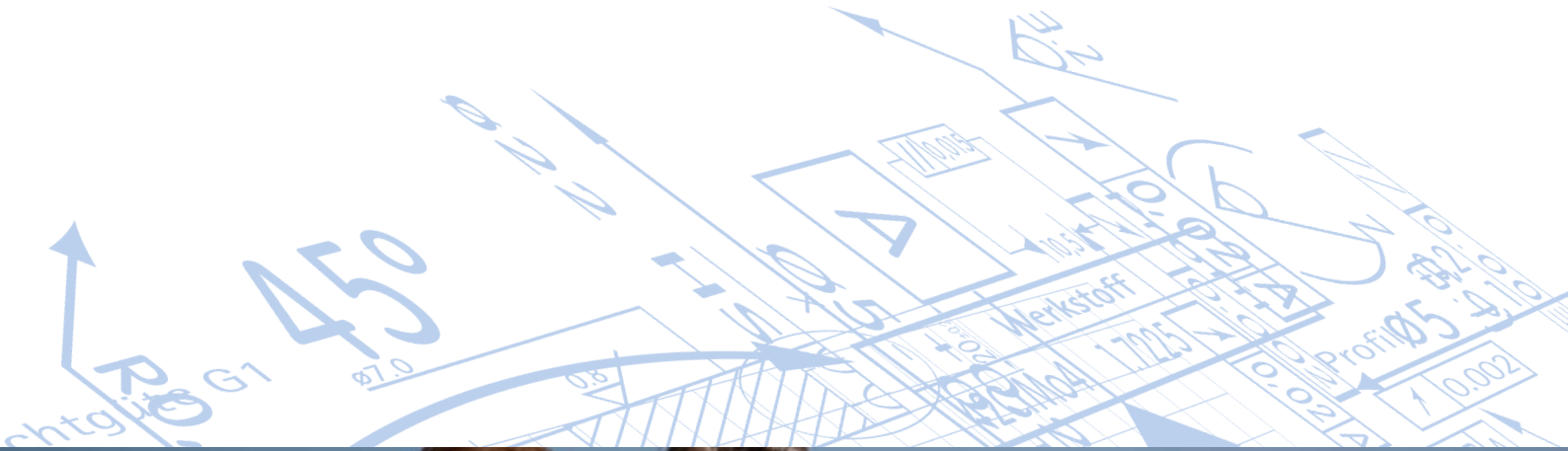


WINTER

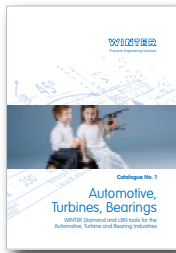
Precision Engineering Solutions



Catalogue No. 1

Automotive, Turbines, Bearings

WINTER Diamond and cBN tools for the
Automotive, Turbine and Bearing Industries



Catalogue No. 1: Automotive, Turbines, Bearings

WINTER Diamond and cBN Tools for the Automotive, Turbine and Bearing Industries



Catalogue No. 2: Tools

WINTER Diamond and cBN Tools for the Tools Industry



Catalogue No. 3: Flat and Crystal Glass

WINTER Diamond Tools for Machining Flat and Crystal Glass



Catalogue No. 4: Electronics, Photovoltaics, Optics, Ceramics and Composites

WINTER Diamond and cBN Tools for the Electronic and Photovoltaic Industries, for Machining Optical Glass, Ceramics & Composites



Catalogue No. 5: Dressing Tools

WINTER Diamond Tools for Dressing of Grinding Tools



Catalogue No. 6: WINTER Standard Catalogue

Stock Programme for Diamond and cBN Tools

WINTER

Precision Engineering Solutions

Automotive, Turbines, Bearings

WINTER Diamond and cBN Tools for the
Automotive, Turbine, Bearing Industries

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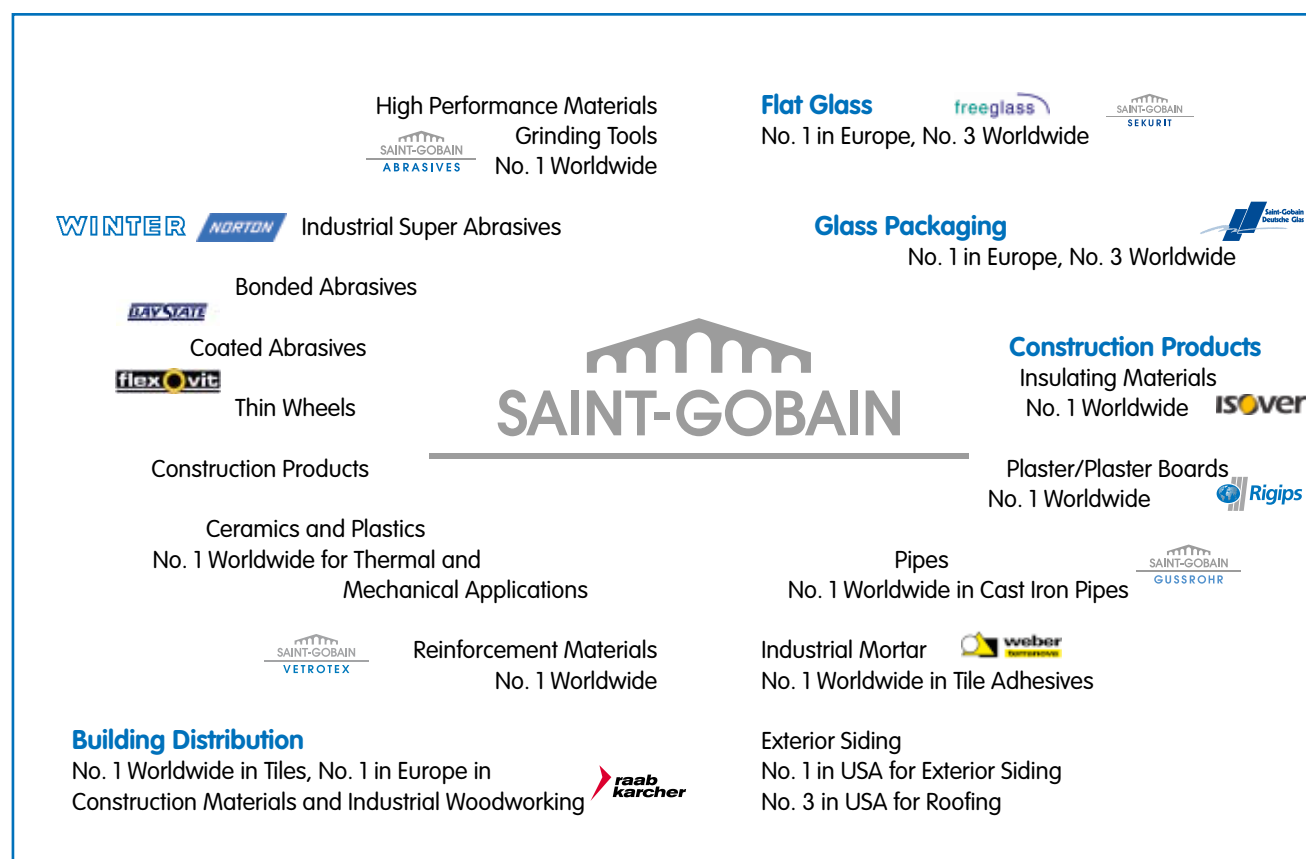


A good Connection

Always close to the customer and customer-focused, our diverse market presence worldwide reflects the strength of a global player. Saint-Gobain's businesses are spread over 45 countries and new locations are being added frequently. Activities are clearly structured to ensure operational leadership. In Abrasives alone, over 16,000 people are employed. The company is the only manufacturer to offer a comprehensive product range of abrasives and dressing tools for almost all fields of industry. WINTER, as the premium brand for diamond and cBN grinding products, is one of the most well established and respected names in the market. Our combination of quality products, expertise and service, together with the international network of the parent company Saint-Gobain, is the key to success; WINTER grinding tools go with you worldwide, and lead you to your goals.

Saint-Gobain...

- ...was established in 1665 to supply glass for the Hall of Mirrors in the Palace of Versailles.
- ...kits out every second car in Europe with window glass
- ...establishes or acquires a new sales location every day
- ...inaugurates a new plant or a new production line every month
- ...presently has 206,000 employees
- ...generates € 43.4 billion annual turnover



Worldwide Expertise

Saint-Gobain is in the top one hundred largest industrial groups in the world and is leading in the production of glass, high performance materials and construction products. Two major milestones stand out in the Saint-Gobain Group's long history; it was established in 1665 by Colbert under Louis XIV, then, over 300 years later, Saint-Gobain and Pont-à-Mousson merged in 1970. WINTER joined the group in 1996. Today, the group invests € 390 million per year in research and development and files around 300 patents per year, to support its reputation for innovation and discovery.

The WINTER Brand:

For over 160 years WINTER has been a worldwide synonym for high-quality diamond and cBN grinding tools for industrial production. As pioneer and trend-setter, WINTER has been actively involved in the development of the success story of grinding, as well as in the production of synthetic diamonds.

Custom-made Solutions - the key to success

Over 75% of all WINTER products are developed in close cooperation with our customers. The results are tailored grinding solutions that perfectly fit your special requirements. Our expert teams would also like to help you. Together we will meet your technical challenges.

Market Leader - in front through quality

In Superabrasives, WINTER is No. 1 in Europe with quality products and services. In Europe, over 500 employees in four production sites take care of our customers' needs. Worldwide, over 2,000 people are employed in our global business.

INNOVATIONS

To this day, the WINTER philosophy is closely connected to innovation and technical progress. We thank our customers for over 160 years of momentum, challenges and confidence. **And in the future our next generation of innovations will ensure your success.**

PRECISION

From ACCURACY to Z-AXIS - the WINTER precision alphabet spells the suitable solution for your needs. Profile accuracies below 1 µm and a surface finish in the nanometer range are achieved regularly. **You can trust WINTER.**

WINTER

PERFORMANCE

The WINTER performance package contains top quality precision grinding tools, comprehensive service and individual customer care - which ranges from best grinding tool selection through to process optimisation. **Benefit from our full service, and make use of our leading technical expertise to increase your profitability.**

QUALITY

Since the foundation of the company, WINTER has stood for quality at the highest level. It begins with the first customer contact, and covers the identification of appropriate tool specifications, manufacturing, customer support and the final optimisation of your production process. **WINTER quality: Satisfaction guaranteed!**

Quality, Environmental Protection and Safety

As a responsible manufacturer of quality grinding tools, WINTER production is eco-friendly and avoids waste of precious resources according to the latest international standards and certification requirements. WINTER is certified to ISA 9001 (Quality Management), ISO 14001 (environmental management) and OHSAS 18001 (health and safety management). All rotating WINTER tools bear the OSA safety seal (OSA: Organization for the Safety of Abrasives), granting WINTER the customers' highest safety tool in application.



