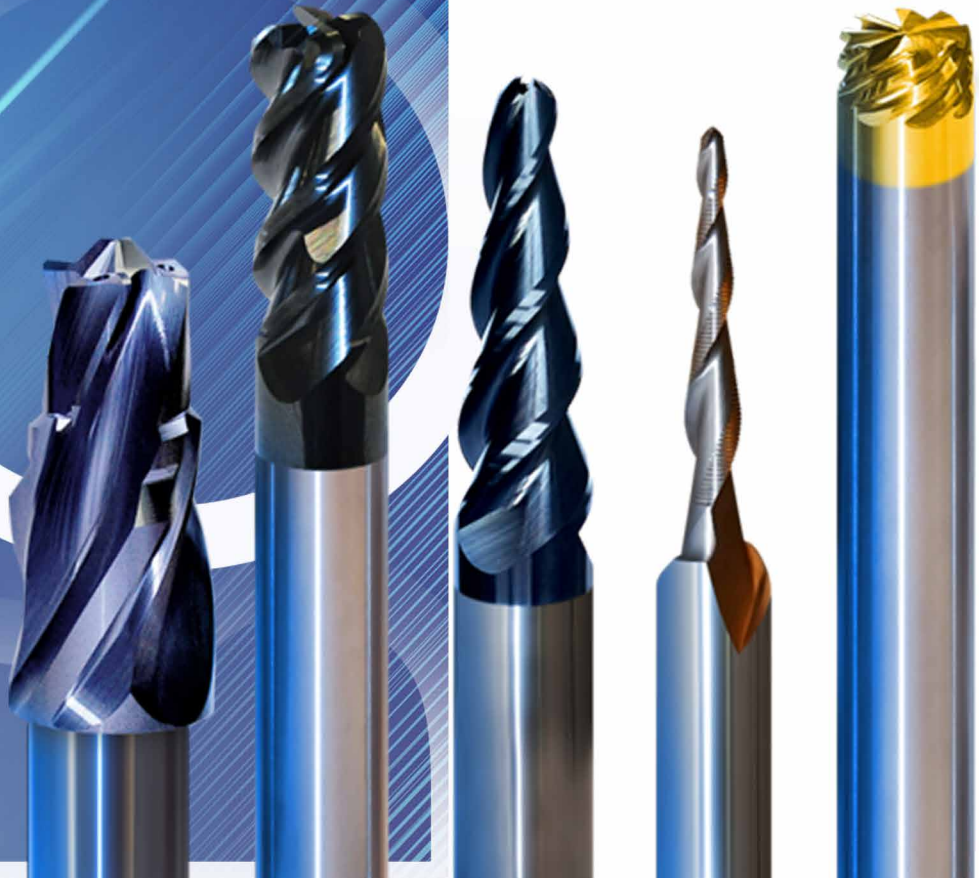




C O A T I N G

PMB

#5 COATING





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Our Company

Hunan Boyun Dongfang Powder Metallurgy Co., Ltd. was founded in 1994 by the Institute of powder metallurgy of Central South University of Technology (now the research center of powder metallurgy engineering of Central South University) and Hunan Yinzhou Co., Ltd. (now the wholly-owned member company of China Dongfang asset management company, Bangxin Asset Management Co., Ltd.),now it is the holding subsidiary of Hunan Boyun New Material Co., Ltd. (Stock Code: 002297), with a registered capital of 307 million yuan. The company is a national high-tech enterprise with Academician Huang Boyun, the top material scientist in China, as the chief scientist and honorary chairman of the board, integrating domestic and foreign talents and technological advantages, integrating production, learning, research and application, engaged in the research, development, production and sales of high-performance cemented carbide. Company is medium-sized enterprises to become state-level technologically advanced 'little giant' enterprises. The member of China Tungsten Industry Association, China mold industry association, China machinery industry metal cutting tool technology association.

Chief Scientist

Academician of Chinese Academy of Engineering
 Winner(1st) of China National Technological Invention Award (2005)
 Former president of Central South University
 Member of Twelfth National People's Congress Standing Committee
 Vice-Chairman, Chinese Association for Science



ACADEMICIAN HUANG BOYUN
 Honorary Chairman, Chief Scientist



With strong support from Central South University, State Key Laboratory of Powder Metallurgy, National Engineering Research Center of Powder Metallurgy, national key laboratory of light and high strength structural materials, Quality Supervision and Inspection Center of Powder Metallurgy Products of Chinese Nonferrous Material Industry , the Company has played leading role in three projects of "National High Technology Research and Development Program (863 plan)".

COMPANY INTRODUCTION

Specialty One: Owned complete discipline system on non-ferrous materials while established top classes of non-ferrous metallurgy in the world.
Specialty Two: Conducted over 60 years of high education and R&D in rail transit system and made vital contributions to major projects including Qinghai-Tibet railway, high-speed railway, urban rail and helped to increase speed of all Chinese trains (six times).

1 GEOLOGY



4 METALLURGY



2 MINING



5 MATERIAL



3 ORE DRESSING



6 MECHANICAL



FEATURE SUBJECTS OF CENTRAL SOUTH UNIVERSITY



The University participated in the "Qinghai-Tibet Railway Project"
The series of railway aerodynamics are widely used in the speeding of western railways and the construction of high-speed railways.

