	–	bright	bright	bright	–	–	–	–	–	–	N
TiCN –	TiCN –	– –	TiCN –	TiCN –	– –	– –	– –	– –	– –	– –	N
–	–	–	–	–	–	–	–	–	–	–	N

[1] *with through hole,* [2] *with blind hole*

GUHRING

Detailed information on the individual coatings can be found from page 16.

Application table
for Guhring coatings

Collection & delivery service Re-grinding Re-coating

Our service centres world-wide

an overview from page 38

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Service centres
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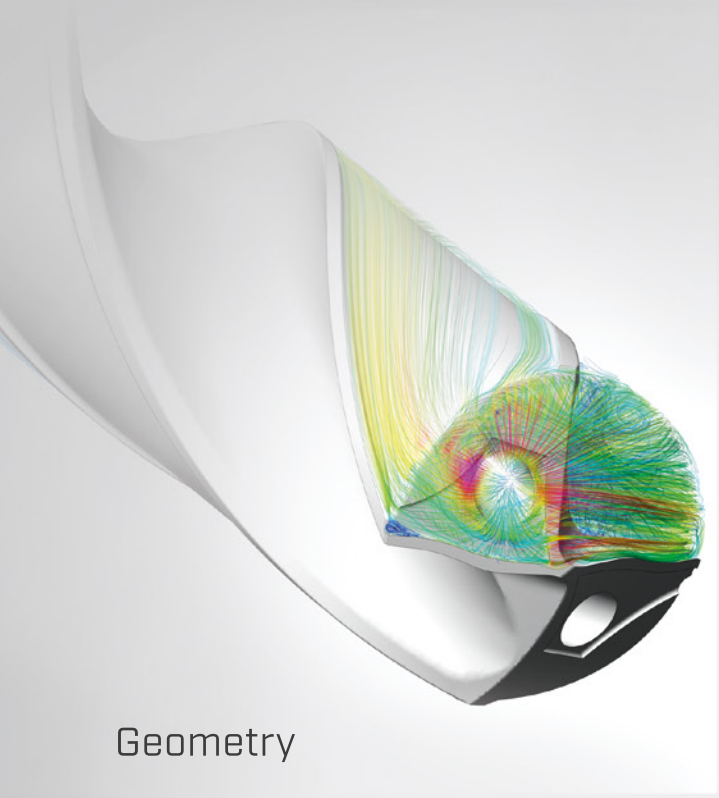
INHOUSE

GUHRING



Geometry

Tool material

Coating

Machinery and
plant engineering

The performance of modern cutting tools

is essentially determined by the tool material, the tool geometry, the cutting parameters and the coating.
An overwhelming number of cutting tools applied are coated. As a manufacturer of precision tools Guhring already recognised the potential early on.

Since the introduction of the world's first TiN-coating on HSS drills in 1980, Guhring can look back on decades of experience in the field of coating. From the start the refinement was carried out in-house.

In-house mechanical and process plant engineering results in further pooling of coating experiences in the company.

The adaptation of tool material, geometry and coating to the respective task can be entirely mapped at Guhring in-house.
Specifically, it means in-house manufacture of carbide blanks that are then given a geometry optimised for the application task on Guhring grinding machines. The package is completed by adapted hard material coatings, refined on Guhring systems with in-house developed coatings.

From hype to status quo:

Development of hard material coatings in the metalworking industry

With the presentation of the world-wide first TiN-coating on HSS drills in 1980, Guhring set the milestone in the machining world. What was initially smiled at as a marketing tool – golden tools in metal cutting – became the status quo of an entire industry.

A suitable coating can significantly improve the performance of cutting tools. Increases by factor 2 to 3 are not impossible.

The range of different hard material coatings has been heavily extended in recent decades. Due to their high hardness, good friction characteristics as well as thermo-chemical resistance they offer considerable advantages in comparison to un-coated tools:

higher cutting parameters ◂
reduction in manufacturing costs per item

increased tool life and volume ◂
tool saving potential
reduction in ausiliary machine process time

possible conversion to MQL/dry machining ◂
reduced cleaning expense
reduced disposal expense