Snapshots of a long history

WINTER was established in 1847 by Ernst Winter as a family-owned company. We still adhere to the original goal of developing ultra-hard crystal tools of the highest quality. Our claim is to be the best. In numerous fields of application for diamond and cBN grinding tools we have been pioneers, and today we still follow this way as trend-setters and the technology leader.



Ernst Winter

Goldsmith and diamantaire, started his diamond tool workshop in 1847.

WINTER in Hamburg

1872: WINTER's first company building in Hamburg.



With WINTER to Outer Space

Laser reflectors ground with WINTER diamond tools enable the most accurate astronomic and geographic measurements.



Posters and Brochures in the course of time



Success from the beginning

Former letterhead and contemporary advertisement of WINTER with images showing medals received at important exhibitions.



Celebrities

Even Helmut Schmidt (Federal Republic of Germany's former Chancellor) acted as a WINTER "diamond maker" in 1983.

Innovations: Yesterday's vision of the

WINTER bridges the combination of inventive skills, creativity, identification of challenges and the ambition to meet our customers' expectations: WINTER developments of the past are found in industrial museums. Yesterday's vision of the future is today's standard. We are committed to over 160 years of company history: Today and in the future, we work hand in hand with our customers on innovations and their economical implementation.

1847

WINTER produced lithography diamonds, replacing the conventional steel tips.

1969

As the first grinding tool manufacturer world-wide, WINTER presented cBN grinding tools with a special resin bond (KSS) for HSS tool grinding.

2008

WINTER offered metal bonded tools with internal cooling for creep-feed glass edging.

1935

WINTER produced the first phenolic bond grinding wheel to replace previously used grinding wheels with loose, hammered or rolled-in grain.



2006

With Q-Flute® Dress, WINTER offered the first resin bonded grinding wheel dressable with a diamond rotary dresser.

1975

WINTER DMC diamond grinding wheels and BMC cBN grinding wheels came into the market: WINTER MC grinding wheels allow cost-effective profile grinding for difficult to machine work pieces. They also reduce thermal effects of the near-surface microstructure and assure extremely long profile lifetime. WINTER DMC and BMC grinding wheels can be profiled by crushing directly on the grinding machine.

2001

WINTER introduced special cutting wheel products for slicing advanced ceramics like SiC.



1993

WINTER SG-CNC rotary dressers conquered the market. They have made dressing of vitrified cBN grinding wheels possible.

1958

WINTER was the first in Europe producing grinding tools with synthetic diamonds. In combination with WINTER special resin bonds, full performance benefits were achieved.

1988

New super-light cutting wheels with carbon fibre bodies were patented.

In|no|

1548. from L. innovatus, pp. of innovare "to renew or change", from in- "into" + novus "new".

WINTER
Facts

Automotive

Turbines

Bearings

Service
Glossary
Contact

e Future

1971

At the European Machine Tool Exhibition WINTER showed for the first time a novel grinding wheel type that met the demand for short grinding cycle times. The structure of metallic and non-metallic bond components allows the efficient grinding of tungsten carbide and steel combinations. (M+789).



2003

WINTER developed the DDS (Diamond Dressing System), permitting the dressing of vitrified and resin bonded grinding wheels directly on the production machine. Until then, it was performed on external machines. Due to its free standing layer, outstanding profile grinding capability is achieved.

1992

New standards are set with the "34SG" series in the field of laminated safety glass and fire-resistant glass machining.

1929

WINTER started producing diamond micro-grain by the sedimentation process.

1875

Delivery of WINTER diamond particles to Zeiss Jena, enabling the engraving of 150 lines per millimeter.

2006

N7 as a glass-ceramic bond system was introduced to the market. This bond can be precisely engineered to meet individual customer application requirements: Very high bond-hardness, optimised wetting of the grains and perfect development of bond bridges enable the creation of very high porosity for cool grinding and extremely long tool life.

1950-1954

WINTER developed a large variety of electroplated tools: Files, grinding pins, cutting wheels, drills...

1982

The patented dressing process "TDC" (Touch Dressing cBN) was developed by WINTER.

1977 / 78

WINTER presented the special bond "VF/VFF" for grinding and finishing polycrystalline diamond and cBN materials.

1996

For four generations the company, founded by Ernst WINTER in 1847, was family-owned. In 1996 it was taken over by the French Saint-Gobain group.



2008

WINTER tools "Ti-Tan" and "Furioso" are a new generation of extremely wear-resistant stationary dressers.



2001

"Tiger" caused a stir with a new revolutionary grinding wheel geometry for narrow tooth gaps in saw manufacturing.

Your best solution

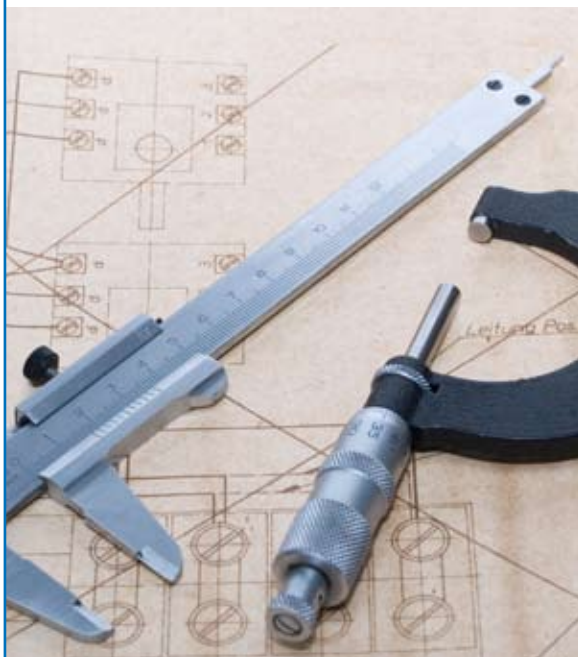
WINTER diamond tools gain great recognition in the fields of quality, performance and cost effectiveness. This is no coincidence, as WINTER is not limited to manufacturing excellent grinding tools: more than 75% of the cases are tailor-made solutions, developed in close cooperation with the customer. This successful engineering is based on a modular performance package, specifically equipped according to individual needs.

Tailor-made products

Optimised grinding solutions for your specific application provide the greatest benefit: In the end, you generate cost savings through more productivity, less down time, and better quality.

Each one of your technological challenges is an incentive for our product managers and our application engineers to achieve the best grinding results. Please contact us.

Besides the high percentage of custom-made solutions, WINTER offers a comprehensive range of stock products - and can supply these short term straight to your production line.



Focused on the goal ahead

Comprehensive technical advice in all questions about WINTER products and grinding processes. Our field sales force and our customer service are at your disposal.



Advice

Expertise

Advantage in accumulated knowledge: Seminars about current grinding issues as well as training programs matching our customers requirements.



Product Development

The cream of the crop

In order to meet your production-oriented challenges, take advantage of our dedicated specialists: In the R&D department and the European Grinding Technology Centre about 50 scientists are at your disposal for developing grinding tools and processes.

Solution

Process Optimisation

Fine Tuning

Our application engineers and our product developers will help you. Either at your premises, or in our EGTC (European Grinding Technology Centre), where we can optimise your production process, without interfering with your workflow.

Trainings

Please ask your sales advisor - contact details on the last page.

Why are there no order numbers in this catalogue?

We take pride in finding innovative solutions for our customers' individual challenges. Optimised high-performance grinding tools, with either cBN or diamond as the superabrasive grain, are finely tuned and customised to your needs and requirements.

Therefore, you will not find any stock products in this catalogue, but an overview of example applications, corresponding grinding tasks and WINTER solutions offered.

Where extensive applications need to be analysed, where advanced technology is required for process optimisation, WINTER is your perfect partner. We see ourselves as a supplier of highly-developed grinding solutions. Our service includes more than simply supplying grinding tools. We closely cooperate with our customers in order to continuously improve existing grinding processes, enhance product quality, and minimize costs.

For over 160 years, our customers have had full confidence in our reliability and expertise. Then as now, we are setting trends in all industrial markets with tailor-made customer solutions. Innovation, performance, quality and technological excellence deliver unique grinding solutions.

WINTER grinding tools are the perfect match when you are...

- ...machining hard or soft materials
- ...grinding short-chipping or long-chipping materials
- ...wet or dry grinding
- ...surface-grinding, OD grinding or ID grinding
- ...roughing, finishing, peel grinding, angular or straight cut
- plunge grinding
- ...high-volume production grinding or
- ...looking for a unique special solution
- ...

WINTER solutions will help you to achieve economic production, higher productivity, and best quality in the ever increasing demands of your market.

Innovative Ideas and new Strategies

Basic Research

WINTER's ISO certified production and planning processes, continuing development and rigorous research pave the way for our customers' ongoing success. Under the umbrella of Saint-Gobain, the world renowned producer of grinding products, WINTER enjoys all the advantages of a global player.

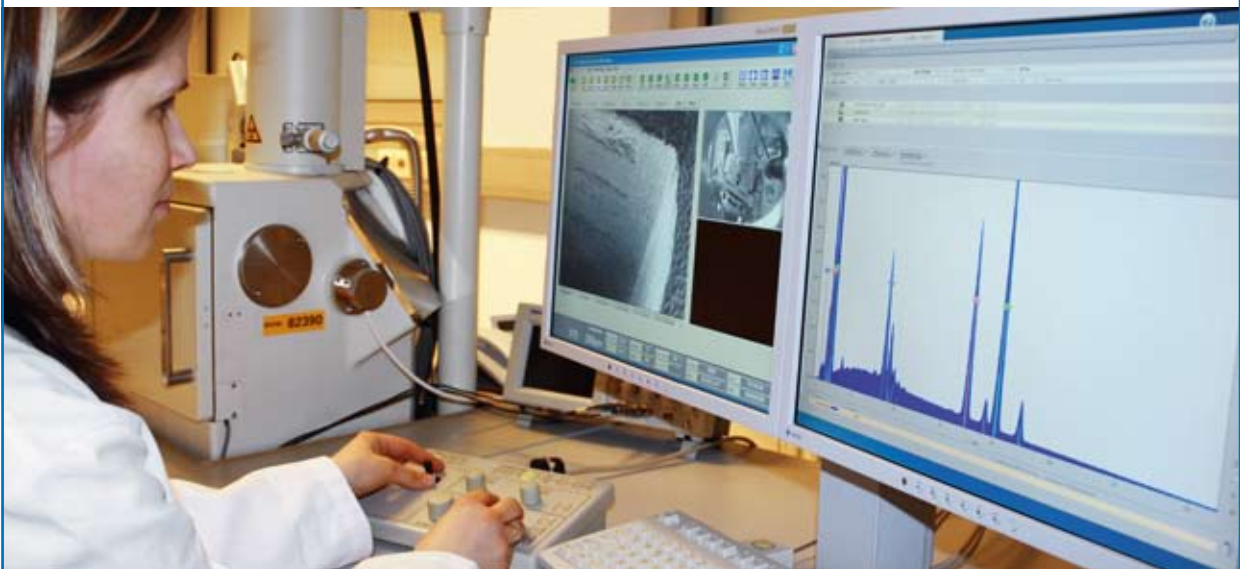
WINTER specialists, located in a worldwide network of competence centers (one is located at the production site in Norderstedt, amongst others) have access to an enormous worldwide knowledge base for grinding applications. Practically-oriented research, as well as targeted cooperation with laboratories in diverse specialist fields, ensure ongoing development and improvement of grinding tools.