INSTITUTE OF POWDER METALLURGY

Among 31 colleges of CSU, the Institute of Powder Metallurgy is a comprehensive base of high education, R&D and industrialization of new materials in China.

P / M Research Institute has established four national level P / M material and technology research and development bases:

State Key Laboratory of Powder Metallurgy

Supervision and Testing Center of Products of Powder Metallurgy of Chinese Nonferrous Metals Industry

National Engineering Research Center of Powder Metallurgy

GLORIOUS HISTORY OF POWDER METALLURGY RESEARCH INSTITUTE



Established at 1958,
First Powder Metallurgy discipline in China.

In 1989,
Expansion, Solidification of fundamental theory
and technology and frontier of PM.

In 1995,
Open up, civil-military integration and innovation-
driven strategies to meet major national needs.

In 2003,
EXCELLENT State Key Laboratory

In 2004,
First Prize of National Technology Invention Award.

In 2008,
EXCELLENT State Key Laboratory.

In 2011,
First Prize of National Science and Technology Progress.

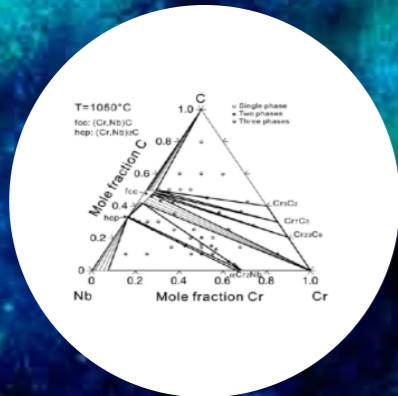
In 2017,
C919 took her maiden flight.

In 2018,
project 2011" Nonferrous Metals
Advanced Structural Materials and
Manufacturing Cooperative Innovation
Center" was passed the acceptance.

2019

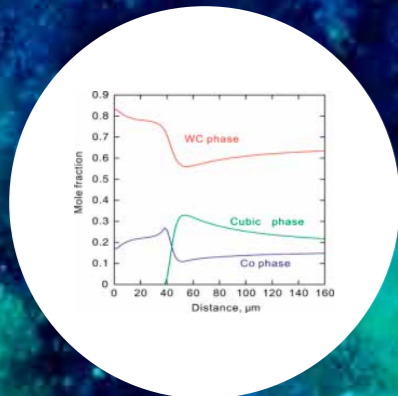
INSTITUTE OF POWDER METALLURGY

Basic research on Application of special PM materials



Thermodynamics database

$$V_{Co} = \frac{u_{Co}^S \cdot V_{Co}^m}{(1 - u_{Co}^S) \cdot V_{WC}^m + u_{Co}^S \cdot V_{Co}^m}$$

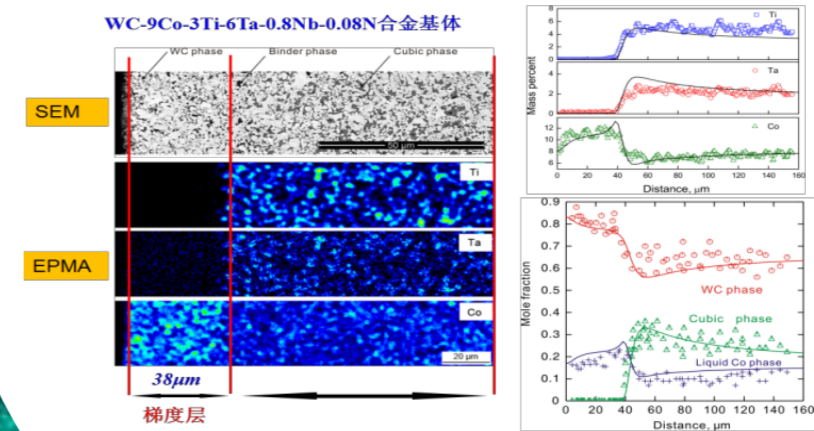


Dynamics database

The Institute of powder metallurgy has built the most complete database of thermodynamics and dynamics of multi-component cemented carbide in the world, which can accurately predict the distribution of phases and elements in the gradient layer of cemented carbide. Based on this database, a series of new gradient cemented carbide have been developed by integrated calculation. Propose the Symplectic Du formula to achieve efficient prediction of liquid phase diffusion coefficient 16-component cemented carbide thermodynamic and dynamics database. Using the database, quantitative description of Phase and Element Distribution in Cemented Carbide Gradient.