2017

▸ in excess of 50 coating centres world-wide
by GUHRING

from 2000

▸ development of diamond coatings and highly specialised coatings
by GUHRING

1994

▸ opening of first service centre for re-grinding and re-coating
by GUHRING

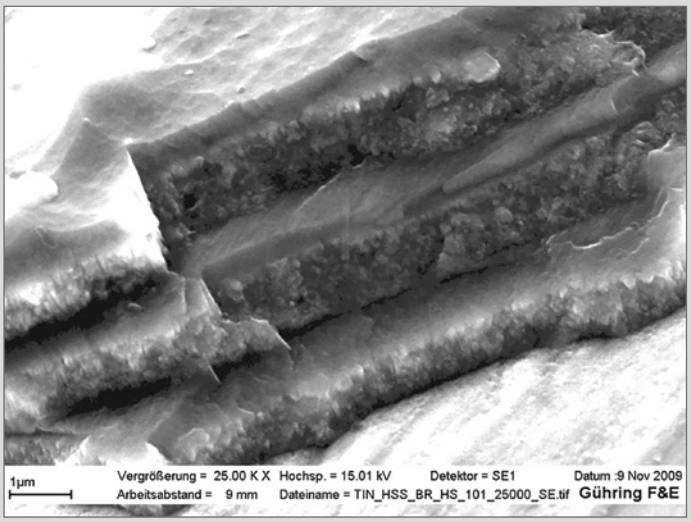
1991

▸ development of coating technologies
by GUHRING

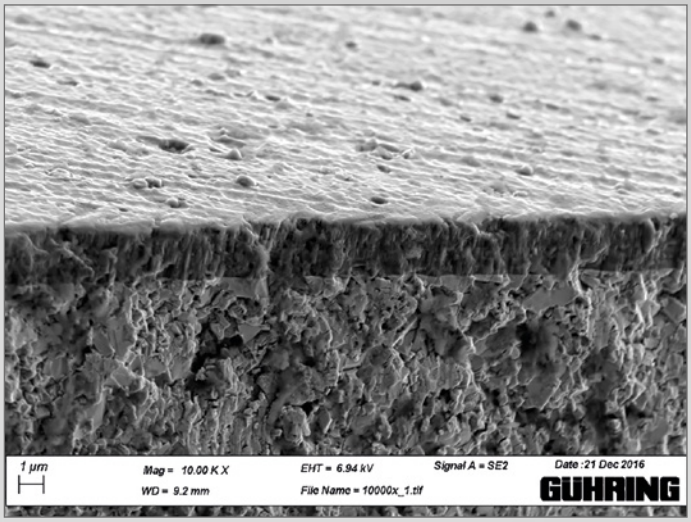
1980

▸ world-wide first TiN-coating on HSS drills
by GUHRING

Fracture patterns are visualised via scanning electron microscopy (SEM) in order to make differences visible in the phase structure, morphology and structure dependent on process design and deposition conditions.



Fracture pattern, multi-layer coating, 25,000 x magnification



Fracture pattern, Arc-coating, 10,000 x magnification

Coating development

In the scope of an application related coating development, coating characteristics can be influenced by different parameters and boundary conditions.

- ***Elementary composition of coatings***
  i.e. titanium, aluminium, chromium, silicon, nitrogen, carbon, oxygen
- ***Coating architecture***
  i.e. single-layer, multi-layer, nano-composite, nano-layer, grading
- ***Process parameters during coating***
  i.e. discharge current, substrate voltage, pressure, temperature
- ***Coating thickness***
  typically between 1 and 10 µm
- ***Cutting edge preparation prior to coating***
  micro-geometry
- ***Post-treatment following coating***
  polishing

The possibilities are more or less unlimited.
The results range from all-rounder to differentiated specialist.

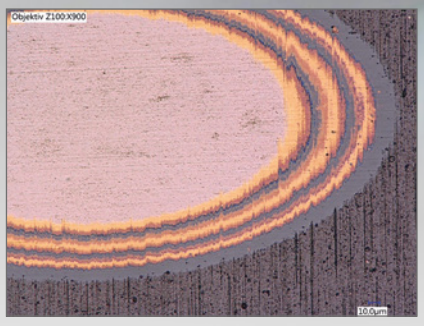
In this context we rely on the state-of-the-art laboratories of our in-house research and development.
As well as systems for depositing the coating there are also analytical processes available to determine the coating properties such as chemical composition, crystal structure, morphology, coating thickness, micro-hardness, friction value and adhesion.

Coating deposit

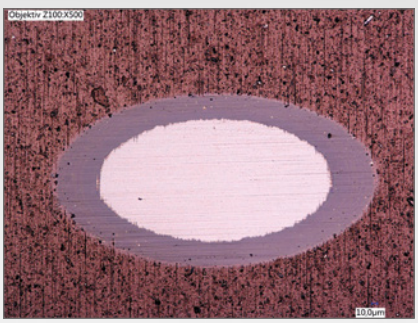
The coating technology Guhring predominantly relies on is the so-calledarc evaporation from the group of PVD processes (physical vapour deposition). Here the metallic target (i.e. titanium or titanium-aluminium) is vaporised by an arc, subsequently reacts with the admitted reactive gas (i.e. nitrogen) and consequently deposits on the tool as a coating (i.e. titanium (Ti) + nitrogen (N) ⟶ titanium nitride (TiN)). This process has largely developed into the global standard for hard material coating of cutting tools due to the high deposit rate, the very good coating adhesion and the high density of the coatings.
Alongside other PVD processes as for example thermal vaporisation and sputtering are applied at Guhring. Thermal vaporisation with which the initial TiN-coatings were deposited can still be found in the threading tool area. As well as for TiN it is also applied for depositing TiCN (titanium carbon nitride). The so-called sputtering (atomising) is suitable for nearly every target material. It is used for example in order to vaporise poor electrically conductive materials. An essential feature and advantage of both vaporisation types is the low coating surface roughness, making polishing following coating not absolutely necessary.