Application Development

Especially for industries such as automotive, turbines, aerospace, electronics and tools, the European Grinding Technology Centre (EGTC) is a key element of WINTER's market strategy and customer orientation. By closely simulating real production conditions, new grinding tools are developed, prototypes are made, and their qualification and capability are tested and optimised.

Optimisation of Customers' Processes and Products

Are you faced with technical grinding challenges? Our product managers are keen to find new tailor-made solutions together with you. Our dedicated application engineers are ready to support you in all aspects of grinding technology.



We are market leader in customised superabrasive grinding solutions.

Diamonds are Forever and we have

WINTER offers a wide range of different bond systems. Each of them is specially designed to meet the individual characteristics of specific grinding methods. In the automotive, turbine and bearing industries, the bonds most frequently used are electroplated and MSL™ for single layer and vitrified bonds for impregnated tools.

Advantages of electroplated Bonds:

- High material removal rates, achieved by high cutting speed and distinct grain protrusion.
- Excellent product quality, even with difficult to machine materials like rubber, carbon fibre, etc.
- Grinding wheel bodies can be produced in individual, complex profiles. In an electroplating process diamonds or cBN are applied. A high profile accuracy is achieved, which lasts throughout the entire lifetime of the tool. Bodies can be replated several times as a worn electroplated layer can be removed without damaging the body.

These advantages make electroplated tools particularly suitable for roughing and chamfering, slot and profile grinding.

Features and Applications

Tolerance codes for electroplated tools	Tolerance range*	Application examples
S (mainly diamond)	± 100 µm	Cast materials Magnetic materials
SE (mainly diamond)	± 80 µm	Fan belts Turbine blade ends Knives Slotting of piston rings
SH (mainly cBN)	± 5 µm	Camshafts Crankshafts Gearshafts Turbine blades Valves

The required tolerances of single layer electroplated grinding wheels are dependent on the profile accuracy of the body and the grit size applied. The tolerances stated are a guideline. However, they are also influenced by the profile.

*Tolerance range refers to wheel diameter, based on grit size B213

MSL™ Technology (Metal single layer)

MSL™ Technology (Metal single layer) describes a brazed, single layer metal bond. The chemical compound of bond and grit leads to extremely high grain adhesion. Therefore, a large grit protrusion of up to 65 - 70% of the grain size is achieved.

Advantages of MSL™:

- Significantly higher removal rates compared to conventional electroplated products
- Considerably longer lifetime through chemical bonding of the abrasive grains

Typical Applications:

- Abrasive composites, such as friction materials
- Metal-matrix composites (brake pads)
- Elastomers
- Graphite
- Resin bond composites
- Thermoplastics

Automotive, Turbines, Bearings

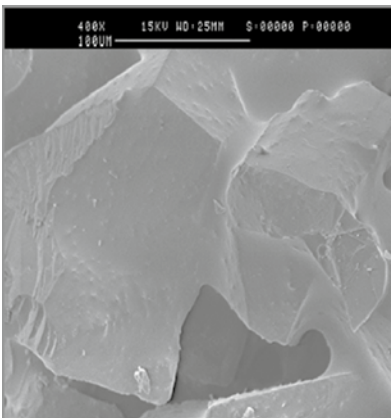


the best Bond for you

Advantages of vitrified bonded Grinding Tools :

- Low temperature grinding due to very good coolant supply into the contact area
- Free cutting ability because of high porosity and self sharpening behaviour
- Low wear caused by tough bonds and strong grit retention
- Less downtimes because of quick and easy profiling, combined with very high profile accuracy
- Maintaining very good surface quality by dressing
- High material removal rates due to high cutting speeds
- Individual layer specifications for sintered, cast or long-chipping materials
- Tight tolerances, even under thermal load

These benefits make vitrified bonds especially effective for fully automated precision grinding processes, as typically used in the automotive, turbine and bearings industries.



The characteristic formation of the bond bridges allows a high pore volume. On the left side a bond bridge is shown, which connects two grains.

The grain adhesion is extremely high because the grain is well wetted, as seen in the curved surface of the bond between the grains.



Optimised for best Results

WINTER vitrified bonds are designed to cater to customer-specific grinding applications. The precise design of bonds is a prerequisite for an optimised grinding result, leading to higher productivity and/or cost reduction in production processes.

Successful WINTER Bond Series include

Bond Series N7	Very high bond hardness, optimal grain wetting, well developed bond bridges: highest porosities for cool grinding and extremely long lifetime.
Bond Series DX40	Very high bond hardness, optimal grain wetting and well developed bond bridges: ideal for grinding large contact lengths, i.e. when ID grinding
Bond Series 46	High profile stability and extreme wear resistance: designed for peel grinding and for thin grinding layer
Bond Series 41	High profile accuracy and high material removal rates in peripheral grinding
Bond Series 43	General purpose, soft acting: ideal for grinding operations which include a face grinding component.
Bond Series 47	Soft grinding, low thermal impact, good for large contact areas
Bond Series VA	Free grinding, especially for face grinding or double disc grinding with large contact areas



Automotive

Rarely has another industrial product changed the life of human beings as much as the automobile. With its invention in 1886, the heart of a new flourishing sector of the economy started beating.

The economic boom was unprecedented: Factories became industries, production sites arose worldwide. Component suppliers specialised, concentrated on core competences and further pushed development.

Information

Please refer to our catalogue "Dressing Tools" to find tools for profiling and dressing of vitrified bonded grinding wheels.



Grinding Applications for Engines and Gearboxes

The most successful companies in the automotive industry are those which meet current and future market requirements. These include primarily:

- lower carbon dioxide and noise emissions
- economical but high-performance engines
- increased reliability combined with longer maintenance intervals
- lower cost price

To meet these demands the machining of engine and gear components and assemblies is critical; both quality and quantity are priorities. To achieve these volumes at the highest quality it is essential that high performance machines and tooling are used. WINTER grinding tools with vitrified bond help to meet these arduous requirements.

Constant Velocity Joint

Constant velocity joints are put under extreme stress by the continual transmission of drive forces especially when operating at acute working angles. The manufacture of these technically advanced components requires the use of high performance grinding tools which deliver outstanding results. Very tight tolerances must be achieved, especially for internal grinding. More on page 24.

Fuel Injection System

Fuel injection systems are important for best efficiency and performance of an engine. The system has not only to withstand pressure up to 1,200 bar, but designs are becoming more complex for better fuel nebulisation. This can only be achieved with grinding tools that can produce extremely smooth and accurate surfaces. More on page 27.

Crankshaft

The crankshaft transfers the energy of the combustion cycle, with as little loss of power as possible and under heavy thermal and mechanical load, to the transmission. Therefore, design and production of crankshafts require extremely wear-resistant materials - and perfectly adapted tools to grind them most accurately. More on page 23.



Valves

Valves are made from tough and hard materials. The precision grinding of the seats and grooves is quite a challenge: the surface of these difficult to machine materials has to be precise to micron tolerances. Only then they can cope with the extreme thermal and mechanical loads to which they are exposed when opening and closing the engine cylinder. More on page 25.

Gears

Today's automotive users demand several years of trouble-free engine performance and power conversion in day-to-day operations. Correct gear geometry and surface quality assure perfect functionality resulting in smooth transmission and extended life of the gearbox. More on page 28.

Brake Pads

Braking performance is crucial to the safe operation of any motor vehicle. Brake pads, and other friction materials such as clutch plates, are made from highly thermally stable and abrasive composite materials, and must be precisely shaped by using diamond grinding tools. More on page 27.

Flat Belt

Flat belts drive the alternator, water pump and fan. They are usually made from elastomeric materials. As composites, they make great demands on the grinding tools, which are necessary to machine the typical drive tooth profiles. More on page 29.

Cylinder Liners

Cylinder liners made of advanced material cope with high engine speeds and increased cylinder pressures. More on page 26.

Hydraulic Cam Followers

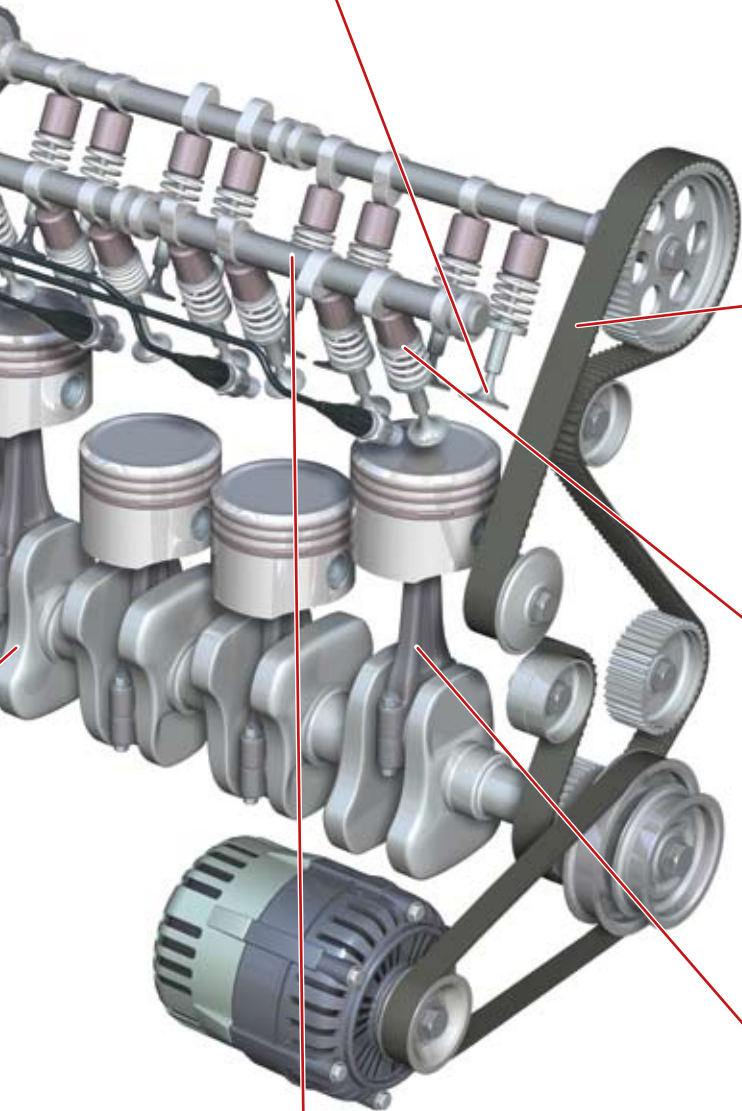
The use of abrasives for the production of hydraulic cam followers is necessary to achieve perfect geometry and high surface quality. A million times during an engine's lifetime, these wear resistant components contribute to smooth running between the valve and the camlobe - and therefore guarantee high engine performance. More on page 26.