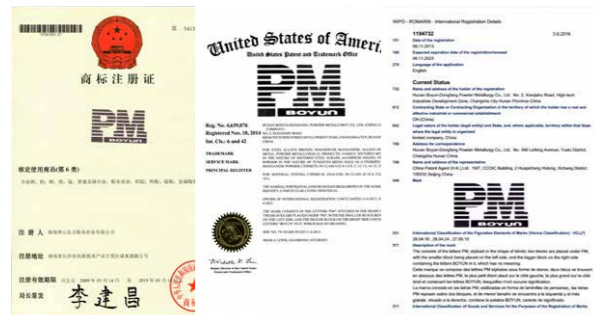
Gradient cemented carbide composition

Comparison of predictions and experimental results



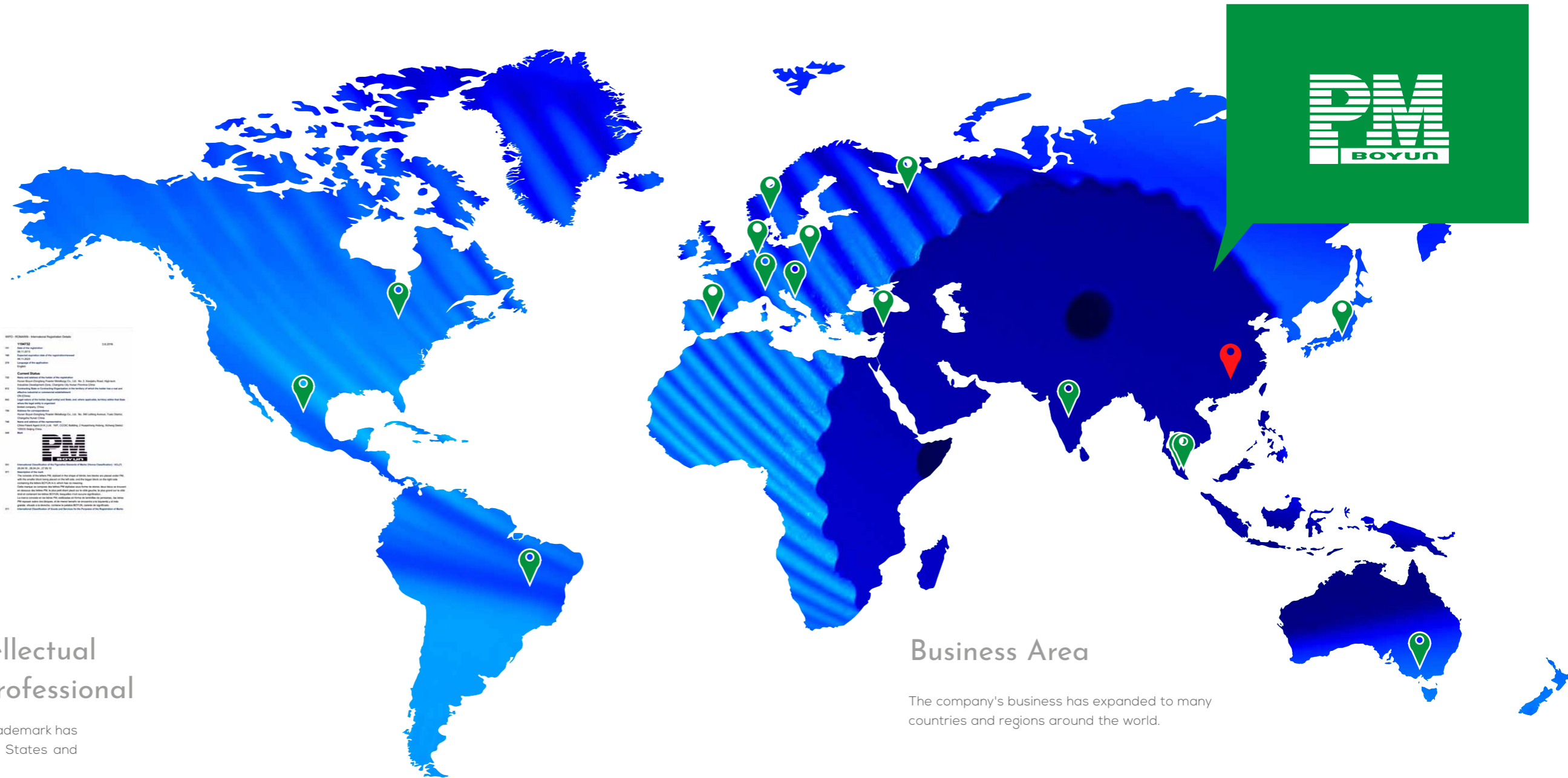
Structure Characterization and Quantitative Description of Element Distribution of Gradient Cemented Carbide

COMPANY BRAND AND MARKET



Protection of Intellectual Property Rights Professional

Besides registered in China, "PM" trademark has also been registered in the United States and the European Union.



Business Area

The company's business has expanded to many countries and regions around the world.

CEMENTED CARBIDE

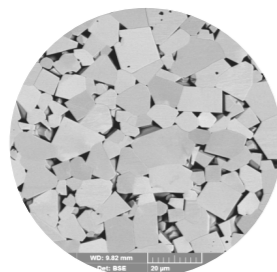
Cemented carbide is a kind of composite material which is made of refractory metal hard compounds (WC, TiC, etc.) and bonding metals (CO, Ni, Fe, etc.) by powder metallurgy. Cemented carbide have high hardness, high wear resistance, high strength, high modulus of elasticity, low coefficient of thermal expansion, high red hardness and stable chemical properties.