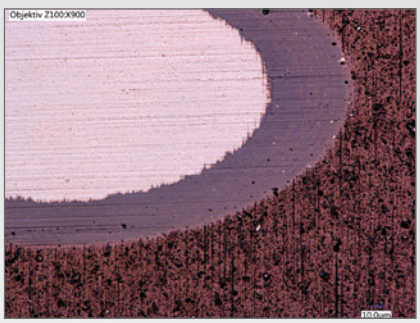
Guhring also uses the CVD process (chemical vapour deposition) according to the hot-filament principle for the deposition of diamond coatings in-house!

A spherical calotte is ground into the surface to be inspected using a steel ball as well as an abrasive fluid.
The ground form is sectioned through the coating up to the substrate lying underneath. The procedure serves to determine the wear resistance, the coating thickness as well as to evaluate the coating structure and is therefore an important element of a quality inspection.



Calotte grind in a multi-layer coating

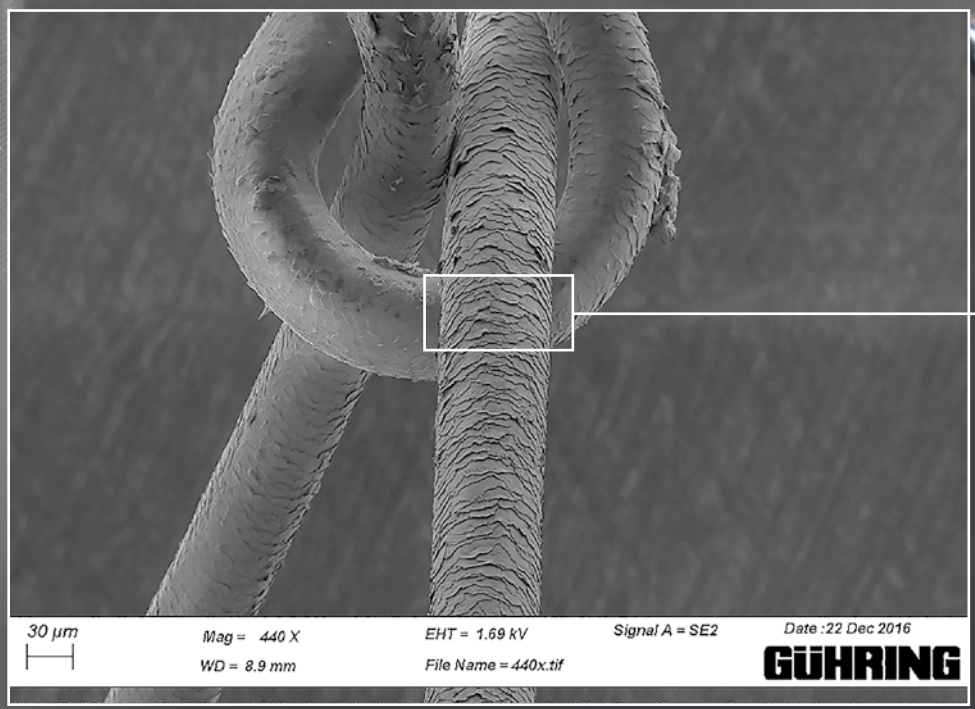




Calotte grind in a nano-structured coating

No matter how fine: Coatings can be adapted.

Features such as composition, micro-structure or hardness have a direct influence on wear resistance, cutting forces, surface quality or cooling lubricant consumption. Decisive is always that the coating is adapted to the specific application task. No matter which parameters are focused on dependent on the application an unbelievably thin coating always guarantees a significant effect.