Camshaft

The balance and smooth running of the engine depends on the camshaft. The grinding process requires the highest degree of accuracy, which can be obtained by the use of high quality grinding tools in this challenging environment. More on page 22.

Con-Rod

The higher the precision of the ground surface, the better the performance of the engine. The connecting-rod converts the piston stroke via the crankshaft into a rotary motion. Precision grinding contributes significantly to engine efficiency. More on page 29.



Camshaft

An engineered system for impressive results:

Vitrified bonded cBN grinding tools for machining camshafts are extremely economical. They are of the highest quality and are well designed for each application. Optimised surface quality, roundness, straightness and conicity can easily be achieved.



Camlobe

Several grinding processes are required to machine the different parts of the camlobe. OD-grinding of the cam nose and cam base circle, as well as flat grinding of straight or concave cam flanks are the challenges. For roughing, electroplated and vitrified bonded grinding tools prove to be the best, while for finishing vitrified bonded tools stand the test.

Post/Flange

Different materials, large contact areas: for high-precision angular plunge grinding of post ends and flange ends, vitrified bonded cBN grinding tools of the bond series 47 and N7 are recommended.

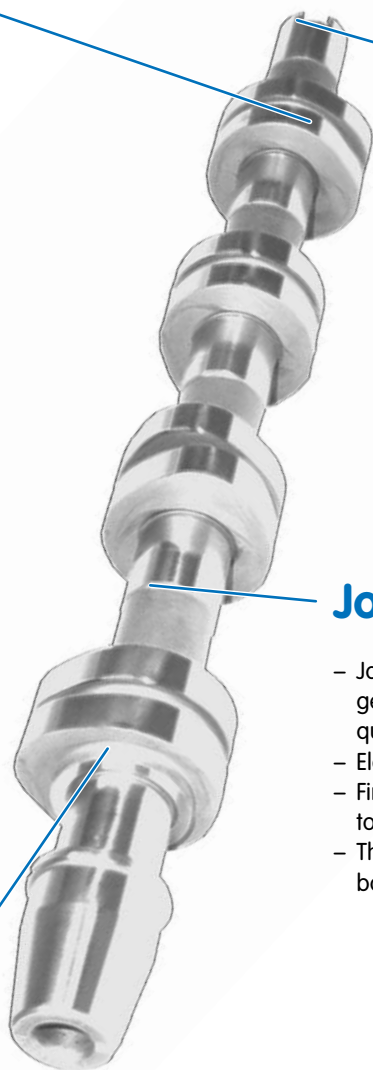
Journals

- Journals made of steel or chilled cast iron require precise geometries, extremely good roundness and best surface qualities.
- Electroplated tools prove to be best in roughing.
- Finer grinding processes require vitrified bonded grinding tools
- The first choice for finishing are either 46 bond or N7 vitrified bonded tools.

N⁷
CAM

Cam Bore

Fitting the ground cams onto the cam shaft calls for tight tolerances. Assembled cam shafts consist of a mandrel, onto which individual cams are shrunk. The bores of the cams can be machined reproducibly, accurate to size and economically, by using vitrified bonded cBN grinding pins. The WINTER bond N7 meets these requirements.



Crankshaft

Deal with constant loads:

For crankshafts, the market requires an operational performance of up to 1.000.000 km. To achieve the desired endurance and strength, high surface quality and precision ground journal geometries are necessary. This calls for vitrified bonded cBN grinding tools.

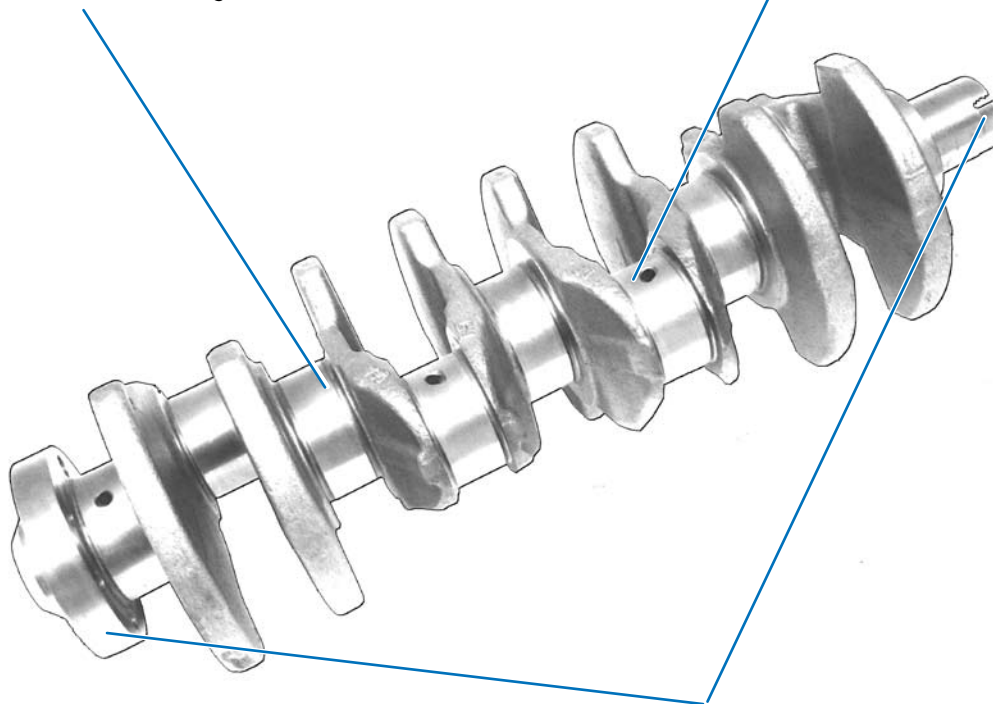


Thrust and Main Bearing

Main bearings are ground concentrically to the rotational axis of the crankshaft, while thrust bearings fix the crankshaft in the axial direction. During the grinding process, WINTER bond series N7 and 43 meet the challenge of burn-free machining of the flat sides.

Pins

Because of the alternating load, pin journal seats are the most highly stressed areas of a crankshaft. The grinding results are measured in surface roughness and roundness. The choice of the grinding wheel bond depends on the grinding method: pins only, or pins with radii and shoulders.



Posts/Flanges

Angle approach plunge grinding of flange and post ends with cBN is state of the art. Different materials and large contact areas are the norm for these high precision grinding applications. Best results delivered by bond series N7 and 47.

N⁷
CRANK

Constant Velocity Joint

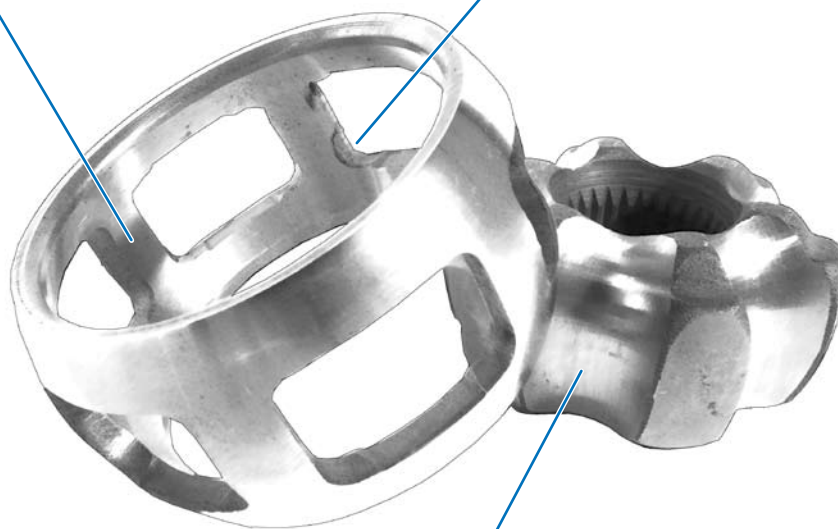
The CV joint transmits the torque from one shaft to another with angular displacement between them. The complex and trouble-free interaction of the assembly can only be achieved by smooth surfaces and extreme profile accuracy.

Cage

The complex combination of the cage, rolling elements and inner and outer races require high-precision design of all components, as the forces are applied in all directions. Vitrified bonded cBN grinding tools provide tight tolerances combined with short cycle times. The recommended vitrified bond series are N7 or DX40.

Cage Window

The cage window accurately guides the balls in the tracks and evenly balances the applied loads. Often, the ID grinding operation of the cage window is part of a combined process requiring short cycle times and extended life between dresses. The accurate guidance in these cages is guaranteed by using vitrified bonded cBN grinding tools with the high-performance bond series N7.



Ball Track

High quality ball tracks feature high accuracy profiles. Due to the large contact areas the grinding wheels often need reprofiling. But vitrified bond grinding tools, bond series N7, feature a long life cycle. This makes this process economical.