Classification of Grain Size of Cemented Carbide (ISO4499-2-2008)

Category	Grain size of WC(μm)
Nano	<0.2
Ultrafine	0.2~0.5
Submicron	0.5~0.8
Fine	0.8~1.3
Medium	1.3~2.5
Coarse	2.5~6.0
Extra coarse	>6.0

Nano cemented carbide which means the WC grain size is less than 0.2 μm cemented carbide, nano cemented carbide has higher hardness and strength than normal cemented carbide, at the same time ,effectively solves the problem of ultra-high speed cutting of hard to machine materials such as superalloy, titanium alloy, composite material, hardened steel, etc., greatly improves the machining efficiency, and is the preferred tools material in the aerospace field and high-end equipment manufacturing industry.

Extra coarse-grained cemented carbide is a kind of cemented carbide with WC grain size larger than 6 μm , compared with coarse grained cemented carbide, it has better toughness, thermal fatigue resistance and higher wear resistance. It is widely used in shield, mining, stamping die, cold heading die, roll and other industries under extreme working conditions, and the product reliability is greatly improved.



SEM micrograph of extra coarse grained cemented carbide (2000X)



TECHNICAL ADVANTAGES

R & D Team

Academician Huang Boyun is the chief scientist, relying on the Central South University, and in combination with the premium customer WOLF group in Germany, the largest shield equipment

manufacturer in China, China railway construction heavy industry group, and the first industrial Internet in China Brand Foxconn Industrial Internet Co., Ltd. consists of a strong interdisciplinary R & D team.



TECHNICAL ADVANTAGES

Ultrafine / Nano Cemented Carbide

Since 2002, Boyun-Dongfang has been cooperating with Central South University to continuously carry out the research and development and preparation of ultra-fine / nano cemented carbide with the support of the

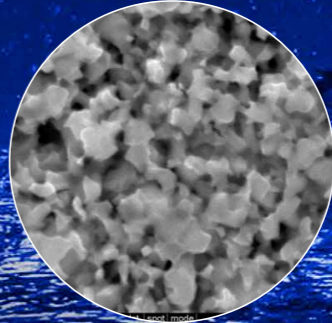
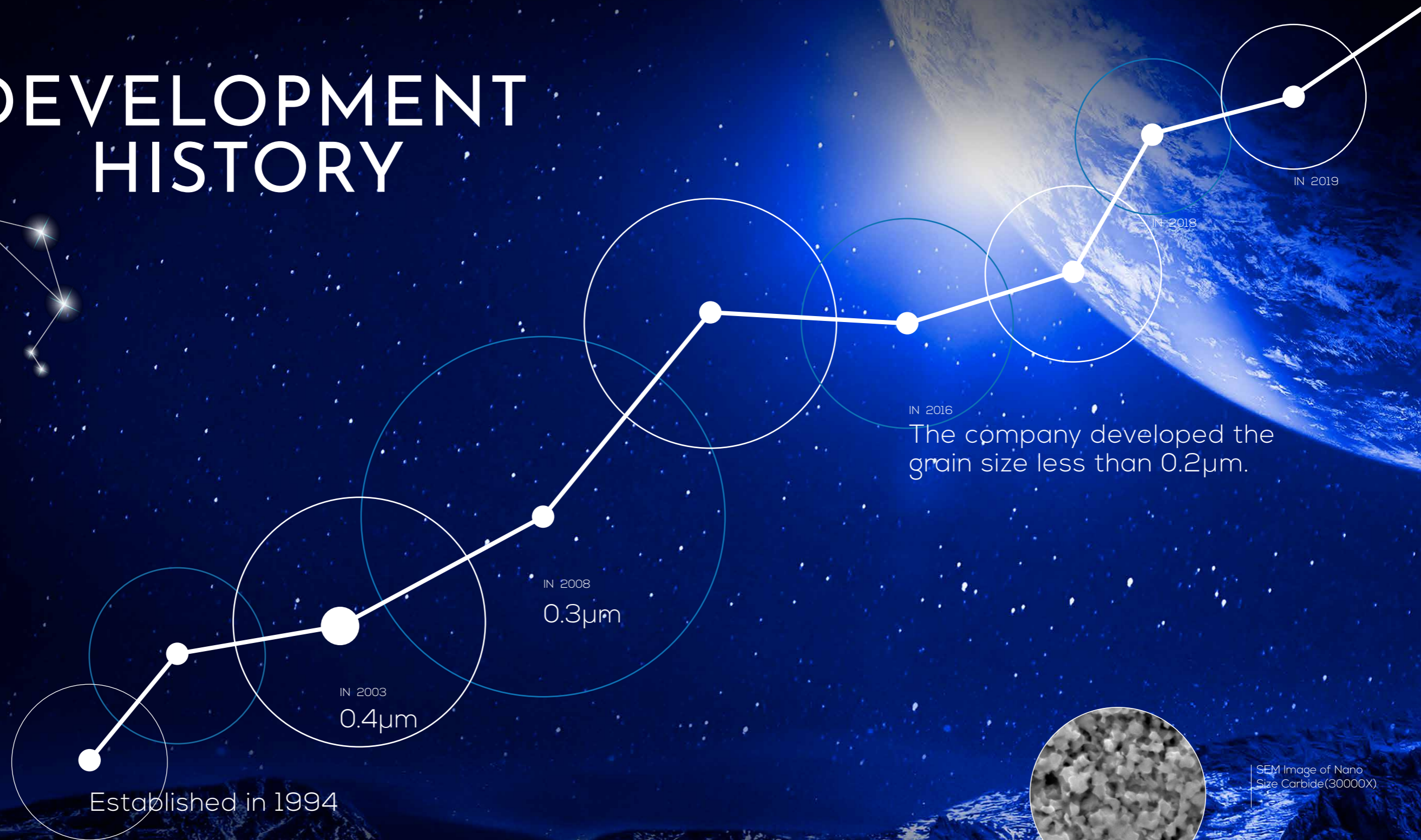
National Innovation Fund for small and medium-sized science and technology enterprises and the national high-tech research and development plan (863 Program).