Human hair

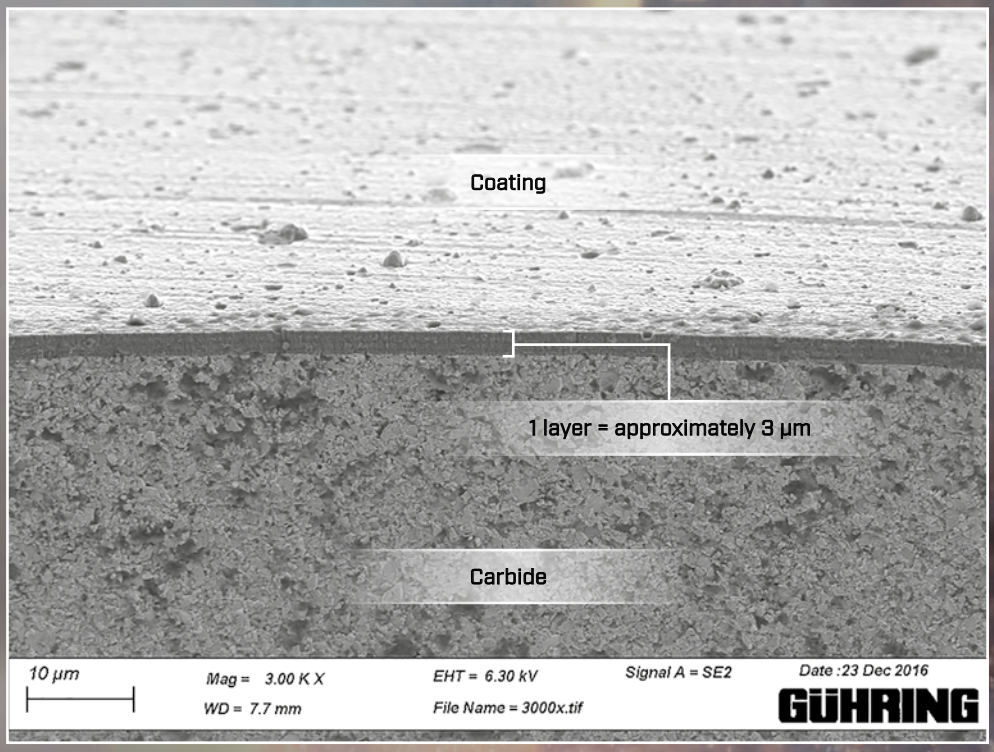
440 x magnification

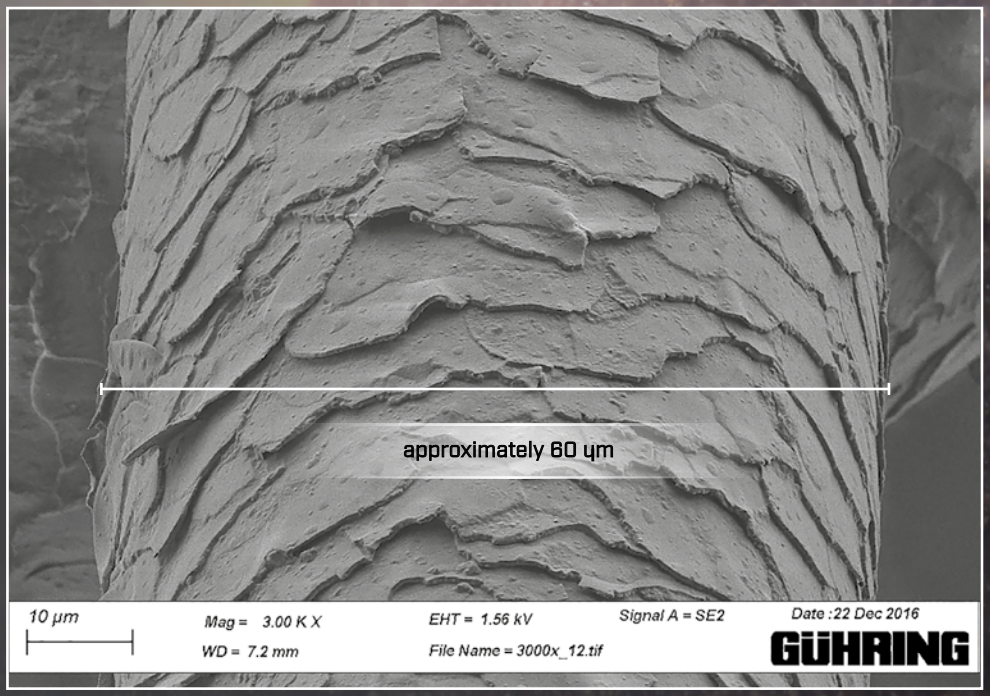
Thin coating, enormous effect

1 hair | 20 coatings

Fracture pattern
Arc-PVD coating
on carbide substrate

3000 x magnification,
approximately 0.003 mm





Human hair

3000 x magnification,
approximately 0.06 mm

In-house plant engineering

The efficiency of our coatings is not accidental but has to be developed by specific research for each application task. This is only achieved by close co-operation between the actual coating development and process engineering.

Guhring has established an in-house coating division that develops and manufactures new coatings as well as the necessary coating technology.
Thanks to in-house process plant engineering Guhring ensures the necessary precision, speed and flexibility to optimally adjust micro-geometry and coating to one another.

and our R&D

As well as coating systems, Guhring's in-house mechanical engineering also develops technologies for cleaning and de-coating systems for the pre-treatment and post-treatment of tools. The aim of the pre-treatment process is to better adapt the tool's micro-geometry to the respective application task and to improve the coating adhesion. Post-treatment is aimed at polishing the coated tool surface which further improves the application behaviour.