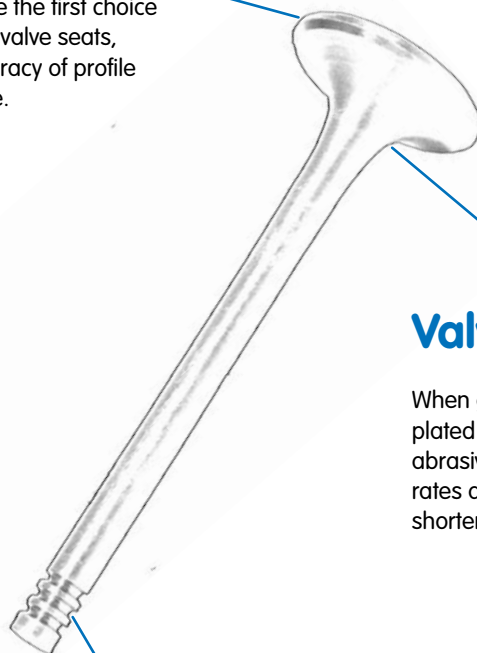
Valve

High pressure and temperature under cyclic load can cause high wear on engine valves. Low-wear materials as well as absolute dimensional accuracy provide long valve lifetime.



Valve Seat

Electroplated tools are the first choice for rough-grinding of valve seats, because of their accuracy of profile and their long lifetime.



Valve Head

When grinding the valve fillet profile, electroplated cBN tools are superior to conventional abrasives: dressing is not required, the removal rates are higher and therefore cycle times are shorter.

Valve Shaft Grooves

Electroplated tools prove to be best for plunge grinding of the valve shaft grooves. They feature a higher removal rate than conventional tools and achieve shorter cycle times. Electroplated tools do not need to be dressed.

Hydraulic Cam Follower

The casing and the piston must fit together precisely. For highest accuracy, the casing is ground both internally and externally, while the piston is ground externally.



Casing Perimeter

Centerless Profile grinding of the casing periphery is performed with long-lasting, electroplated tools.

Casing Bore

The tight tolerances required for the component's surface can be achieved by using vitrified bonded cBN grinding pins. The bond series N7 and DX40 are recommended.

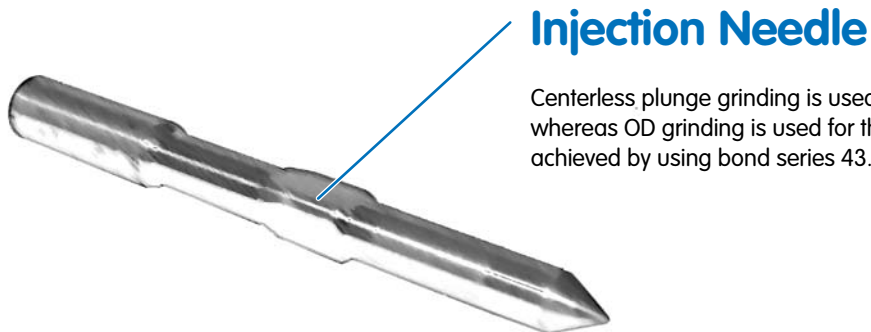
Cylinder Liner

Proven technology requires adequate surface finish. To assist the retention of the oil film in the cylinder bore, cross hatching is created by a honing process. WINTER honing sticks deliver best results.



Fuel Injection System

The injector atomizes the fuel supplied by a pump. As the injectors work under high pressure, precision of surfaces and geometries are fundamental for safe function and a long lifetime.

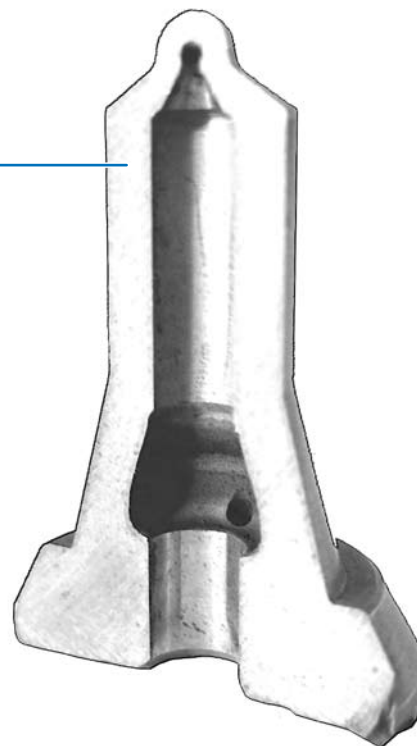


Injection Needle

Centerless plunge grinding is used for the injection needle profile, whereas OD grinding is used for the facet. Excellent results are achieved by using bond series 43.

Nozzle Body

Nozzle bodies work under permanent load of 1,200 bar. Their grinding requires highest precision. This is guaranteed by using vitrified bond N7.



Brake Pads

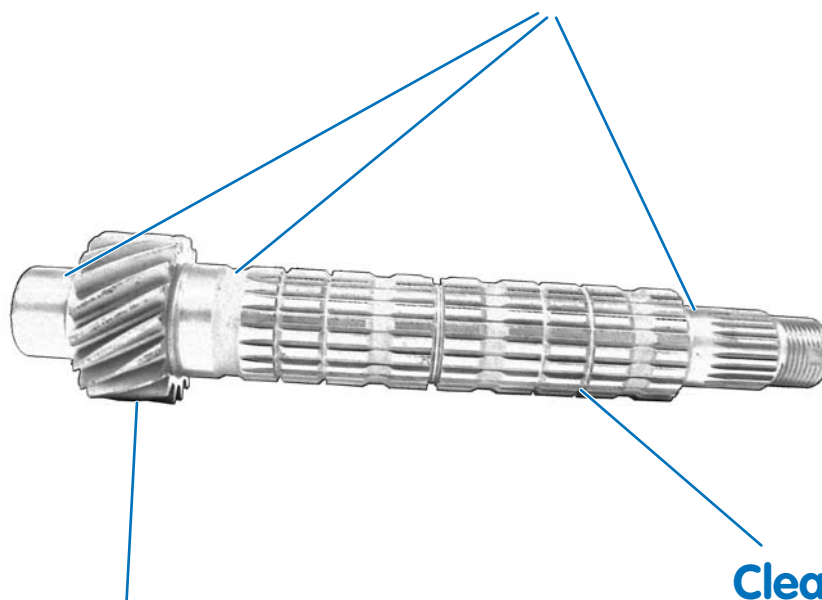
The Metal Single Layer (MSL™) technology ensures high material removal rates and shorter cycle times due to very good grain retention and excellent grit protrusion. High cost effectiveness and superior quality derive from the high performance of this single layer bond. This is what makes MSL™ so successful when grinding composite material such as brake pads.

Gear Shaft

Vitrified bonded WINTER cBN grinding tools are unique when grinding hard and tough materials. They deliver perfect results with tight tolerances in surface quality, roundness, straightness and conicity.

Journals

Very good roundness and high surface quality protect the gear shaft journals from wear and tear. High-precision peel grinding with controlled contact areas are the challenge to be met. Bond series 46 is the best recommendation.



Faces

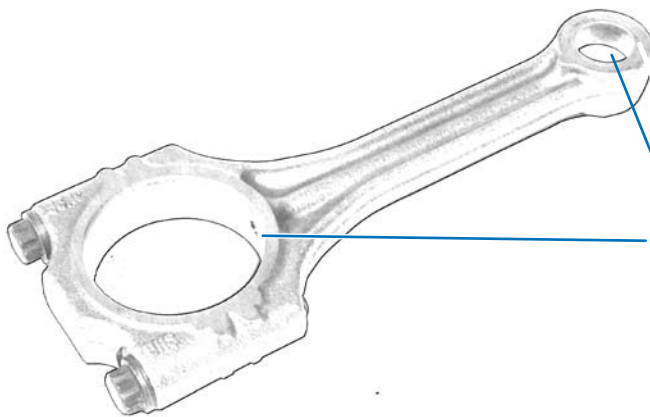
Grinding of face and journals is significantly improved by combining both grinding operations in one setting. Bond series 46 creates highly accurate profiles, very good surface quality and achieves very short, unrivaled cycle times.

Clearance Grooves

Electroplated profile grinding wheels are effective, economical solutions for plunge grinding of gear shafts, as no dressing process is required.

Con-Rods

Connecting-rods must withstand push and pull forces as well as bending and flexing, but must be light-weight to minimize reciprocating mass. Besides the material, the surface finish is important for the connecting-rods' durability.

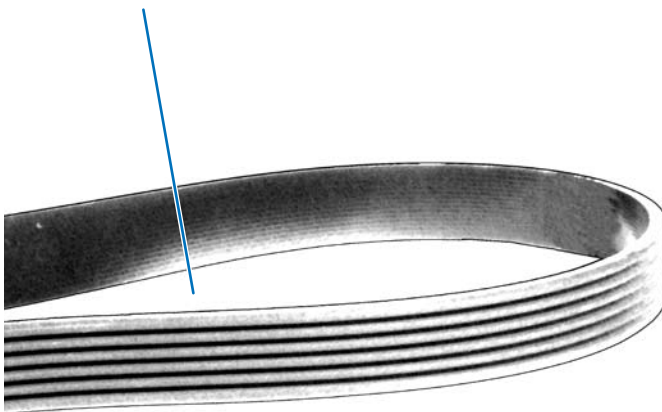


Side Faces of Connecting Rods

Different materials are machined in this face grinding process. Bond series N7 is highly recommended.

Flat Belt

Electroplated tools feature very high removal rates due to excellent chip clearance, especially when profile grinding rubber compounds such as drive belts and flat belts. During their entire service life, WINTER grinding tools maintain the required profile accuracy. Therefore, a dressing unit on the production machine is not needed, and costly non-productive time is reduced.





Turbines

Whether it's turbojets for an aircraft or stationary turbines to produce energy - profitability, performance and safety have top priority.

Information

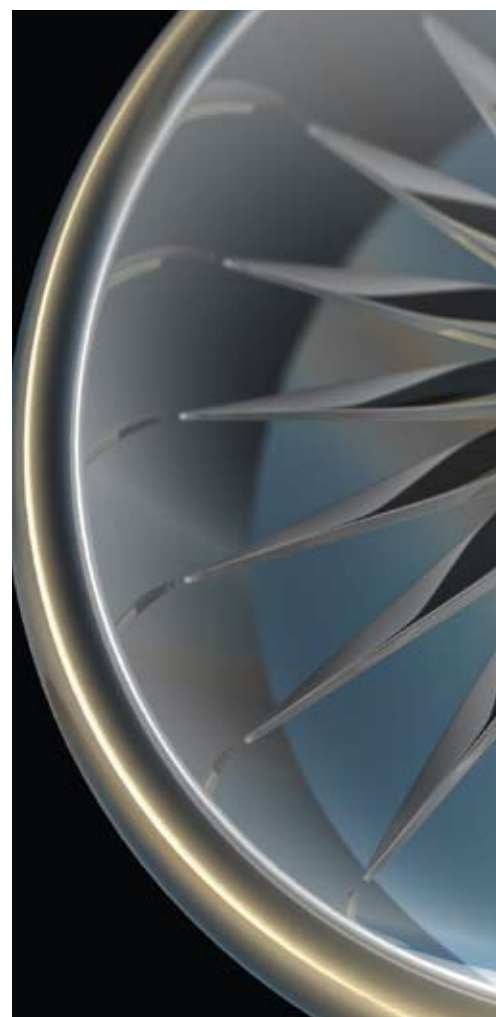
Please refer to our catalogue "Dressing Tools" to find tools for profiling and dressing of vitrified bonded grinding wheels.