Extra Coarse-Grained Cemented Carbide

The company developed the extra coarse-grained cemented carbide with WC grain size greater than $9\mu\text{m}$ has better toughness, better thermal fatigue resistance and higher wear resistance than the traditional extra coarse-grained cemented carbide. It is widely used in shield, mining, stamping die, cold upsetting die, roll and other industries under extreme working conditions, and the product reliability is greatly improved.

Have independent intellectual property rights and advanced self-activation high temperature reduction high temperature carbonization extra coarse-grained tungsten carbide powder preparation technology.

DEVELOPMENT HISTORY



SEM Image of Nano Size Carbide(30000X)



Ultrafine / Nano Cemented Carbide development history

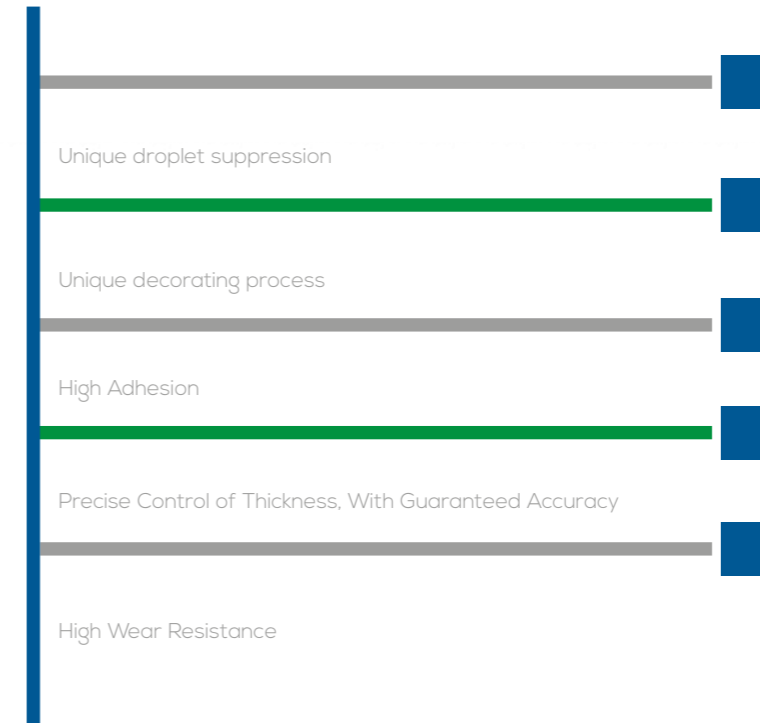




TECHNICAL ADVANTAGES

Coating

Coating technology reaches the international leading level

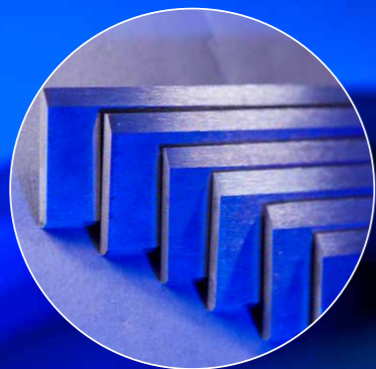


We are the strategic partner of eifeler and wolf in China
 We are eifeler's demonstration plant in China
 Our coating products have the same performance level as Germany

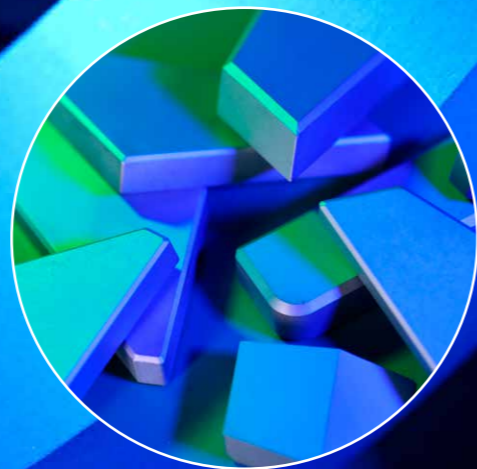


MAIN BUSINESS

The main business is the R & D, producing and sales of high-performance cemented carbide products. The main products are high-performance ultra-fine / nano cemented carbide rods, high-performance cemented carbide mold materials, high-performance extra coarse grain size cemented carbide in engineering and mining, refined and deep processed cemented carbide products (parts / components), etc. Our products are widely used in aerospace, automobile, metallurgy, engineering & mining, microelectronics and other industrial fields, and have been well known by our customers.