1st generation

world-wide first TiN-coating
on drills

2nd generation

TiN- / TiAlN multi-layers

TiN
p. 32

Fire
p. 33

TiCN
p. 32

TiAlN
p. 34

1980 1990

Coating evolution

3rd generation

high Al-content, nano-layers,
AlCrN-coatings, diamond-coatings

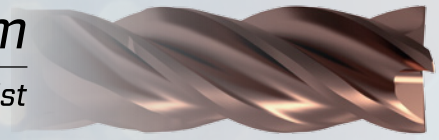
4th generation

nano-layers, nano-composite,
chip-adapted chemistry, DLC

2000 2010


highlights

Signum
Hard machining specialist



S. 18 – 19

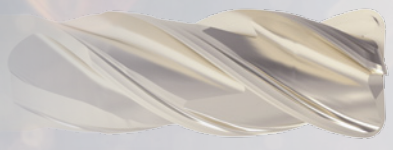
Sirius
VA specialist

S. 20 – 21

Raptor
Steel specialist

S. 22 – 23

Zenit
Titanium specialist

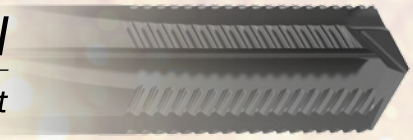


S. 24 – 25

Endurum
Steel drilling specialist

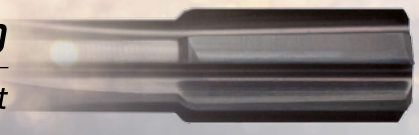
S. 26 – 27

Cristall
GFRP / CFRP specialist

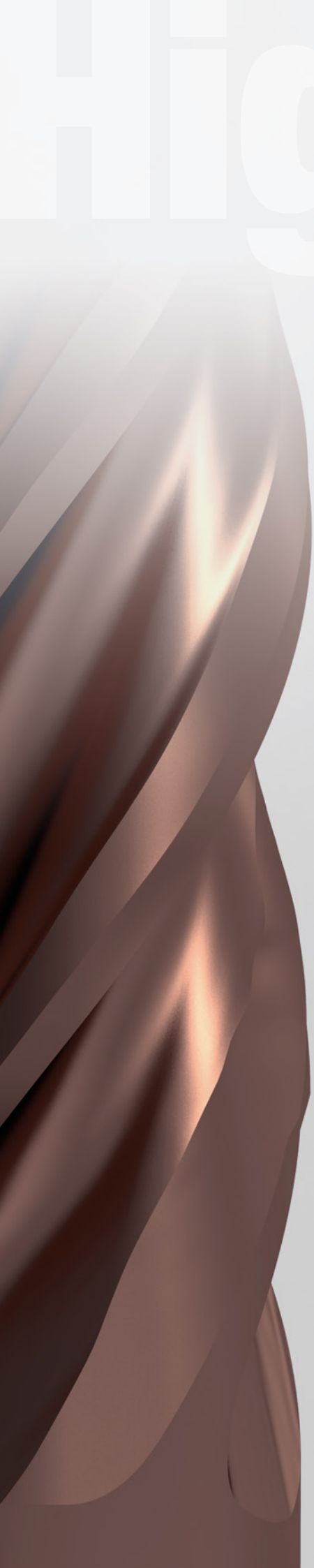


S. 28 – 29

Carbo
Non-ferrous metal specialist



S. 30 – 31



Highlight

Hard machining specialist

Signum

Y

Main application

Drilling / milling / reaming of hardened steels and cast iron

H — Hardened steel

K — Cast iron

- ***structure***
  multi-layer, nano-structure
- ***colour***
  bronze
- ***hardness***
  5500 HV 0.05
- ***application temperature***
  < 800 °C
- ***coating material***
  TiAlSiN-based

With a hardness of 5500 HV Guhring's in-house developed Signum-coating is one of the hardest nitride coatings on the market. Guhring was able to achieve this extraordinary coating hardness thanks to the special nano composite structure with a TiAlN and TiAlSiN layer structure. In these nano composite structures extremely fine TiAlN-crystals [<10 nm] are embedded in a glass-type silicon nitride matrix. This results in an extremely high hardness, that is retained even at high temperatures. As there are no continuous grain boundary networks in this structure, the diffusion of chip material is heavily impeded by the coating. Therefore, the Signum-coating provides an especially high wear-resistance and at the same time a high diffusion resistance.

Signum

Highlight

VA specialist

Sirius

S

Main application

Tapping in VA (through holes)

Drilling / milling in VA

M

Stainless

- ***structure***
  multi-layer, nano-structure
- ***colour***
  pale gold
- ***hardness***
  3400 HV 0.05
- ***application temperature***
  < 900 °C
- ***coating material***
  TiAlSiN-based with ZrN cover coating

When drilling in VA the cutting edges of cutting tools are subjected to extreme stresses. A mechanically especially wear resistant coating with a low friction value prevents damage to the cutting edges. Pre-requisite is a very low chemical interaction with stainless steels. The tough-hard TiAlN function coating guarantees a very high wear resistance. Zircon nitride in the cover coating significantly improves chip evacuation as the chemical reaction between coating and workpiece is reduced. Therefore, SIRIUS offers the best pre-requisites for the machining of VA materials.


Sirius

Highlight

Steel specialist

Raptor®

Main application

Drilling / milling of carbon, free-cutting as well as low-alloyed steels

Steel

- ***structure***
  multi-layer, graded
- ***colour***
  pale gold
- ***hardness***
  3300 HV 0.05
- ***application temperature***
  < 800 °C
- ***coating material***
  TiN / TiAlN based
  with ZrN cover coating

Guhring's Raptor-coating relies on a proven TiN and TiAlN multi-layer structure combined with a ZrN based cover coating. The multi-layer structure guarantees good values of hardness and toughness making it possible to limit the mechanical wear. The cover coating minimises the chemical reaction between the coating and the material to be machined thereby reducing the development of edge build-up and the adhesion of the material to the cutting edge as much as possible.