Grinding Applications on the Turbine

The trend in turbine technology is to develop more economic, efficient and eco-friendly engines. This is achieved by increasing the amount of high-performance materials in turbine assemblies

Components consist of unhardened, long-chipping materials, for example Inconel, Nimonic or Waspalloy. Conventional grinding tools usually cannot cope when machining such high-tech alloys, but superabrasives meet the challenge of grinding these highly wear-resistant materials. Specifically designed grinding tools achieve the desired performance.



Turbine Blade Root

Combined with a continuous dressing operation, conventional grinding tools give an excellent performance when grinding turbine blade roots. For processing small compressor turbine blade roots, electroplated grinding tools give the most economic results.

A precondition for secure anchoring of turbine blades at the rotor is high-precision profile grinding. With electroplated and vitrified tools, true-to-size grinding of the Christmas tree profile is achieved.



Turbine Casing

The inner wall of the turbine casing must withstand very high temperatures caused by the thermodynamic process. In spite of the extreme thermal load, no distortion of the casing is allowed. Attention must also be paid to the outer casing, where the engine measuring systems are attached.

The enormous size of the workpiece is one of the challenges when grinding turbine casings. The grooves must be precisely formed in a creep feed grinding process, while the casing is held firmly on a rotary table. However, the access is limited. Therefore, casings are machined with comparatively small grinding wheels mounted on a long overhanging shaft.



Annular Grooves

Annular Grooves are found on the outer diameter of the compressor assembly. There, at the blade tips, highly accurate geometry is required to achieve ultimate gas-tightness.

Strict adherence to tolerance requirements is a prerequisite when flat grinding annular grooves. In operation, these must be absolutely gas-tight. Here, electroplated tools are the first choice.



Bearings

The wide diversity of bearing designs requires an equally diverse range of grinding processes and tools: ID-grinding, OD-grinding, flat grinding and profile grinding.

Vitrified WINTER grinding tools are custom-made for your application, to achieve economic grinding with outstanding results.

Information

Please refer to our catalogue "Dressing Tools" to find tools for profiling and dressing of vitrified bonded grinding wheels.



Grinding Applications on Bearings

The quality of bearings has a significant impact on the lifetime of rotating parts. By reducing wear and rolling friction, the lifetime of the bearing assembly is extended, as is the lifetime of the overall product. Bearings transmit forces from rotary to stationary components and must be non-slip and wear-resistant.

Today's quality standards for bearings are much higher than in the past. In order to avoid warranty claims for finished products, bearings must last much longer. This can only be achieved with very smooth surfaces and less friction. New WINTER grinding solutions meet these high standards.



Inner and Outer Bearing Race

On each of the different contact areas, rolling elements must be held in place and guided with as little friction as possible. The grinding zones are the race outer ring, the race inner ring and the side faces of the bearing races.



OD-Grinding and ID Grinding of Outer and Inner Race

High quality but economical: Grinding of the bores of the inner ring as well as the perimeter of the outer ring can be achieved with bond series N7, 46 and 41.



Outer and Inner Race

The races are exposed to high static and dynamic loads. Low-wear materials and high-precision grinding are requirements for a long lifetime and perfect operation.



Races

The hard and tough material creates great demands on grinding tools. Although the material is difficult to machine, geometry and surface finish must adhere to tight tolerances. Outstanding grinding results, combined with long lifetime is delivered by bond series N7, 46 and 41.

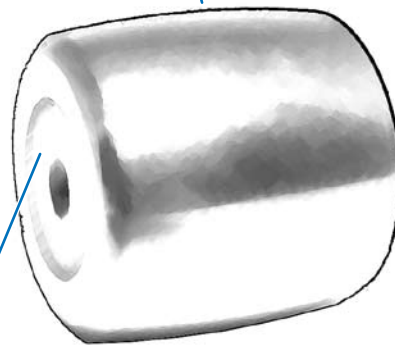
Rolling Elements

Rolling elements often have to cope with high mechanical loads. Whether these are balls, cones, barrels, needles or other cylindrical shapes, all rolling elements must be designed for endurance and strength. High precision grinding ensures that they can fulfill their tasks.

Force may be applied to rolling elements in either axial or radial direction. Strength and accuracy are decisive for low-friction and long lifetime.

Perimeter

Centerless grinding is used to machine cylindrical rolling elements. Bond Series 43 for damage-free grinding is highly recommended.



Faces of rolling elements

For face grinding of rolling elements and races, grinding tools have to cope with hard, short-chipping materials. WINTER tools of bond series N7, 43 and VA will manage.

Faces of races

For race grinding of hard, short-chipping materials, tools of the bond series N7, 43 and VA achieve longest lifetimes. Specific bond features make high-precision grinding possible, even when very tight tolerances are specified.

Compendium

The WINTER brand represents over 160 years of heritage and grinding experience. Many companies worldwide involved in industrial production benefit from this expertise.

We know our customers' requirements and help you with our technological expertise and competence. This way, your grinding process becomes more effective and profitable.





40 Service

In addition to design and production of grinding tools, WINTER offers you a multitude of services.

42 Glossary

Compiled for you: this little reference guide explains terms around grinding: bonds, roughness, material removal rates, etc.

52 Index

This catalogue-spanning index helps you to easily find the right information for your application and the corresponding grinding tools.

59 Contact

Whom to ask first?

Who is my nearest contact person?

Where can I get quick and easy help?

Service

Competition is keen, and cost pressures are acute. To improve productivity and technical capability, you need a supplier who co-operates efficiently. WINTER not only provides high performance grinding tools but can also assist in analysing your processes, to identify the best solution, and then to implement it together with you.

Advice

Our field service engineers and customer service team are here to help, and can offer advice on all WINTER products and grinding processes. Together with product management and our application engineering team, customised solutions will be found which meet your needs.

Product Development

WINTER, as the grinding industry's technology leader, invests heavily in Research and Development. Basic research supports new customer-specific product and application developments at our global Technology Centres. Our EGTC (European Grinding Technology Centre) with the R&D Department in Norderstedt, closely co-operate with our Research and Technology Centres in the USA, France and China.

Process Optimisation

At our EGTC (European Grinding Technology Centre), we can evaluate your grinding processes using sophisticated sensing and measurement systems which you may not have access to. So we can demonstrate improvements to your process without interrupting your production. On your factory floor, our application and development engineers continue to support you. Our dedicated specialists are expert in the field of complex grinding systems, and can advise on new production strategies with the help of innovative process diagnostic technology. The result for customers is a fine-tuned production process, and optimised day-to-day operations.

Training and Continuing Education

We offer regular seminars on current issues and developments at our European Grinding Technology Centre (EGTC) in Norderstedt. Economic and advanced production processes are reviewed with top-class experts from different parts of the industry. We invite internal and external consultants on specific subjects to comment on the technological state-of-the-art and development trends.

Ask your field salesman for the latest calendar of scheduled seminars and get yourself registered.

Specific training programmes can also be arranged according to your individual requirements.

Just contact us - we will gladly make an offer that meets your needs.

WINTER offers seminars on topics such as:

- Tool Grinding Technology Forum (expert panel discussion)
- Grinding (basic training)
- Grinding fluids (focused technology review)
- Dressing technology (focused review)



Field Instrumentation System (FIS)

Optimise your production process

Have us make a **FIS process analysis** and optimise your production process: field instrumentation system is a portable system to monitor and measure your grinding process. Exact and comparable data is obtained and can contribute to increase your performance:

- Process optimisation, reduction of cycle time
- Prolongation of tool life time
- Machine and process studies
- Analytical determination and benchmarking

Give it a try!



MDress - Mobile Dressing Unit

For better grinding results

Almost every CNC grinding machine can be upgraded by MDress, the mobile rotary diamond dressing unit. Using MDress ensures highly precise reconditioning of grinding wheel profiles. The grinding wheel achieves its ultimate axial and radial running truth directly on the main spindle. Our customers are enabled to test, for example, vitrified bonded grinding wheels, on the CNC grinding machine and obtain a more economic grinding result.

Our application engineers will give you support, to demonstrate an optimised dressing process with the MDress dressing system on your machine at your premises.

Just contact us.



RFID – Radio Frequency Identification

This technology makes it possible to transfer stored data from the grinding wheel to the grinding machine. The advantages are

The increased level of transparency

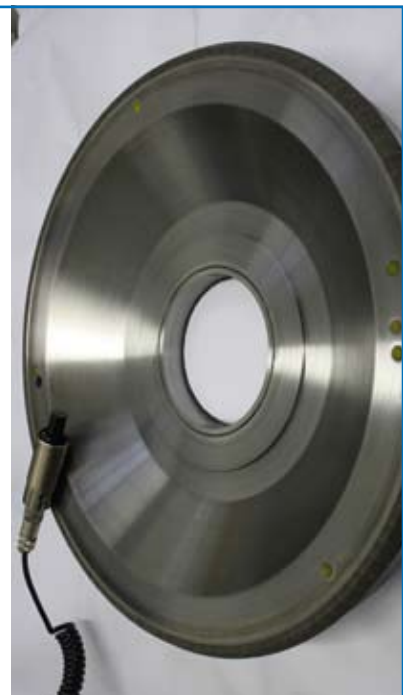
- Integrated tool-life monitoring
- Automated scanning and storage of tool use

Shorter set-up times

- Direct access to grinding wheel data by the machine control system
- Elimination of operator error in manual recording and entry of data

Improved profitability

- Reduced machine downtime by automatic data transfer between machine and grinding wheel



Glossary

For your reference: a short explanation of grinding terms

Bonds

To meet the challenges of the wide diversity of grinding applications, it is inevitable that a wide range of bond systems is required. Bonds are categorised according to the fundamental material type used, and many variations exist within each type.