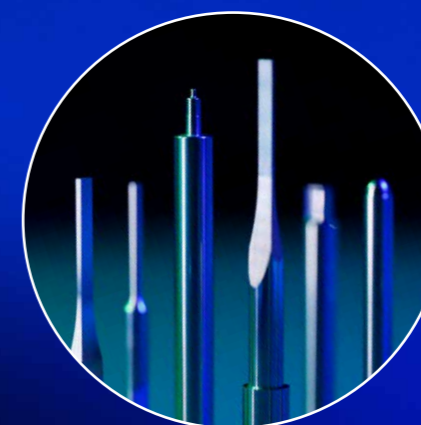
Special Tools



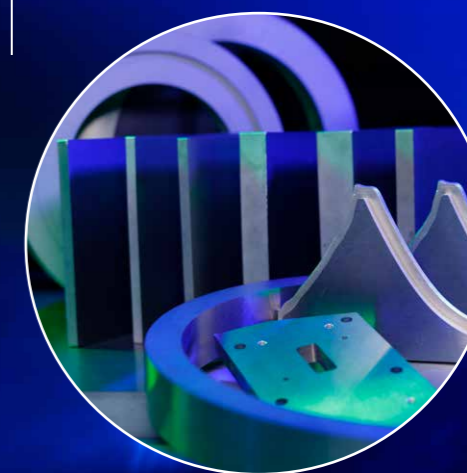
Shield Cutter



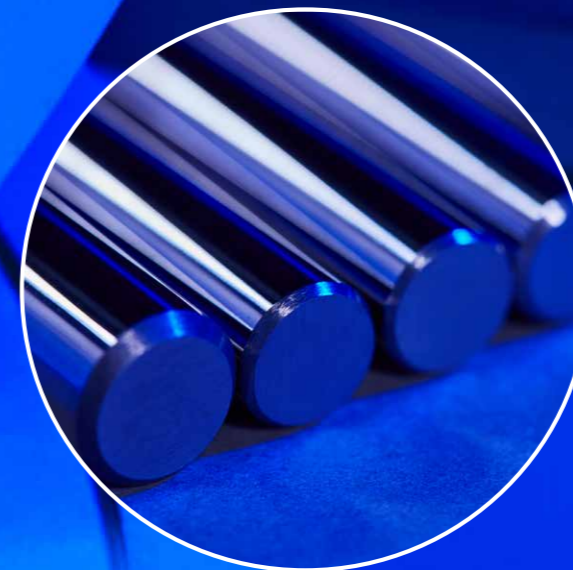
Coating



Finished Products



Molds



Rods

Coating

GENERAL INFORMATION

High-end surfaces
for your success.

In general thin hard coatings produced with PVD technology (Physical Vapour Deposition) show excellent qualities in wear protection and friction reduction. Additionally, customized coating variations can realize a multitude of surface properties for different requirements.



GENERAL INFORMATION

Pre- and post-processing

Decoating

Micro blasting

Polishing

Re-grinding

Manufacturing Beschichtungen

ARC coating

Analysis

Surface analysis

Coating list

Coating Material	Coating System	Coating Color	Coating Hardness(HV)	Coating Thickness(μm)	Friction Coefficient	application temperature(°C)
AlTiN	SUP	black	3,500	2-3	0.4	800
AlTiN	EX	black-blue	3,300	2-3	0.4	900
AlTiN	EX-S	silver	3,200	2-3	0.3	800
AlTiN	EX-G	gold	3,200	2-3	0.4	700
AlTiN	SIS	black-blue	3,500	2-3	0.4	1,000
TiAlN	VAR	antique-pink	3,500	2-3	0.2	600
AlCrN	CRO	black	3,200	2-3	0.4	1,100
TiN	TiN	gold	2,200	2-4	0.4	600
TiCN	TiCN	grey-blue	3,200	2-3	0.2	600
CrN	CRN	silver-grey	2,500	2-4	0.3	800

INDUSTRY APPLICATIONS

Chipping

Layer by layer – better tools.



Areas of application in chipping

1. Drilling
Hard PVD coatings protect cutting edges and optimize friction and chip removal
2. Milling
PVD coatings are used for milling of hardened materials and for high cutting parameters
3. Turning
Coated turning plates show an increased wear volume in abrasive machining processes
4. Gear cutting
Solid carbide hobs can achieve extreme tool life with high temperature stable coatings

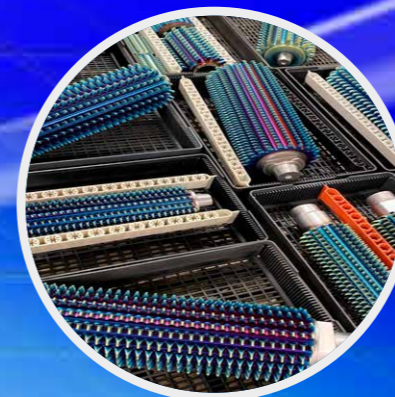
PVD coatings for chipping

1. Silicon-doped hard coating for processing of hardened materials
2. Multilayer coating for processing of aluminum, nickel and other non-ferrous alloys