Raptor

Highlight

Titanium specialist

Zenit

Z

Main application

Drilling / milling of titanium-alloys

N — Aluminium

S — non-ferrous metals, plastics

- ***structure***
  multi-layer, nano-structure
- ***colour***
  pale gold
- ***hardness***
  2500 HV 0.05
- ***application temperature***
  < 700 °C
- ***coating material***
  TiAlN-ZrN based

With the pale gold Zenit multi-layer system the aluminium content of established coatings was specifically reduced and partly replaced with Zircon. This causes a minimised chemical reaction when coming into contact with titanium alloys. Thanks to the special structure of the coating system the reaction tendency between material and coating should be significantly reduced. Furthermore, this coating also brings significant benefits for the machining of cast aluminium (<10% Si) and wrought aluminium alloys. The focus here is primarily the prevention of built-up edges between coating and material.


Zenit

Highlight

Steel specialist

Endurum

E

Main application

Drilling carbon, free-cutting and manganese steel
at low and medium cutting speeds

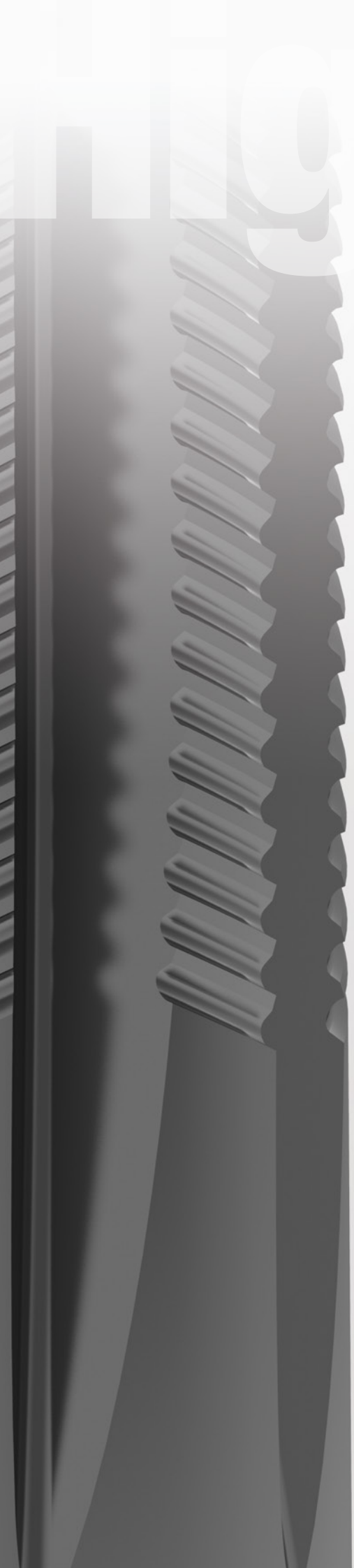
P

Steel

- ***structure***
  multi-layer with nano-layers,
  nano composite
- ***colour***
  copper
- ***hardness***
  4000 HV 0.05
- ***application temperature***
  < 800 °C
- ***coating material***
  TiAlSiN based

Thanks to a nano-layer structure as well as reduced aluminium content Endurum was specifically adapted for the drilling of low-alloyed steels such as carbon, free-cutting and manganese-alloyed steels. By adding silicon it forces a nano composite structure causing a high hardness. In addition, thanks to the composition the reaction tendency is decisively reduced. Especially with low and medium cutting speeds it is the first choice for drilling operations.

Endurum



Highlight

GRFP / CFRP specialist

Cristall

D

Main application

Drilling / milling of graphite, ceramics, fibre-reinforced plastics, aluminium-alloys (≥ 12% silicon)

N

Aluminium, non-ferrous metals, plastics, graphite, ceramics

- ***structure***
  single-layer, micro-crystalline
- ***colour***
  grey black
- ***hardness***
  8000 HV 0.05
- ***application temperature***
  < 600 °C
- ***coating material***
  carbon

Like its naturally occurring relative, this diamond-coating possesses an outstanding hardness in excess of 8000 HV. Thanks to the so-called sp^3-structure in which the carbon atoms with both materials are spatially arranged, Cristall is qualified for highly abrasive applications such as for example the machining of GFRP and CFRP, aluminium-alloys, ceramics and graphite. Thanks to different coating thicknesses it is adapted to the specific application task. Due to the high coating temperature it is only possible to deposit it on carbide. Thanks to Guhring's in-house carbide production this is not a problem. Process related re-grinding and re-coating is not possible.