Resin Bond Systems

These are based on either phenolic or polyimide resins, usually together with added fillers, as well as the abrasive grains. Resin bonds are at the lower end of the hardness scale, and are used in a wide range of applications due to their fast and cool grinding behaviour.

Sintered Metal Bonds

Most metal bonds are based on bronze, although harder systems may be based on steel or even hardmetal. Sintered bronze bonds are relatively soft and at their softest can overlap the hardest resin bonds. Steel and hardmetal bonds are more wear resistant, so therefore act harder and grip the abrasive grains more strongly, leading to longer tool life, although the abrasive can sometimes appear blunt.

Metal bonded grinding wheels generally grind more slowly, in most applications acting harder, and more grinding heat is developed than in resin bonded wheels. However, metal bonds can also readily dissipate heat, which also impacts the grinding process. Metal bonds are ideal for grinding wheels with sharp edge profiles, and for machining abrasive materials that would otherwise wear the bond. Furthermore, metal bonds are shock-resistant, and are suitable for very aggressive operating conditions. Metal bonds are mostly used in wet grinding. Special variants are crushable, brittle metal bonds that can be dressed on the machine in a special crushing process. These bonds are especially useful in creep feed grinding.

Electroplated Bonds

In this bond system, the metal bond is deposited electrolytically onto a bronze or steel body. The grit is tenaciously anchored by the bond, and grain tips can protrude from the bond layer by 30 - 50 % of the grain diameter. This leads to a grinding layer with a very high material-removal-rate capability. However, only the outermost grain layer acts in this way, which is why these tools are mainly designed in single-layer versions. Such single layer bond systems are suitable for profiled wheel bodies of all kinds; profile accuracy is dependent on the grit size specified.

Vitrified Bonds

Vitrified bonds are based on fusible glasses combined with fillers and the abrasive grains. While resin and metal bonds are generally fully dense, vitrified bonds are usually produced with a defined porosity, and are available in different hardness levels. This variation in porosity and hardness is analogous to the vitrified bonds of conventional grinding wheels. The main features of vitrified bonds are:

- Good dressability and profileability
- Free-cutting due to the porosity and self sharpening behaviour
- Fluid availability, due to porosity, in the grinding zone allows cool grinding at low grinding forces
- High cutting speeds and material removal rates are possible.

Concentration

According to the WINTER system, the concentration value defines the volume fraction of diamond or cBN in the abrasive layer as follows:

Diamond			cBN		
Concentration	Carat / cm ³	Volume %	Concentration	Carat / cm ³	Volume %
C50	2,2	12,5	V120	2,09	12
C75	3,3	18,75	V180	3,13	18
C100	4,4	25	V240	4,18	24
C125	5,5	31,25	V300	5,22	30

These definitions are not applicable for single layer electroplated tools.

Conditioning

Conditioning of a grinding wheel consists of dressing and cleaning:

Dressing		Cleaning
Profiling	Sharpening	
Influences macrostructure	Influences microstructure	Influences microstructure
Produces concentricity and grinding wheel profile	Generates topography and grain exposure by eroding the bond	Removes chips from chip space
Need: Shape or re-shape the wheel surface	Need: Create grit protrusion	Need: No change in the surface

Cubic Boron Nitride (cBN)

Boron nitride is found in two structural modifications: Cubic boron nitride (cBN) has the zinc-blende crystal structure equivalent to diamond, and has a hardness just a little below that of diamond. The graphite-like hexagonal modification of boron nitride (hBN) is soft and is used as a lubricant.

Compared to diamond, cBN has technological and economic advantages when grinding materials having a chemical affinity to carbon, such as steels and ferrous alloys. Applications for cBN are becoming increasingly economic, and cBN grinding of workpieces with hardness as low as 50 HRC have been demonstrated.

Diamond

Together with graphite and fullerenes, diamond is one of the three carbon modifications and, with a Moh's hardness of 10, diamond is the hardest material known. The grinding (Rosiwal) hardness is 140 times higher than that of corundum. Because of its hardness and wear resistance, diamond is used for grinding hard, brittle and short-chipping materials. Examples are tungsten carbide, glass, ceramics, quartz, semiconductor materials, graphite and wear-resistant thermal spray alloys as well as hardfacing alloys, plastics with glass fiber reinforcement and other difficult to machine materials. Natural diamond is used as well as synthetic diamonds.

Direction of Rotation Indicator

Resin and metal bond diamond and cBN grinding wheels always show an indicator for the direction of rotation. At the end of the production chain of a multilayer grinding wheel is the profiling and sharpening process. In the sharpening process, a bond tail is formed behind each of the active abrasive grains. This bond tail supports the grain and prevents the grain from untimely fracture. If the wheel is mounted the wrong way round, this bond tail would precede the grains during cutting, which would lead to lower chip-space, increased grinding pressure, and early grain fracture. Therefore, it is important to adhere to the rotational direction shown by the indication arrow or to re-sharpen the grinding wheel before use, if you chose to change the direction of rotation.

Dressing = Truing + Sharpening

It is necessary to distinguish between the key wheel preparation steps of truing, sharpening and cleaning of the grinding wheel surface.

Dressing describes the processes of truing and sharpening a grinding wheel. When grinding with conventional alumina or silicon carbide wheels, "dressing" is the combined process of truing and sharpening. However, for superabrasive grinding wheels containing either diamond or cBN abrasives in a resin or metal bond, after truing, a separate sharpening step is usually required to remove some of the bond material and expose the grains. In addition, the grinding wheel surface must be cleaned (Dressing + Cleaning = Reconditioning) periodically. The dressing interval depends upon the grinding process parameters being used, and the type of workpiece material being ground.

Grinding wheel truing generates the correct geometric shape, develops the necessary concentricity, and also removes any surface contamination. In so doing, worn blunted grains are either removed or resharpened, and fresh grains are exposed. To achieve optimum results, dressing tools, dressing parameters and dressing strategy must be finely tuned to the grinding wheel and grinding process. Therefore, different tools and methods are used, such as either alumina-based or SiC sharpening stones, SiC grinding wheels, the WINTER brake-dressing device, CNC rotary dressers, diamond dressing sticks, rotary profile dressers, etc.

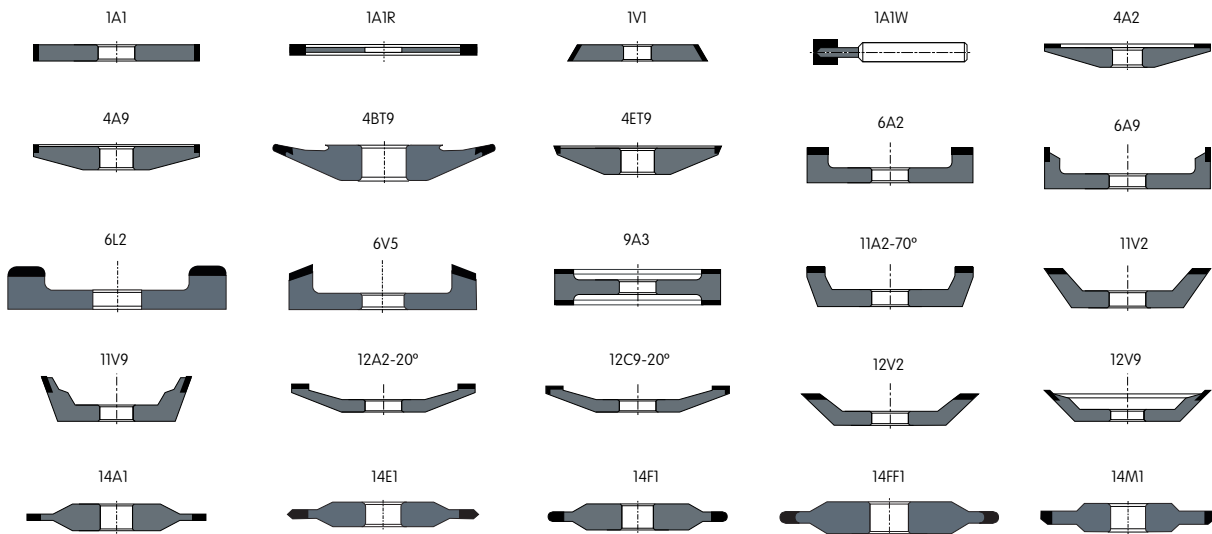
Our engineers can offer advice to help you chose the best method for your application.

FEPA

The Federation of European Producers of Abrasives (FEPA) is a non-profit European organisation which publishes safety guidelines and standards for conventional and superabrasive (diamond and cBN) grinding tools as well as loose abrasive grain (see grit sizes). It also provides standards for the most common grinding wheel shapes and dimensions.

FEPA-Shapes

These drawings show the most important grinding wheel geometries:



Grinding

According to DIN 8589, grinding is defined as material removal using geometrically undefined cutting edges. All grinding wheels with either diamond or cubic boron nitride (cBN) are grinding tools according to DIN 8589. The "cutting edges" are composed of the diamond or cBN grit.

Grinding Ratio (G-Ratio)

The grinding-ratio is calculated as a ratio of the ground workpiece volume V_w to the wheel wear volume V_s .

Grinding Wheel Bodies

The body of a grinding wheel provides the static and dynamic stiffness to the tool. Dependent on the kind of grinding layer, it may consist of aluminium, filled resin, brass, steel or ceramics. The body significantly influences the vibration behaviour and the thermal conductivity of the grinding wheel; the following table shows examples for superabrasive grinding wheel bodies.

Body material type	Label	Vibration Absorption	Heat Transmission	Mechanical Stiffness
Resin with metal fillers	H	medium	sufficient	good
Resin with non-metallic fillers	B or D	good	bad	satisfactory (not sufficient with thin-walled bodies)
Aluminium	A	bad	good	very good
Steel	E	bad	satisfactory	very good
Copper	C	bad	very good	very good
Composite material	CFK	good	bad	good

Grit Sizes

The sieve-sizes for diamond and cBN range according to FEPA standards (also ISO 6106) and are shown in the following table. As abrasives always contain a range of grit sizes, the values given for average grit sizes and particles per carat are approximations. D-prefix indicates diamond, while B-prefix refers to cBN.

FEPA grit size D or B	Standard [Mesh]	Average Grit Size [µm]	Particles per ct
1181	16/18	1100	60
1001	18/20	930	100
851	20/25	780	160
711	25/30	660	270
601	30/35	555	450
501	35/40	465	760
426	40/45	395	1200
356	45/50	330	2100
301	50/60	280	3500
251	60/70	233	6000
213	70/80	197	10000
181	80/100	167	16000
151	100/120	140	28000
126	120/140	118	46000
107	140/170	99	80000
91	170/200	83	135000
76	200/230	72	200000
64	230/270	63	300000
54	270/325	55	460000
46	325/400	47	750000
39	400/500	38	1400000
33	500/600	33	2100000

WINTER has its own classification for fine and microgrit sizes. FEPA standards are similar (M 63...M1.0).