Advantages of PVD coatings for chipping

1. Wear-protection coating for longer use of tool edges
2. PVD coatings reduce flank wear and crater wear
3. Reduction of friction and improvement of chip removal
4. Reduced adhesion of materials and protection against formation of build-up edges
5. High-temperature-stable PVD coatings allow application in dry machining
6. Hardened and hard-to-cut materials can be machined with super-hard PVD coatings



PUNCHING AND FORMING

For optimal production processes

Various PVD coatings are used in punching and forming for application on tool components. While a hard coating is required to protect the cutting edge during the cutting process, various PVD coatings are applied for the complex forming processes.



PVD coatings for punching and forming

PVD coating for processing copper and non-ferrous alloys

Universal coating of stamping and forming tools for steel materials

PVD coating for the more massive forming processes of thicker steel sheets

Areas of application for punching and forming

1.Cutting

Cutting blades and brake tools are coated for wear protection

2.Punching

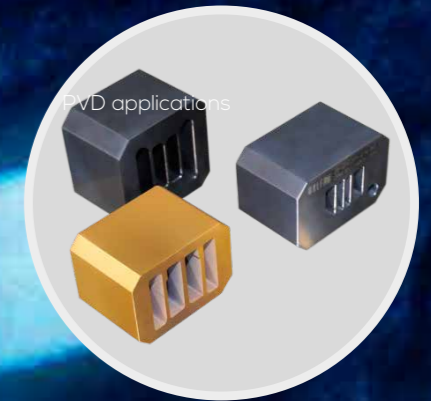
PVD coating of stamps and dies to increase tool life in punching processes

3.Forming

Possible PVD applications are bending, deep drawing and embossing tools

4.Massive forming

Massive forming, hot forming and forging are marginal



Advantages of PVD coatings for punching and forming

Wear protection coating for increased tool life of stamping and forming tools

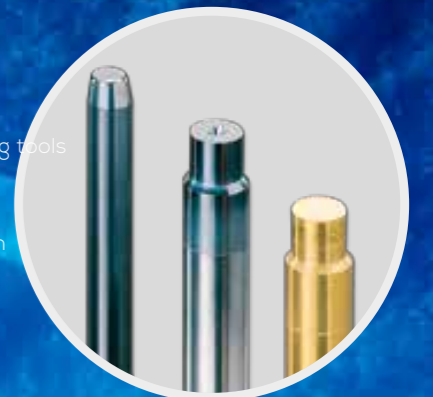
Improved surface and cut surface quality by use of coating

Reduction of friction, adhesion and material build-up during application

Reduction of lubricant use to the extent of dry forming processes

Increase of stroke rates during stamping

and reduction of drawing steps during forming



PLASTICS TECHNOLOGY

In best shape with intelligent coating systems.

Numerous application fields for PVD coatings in plastics technology are known and well established. Next to the main usage plastic injection molding, other areas are extrusion, connecting and processing of plastics.

Areas of application in plastics technology

1. Plastics injection molding

Coating of mold contours and tool parts

2. Plastics extrusion

Coating of tool components

3. Cutting of plastics

Coated cutting tools

4. Connecting of plastics

For example welding plastics with coated tools



PVD coating in plastic technology

Titanium nitride as demolding agent or abrasion protection

Chromium nitride for the reduction of residue or corrosion protection

Titanium aluminum nitride as abrasion protection for e.g. glass fibre plastic



Advantages of PVD coatings in plastics technology

Abrasion protection for structured and polished surfaces

Reduction of mold residue and cleaning effort

Reduction of corrosive and chemical wear

Improved demolding and lower cycle times

Friction reduction and dry run option for movable parts

Improved surface of plastics parts



INDUSTRY AND ENGINEERING

Coatings for smooth procedures

The extensive sector of general machining allows for a multitude of application fields for the use of PVD coatings. For example, parts and components used in machining can reach noticeably extended lifecycles by the introduction of abrasion and friction reducing coating systems.

Areas of application in industry and mechanical engineering

1. Gear components

Friction reducing coating of gear wheels and other gear components

2. Pump technology

Reduction of wear and friction for pump pistons

3. Hydraulic

Cr-VI free PVD coating systems for hydraulic pumps and valves

4. Bearings

Coating of bearing components to reduce lubrication and abrasion

PVD coatings in industry and mechanical engineering

Allround coating for machine parts against corrosion, friction and abrasion

Reduction of friction force, fretting corrosion and tendency to seize

Coating allows use of mechanical parts without lubrication

Protection against corrosion and all forms of chemical wear

Food-safe and biocompatible coating for medical, pharmaceutical and food industries

Absorbing coatings to reduce scattered radiation in measurement technology and optics



Reduction of friction force, fretting corrosion and tendency to seize

Coating allows use of mechanical parts without lubrication

Protection against corrosion and all forms of chemical wear

Food-safe and biocompatible coating for medical, pharmaceutical and food industries

Absorbing coatings to reduce scattered radiation in measurement technology and optics

AREAS OF APPLICATION IN AUTOMOTIVE INDUSTRY

High tech coatings for your progress.