Cristall

Highlight

Non-ferrous metal specialist

Carbo

Cb

Main application

Drilling / milling / reaming / threading in aluminium and aluminium-alloys (up to max. 10% Si)
non-ferrous metals (copper, brass, bronze)
GFRP / CFRP, wood

Aluminium,
non-ferrous metals, plastics

- ***structure***
  single-layer
- ***colour***
  grey black
- ***hardness***
  5000 HV 0.05
- ***application temperature***
  < 500 °C
- ***coating material***
  carbon (ta-C)

Thanks to its composition of 100% carbon and its high spatial bond content (sp^3-content >60%) Carbo displays a high hardness and application temperature. Therefore, this also as ta-C (tetrahedral carbon) described coating type is suitable for a wide field of applications. Carbo closes the gap to Cristall, where un-coated tools or conventional carbide grades fail. For example, it concerns the machining of aluminium and aluminium-alloys (up to max. 10% silicon), non-ferrous metals, GFRP / CFRP or wood. Up to a certain abrasive stress the considerably more expensive diamond-coating can be substituted by Carbo. In addition, the coating of HSS and carbide as well as re-grinding and re-coating is possible.

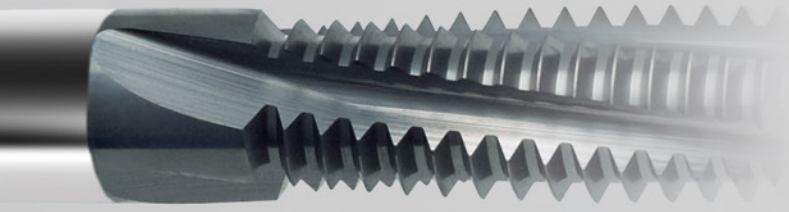
Carbo

Basic protection

S

TiN

Guhring already in the early 80's introduced TiN-coating which can be applied for drilling and milling on HSS as well as on carbide as a cost-efficient broadband coating. It is still particularly widely spread in threading applications.



C

TiCN

Due to the additional embedding of carbon, TiCN distinguishes itself with a higher toughness, hardness and a reduced friction coefficient compared to TiN. With its high wear resistance it is very well suited for more abrasive threading applications.

Broadband protection

Fire / nanoFire

The Fire-coating was introduced at the end of the 90's.
Its further development nanoFire came on the market in 2008.
As well as titanium and nitrogen the coating also includes aluminium and distinguishes itself with a higher hardness as well as an improved thermo-chemical resistance. It is suitable for coating HSS as well as carbide.
To today it is a very good choice for drilling and milling steel.

Broadband protection

A

TiAlN

The TiAlN-coating with its titanium-aluminium structure displays similar characteristics to Fire and nanoFire. Thanks to its single-layer structure it is especially suitable for the coating of micro-precision tools.

A

SuperA

The single-layer and aluminium rich SuperA is for example applied for milling hardened steel or titanium-alloys due to its high hardness and oxidation resistance.

Broadband protection

nanoA

The TiAlN based nanoA has proven itself especially in the machining of stainless steels, but is sometimes also applied for drilling and milling of cast iron, titanium, nickel based and cobalt-chrome alloys. Its nano-layered structure delays the fracture growth.

Individualist

Ice

The titanium, aluminium and chrome based Ice specialises in the machining of non-ferrous metals, e.g. copper-alloys as well as bronze and brass.

Adapting your tools to your requirements

GUHRING

Special solutions

The application conditions during the cutting process as well as the demands on the cutting tools themselves are becoming ever more complex and individual.

Boundary conditions for tool adaptation:

- ***Cutting parameters***
- ***Material***
- ***Workpiece***
- ***Demanded workpiece dimensions and surface finish quality***
- ***Tool life***
- ***Cycle times***
- ***Machine influence***
- ***Cooling***

To be able to map this complexity, more and more customer specific special solutions are applied in tooling as well as in coating.
The demand for special tools is constantly increasing.
In this context not only macro- and micro-geometry is adapted to the specific machining task but also the coating is selected accordingly.

Service centres

Our support from the service centre

Speed requires short routes, therefore, we have developed in excess of 50 service centres for you world-wide – and are constantly increasing this service. All service centres are equipped with high-performance production machines and Guhring developed coating systems. Every service centre has its own collection and delivery service. This way we can process your orders saving time and money. We provide this high-tech upgrade with Guhring coatings also for non-Guhring products.