WINTER diamond classification	Grit size [µm]
D 25	40 - 60
D 20 C	34 - 45
D 20 B	25 - 37
D 20 A	20 - 30
D 15	8 - 25

WINTER diamond classification	Grit size [µm]
D 15 C	15 - 25
D 15 B	10 - 20
D 15 A	8 - 15
D 10	6 - 10
D 7	5 - 10
D 5	3 - 7
D 3	2 - 5
D 1	0,5 - 2
D 0,7	0 - 1
D 0,25	0 - 0,5

Hardness of Abrasives

The hardness value of a material is generally influenced by the method of measurement. Different measuring methods and equipment result in different scales and units which cannot easily be compared. Thus several scales exist, for example:

Moh's hardness: abrasion behaviour (measure of scratch resistance)

Rosival hardness: stock removal behaviour (measure of resistance to stock removal)

Vicker's Microhardness: indentation behaviour (resistance to penetration)

In the following table, different hardness values for abrasives are given and compared to some reference materials:

Material	Moh's Hardness	Rosival Hardness	Vickers Microhardness (HV)
Diamond	10	140,000	10,000
cBN	9,9		9,000
Silicon carbide	9,6		2,600
Corundum	9	1.000	2,060
Quarz	7	120	1,120
Manganese	5	6.5	540
Gypsum	2	1.25	36
Talc	1	0.03	2.6

Diamond's stock removal resistance (Rosival hardness) is 140 times higher than corundum (alumina), even though its penetration hardness (Vickers) is only 5 times higher.

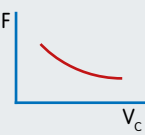
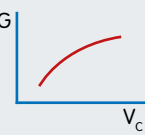
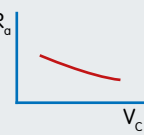
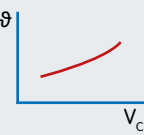
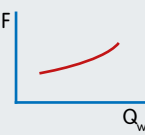
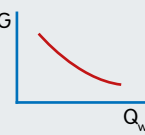
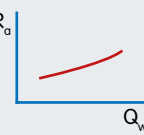
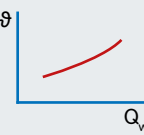
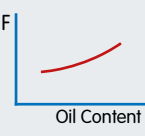
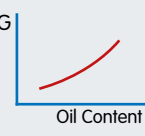
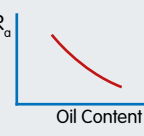
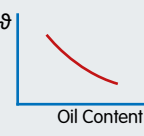
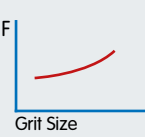
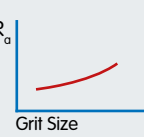
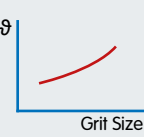
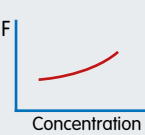
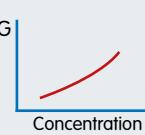
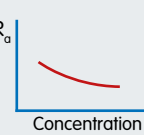
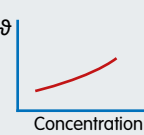
Material Removal Rate

The material removal rate, MRR, is expressed in mm^3/s and defines the volume of workpiece material ground per unit time (second).

The specific material removal rate, MRR' , refers to the removal rate per millimetre of wheel contact width and is expressed in units of $[\text{mm}^3/(\text{s} \cdot \text{mm})]$.

Parameters influencing Grinding Results

The table shows some correlations between process variables and the grinding results.

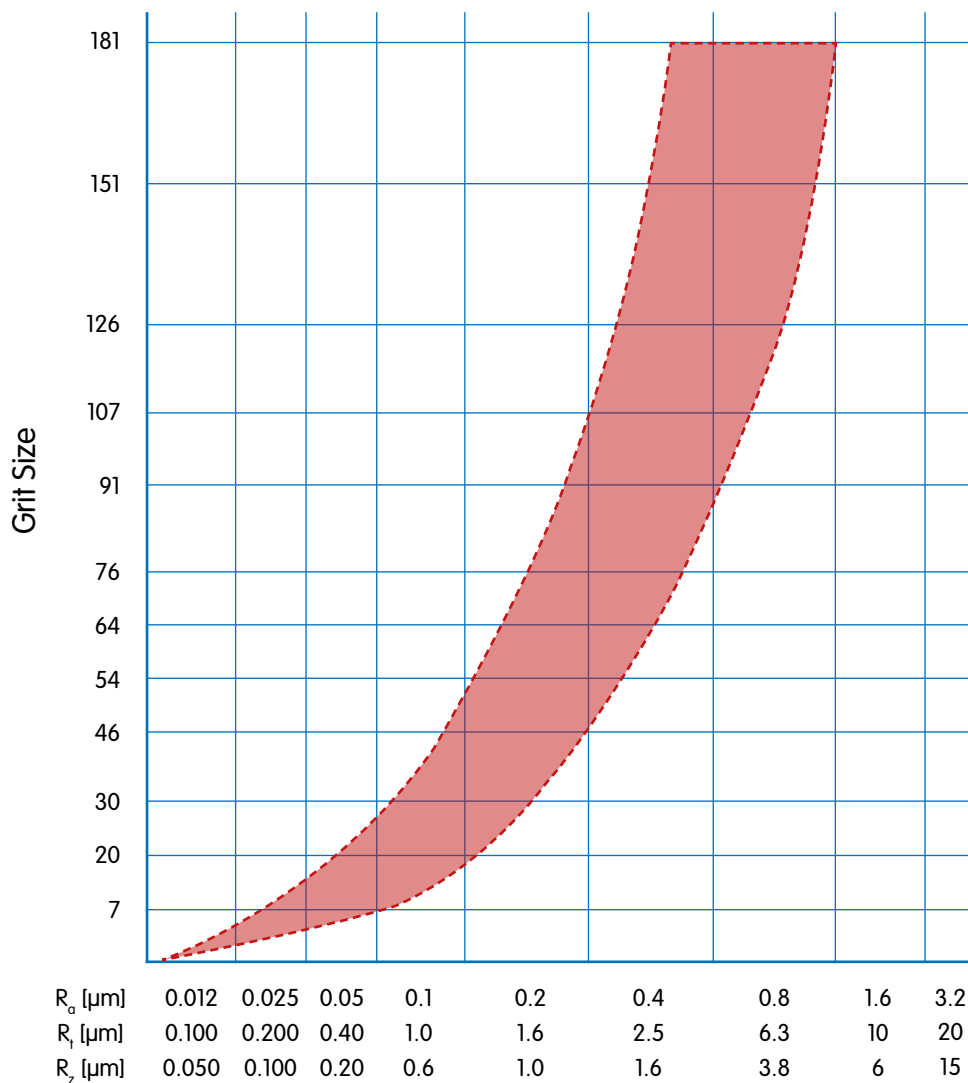
Influencing Parameters		Appraisal criterion Cutting Force F $F = f(\dots)$	Grinding Ratio G $G = f(\dots)$	Roughness R_a $R_a = f(\dots)$	Temperature ϑ $\vartheta = f(\dots)$
Machine- and Operation Parameters	Cutting Speed v_c (m/s)				
	Material Removal Rate Q_w (mm^3/s)				
	Coolant (Oil Content)				
Grinding Wheel	Grit Size (μm)				
	Concentration (Carat/ cm^3)				

Roughness

The surface roughness of a ground workpiece is influenced by many diverse parameters:

- Grit size of abrasive grain
- Concentration of abrasive grain
- Specification of bond system
- Type and hardness of work piece
- Grinding process
- Grinding parameters
- Dressing parameters

A general and qualitative correlation between grit size and surface roughness is shown below:



Specification

The specification is the general description of the grinding tool and contains all relevant information concerning the product's features. In general, the specification always contains the following details:

Example:

11V9	100-2-10-20	D126	K+888R	C75	A
Shape	Dimension	Grit Size	Bond	Concentration	Body Material

Furthermore, the specification can contain additional information regarding drawing index, production method, structure, and other details.

Superabrasives

Diamond and cubic boron nitride are the hardest materials existing in industry today, according to the current state of knowledge. The levels of hardness of diamond and cBN are significantly higher than those of conventional abrasives like alumina (corundum) and silicon carbide (see hardness).

Wear effects on diamond and cBN

The hardness of an abrasive grit type alone is not sufficient to determine the grinding tool's grinding behaviour. Diamond and cBN grains can wear in many ways, causing different effects.

Primarily, there are two main types of wear.

Mechanical wear:

Abrasion, micro-chipping of cutting edges, grit macrofracture, and breakout of grain from the bond.

Chemical and thermal wear

Carbon diffusion, graphitization, oxidation, and reaction with grinding fluids.

Diamond not only reacts with iron (above a certain threshold temperature), but also with chromium, vanadium and tungsten. cBN does not show chemical reaction with iron or other metals.

Therefore, cBN has proven to give better tool performance when machining, for example, high speed steel, although it is not as hard as diamond.

An outward sign of the occurrence of thermo-chemical wear is the rapid appearance of wear flats on the grains, when no grain chipping from mechanical wear is present.

Notes

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- C3 – see catalogue No. 3 “Flat and Crystal Glass”
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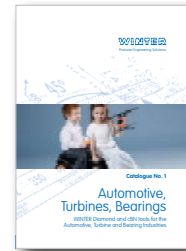
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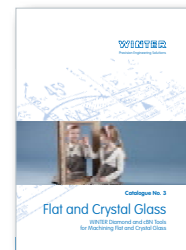
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Catalogue No. 2: Tools
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Catalogue No. 3: Flat and Crystal Glass
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Catalogue No. 4: Electronics, Photovoltaics, Optics, Ceramics and Composites
WINTER Diamond and cBN Tools for the Electronic and Photovoltaic Industries, for Machining Optical Glass, Ceramics & Composites



Catalogue No. 5: Dressing Tools
WINTER Diamond Tools for Dressing of Grinding Tools



Catalogue No. 6: WINTER Standard Catalogue
Stock Programme for Diamond and cBN Tools



Thank you to Jasmina and Eric, who had their photo taken for our front cover.
Their father works in our R&D department.

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Whom to ask first? Who is my nearest contact person? Where can I get quick and easy help on grinding tools and grinding processes?

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