Resource conservation

Reducing tooling costs

Re-grinding to original geometry

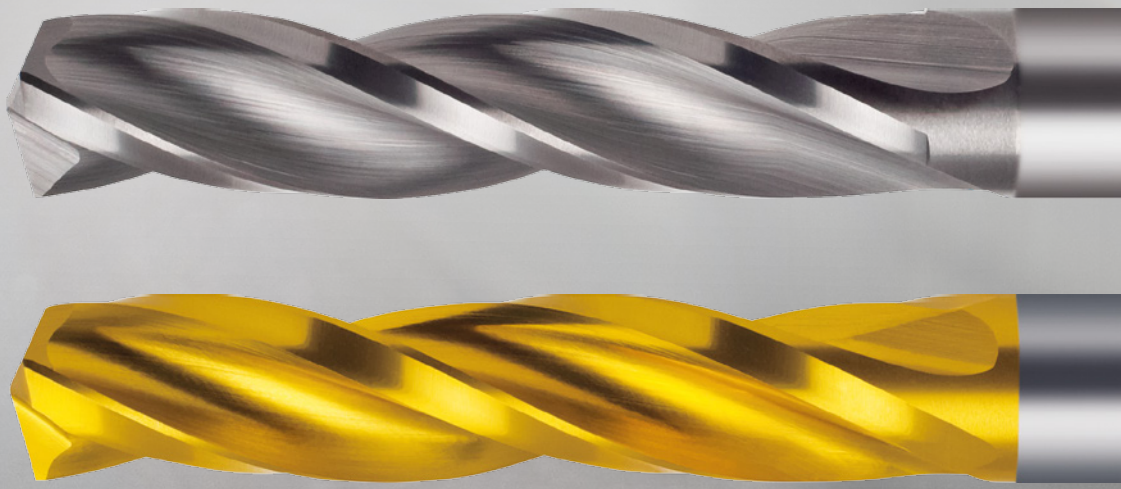
Re-grinding and re-coating non-Guhring tools

Collection and delivery service

Available world-wide

Tool refurbishing

Re-grinding and re-coating



EUROPE

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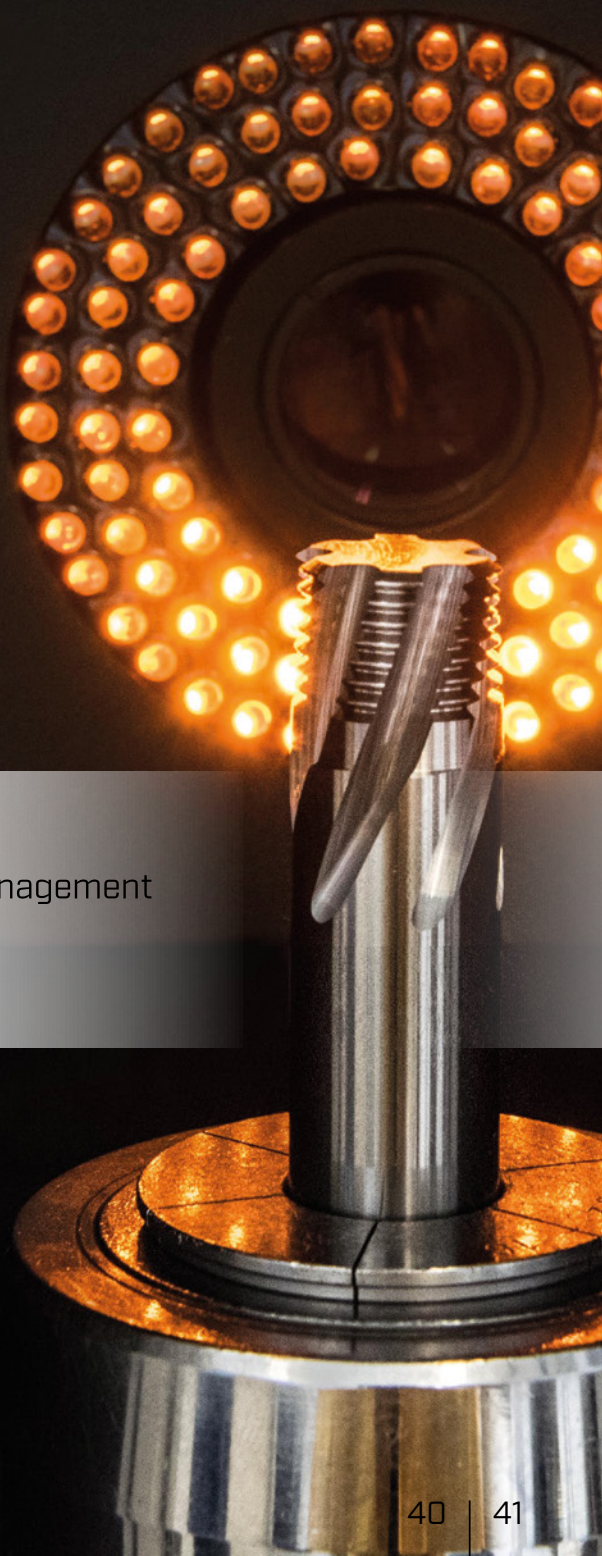
What lasts long is good

Sustainability & certifications

Whether during machining, coating or refurbishing:
Solutions from Guhring revolve around reducing the requirement and increasing the performance at the same time. Longevity and a lower consumption of resources, be it operating materials, energy or raw materials, ultimately mean reduced pollutant emission, more efficient production, lower process costs and improved sustainability.

Pre-requisite for these successes is the high priority Guhring attaches to the best possible quality of its products and services.



This is why Guhring is certified to:

ISO 9001:2008 Quality Management System
ISO 14001:2004 + Cor 1:2009 Environmental Management
ISO 50001:2011 Energy Management
VDA 6.0 part 4 with product development

GUHRING

Coatings

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