Mentionable usages of coatings in automotive, truck and racing sectors primary are components for engines and drive trains.

Areas of application in automotive industry

1.Engine components

Reduction of abrasion and friction, e.g. for piston pins and rings

2.Valve train

Reduction of friction by coating of rocker arms and bucket tappets

3.Fuel injection

Coating of elements in unit injectors and common rail systems

4.Gear parts

Friction reducing coating of gear wheels and other gear box elements

PVD coating in automotive industry

DLC coating against wear and friction in engine and drive train

CRN hard coating featuring oxidation resistance and good wettability

EX-S combines a hard wear protection layer with a silver top color

Advantages of PVD coatings in automotive industry

Wear protection coating for all mechanically stressed components

Reduction of friction resulting in optimized fuel consumption

Coating allows for emergency running properties of components

Protection against corrosion and against all forms of chemical wear

Decorative coating of interior and exterior parts

MEDICAL TECHNOLOGY

For the highest level of mobility.

In medical technology more and more application fields are developed for PVD coating use. Next to the obvious coating areas such as instruments for surgery or dental medicine, there are numerous functional coatings used on medical components and devices.

Areas of application in medical technology

1.Instruments

Coating of instruments for surgery and dental medicine

2.Bone saws and bone drills

Abrasion protective coating for tools

3.implants

Coating of medical implants for reduced wear and low friction

4.Medical devices

Medical devices with various functional layers

PVD coatings in medical technology

Titanium Nitride as the standard solution with FDA approval

Advantages of PVD coatings in medical technology PVD

Wear protection for medical instruments and tools

Resistance against corrosion when sterilising in autoclaves

Absorbing coatings to prevent scattered radiation problems

Biocompatibility of coatings allow a harmless use within the human body

Coatings have anti bacterial and anti allergic features

Friction reduction and lubricant free use in mechanical systems



Application Recommendation

Chipping

Material	Turning tools	Drilling tools	Milling tools	Thread tools	Broach tools	Hobbing
low-alloy steel	EX, EX-plus, TIN	EX, EX-plus, SUP	EX, EX-plus, SUP	TIN, TICN	EX, EX-plus	CRO
high-alloy steel	EX, EX-plus, TIN	EX, EX-plus, SUP	EX, EX-plus, SUP	EX, TICN	EX, EX-plus	CRO
hardened steel	SIS	SIS	SIS	EX, SIS	SIS	CRO
stainless steel	EX, EX-plus, EX-S	EX, EX-plus, EX-S	EX, EX-plus, EX-S	EX, EX-S		
cast iron	EX, EX-plus, SUP	EX, EX-plus, SUP	EX, EX-plus, SIS	EX, EX-plus, SUP		CRO
aluminum alloys	EX-S, DLC	EX-S, DLC	EX-S, DLC	EX-S, DLC		
aluminum silicon alloys	EX-S, DIAMANT	EX-S, DIAMANT	EX-S, DIAMANT			
nickel alloys	SIS	SIS	SIS	SIS		
titanium alloys	EX-S	EX-S	EX-S	EX-S		
copper, brass, bronze	CRN, EX-S, DLC	CRN, EX-S	CRN, EX-S	CRN, EX-S, DLC		
graphite	DIAMANT	DIAMANT	DIAMANT			
plastics	EX, EX-plus, SIS	EX, EX-plus, SIS	EX, EX-plus, SIS			
CFK	SIS, DIAMANT	SIS, DIAMANT	SIS, DIAMANT			

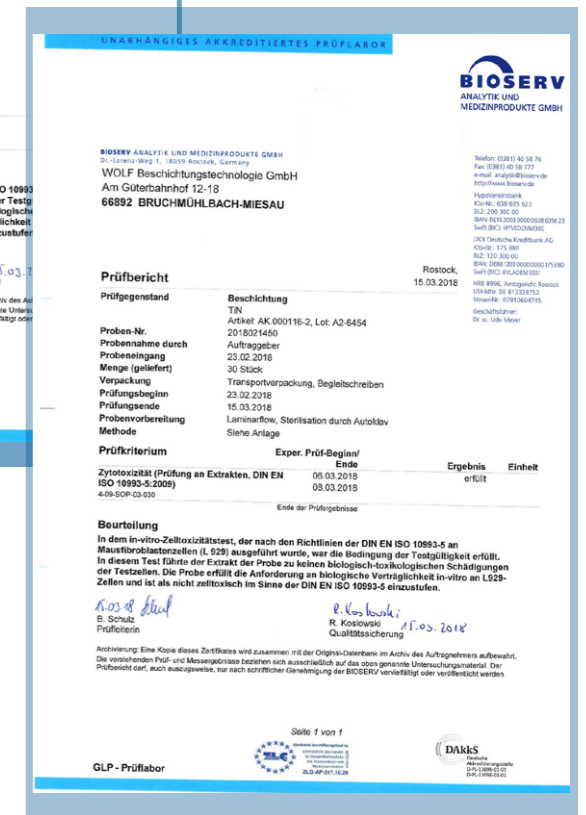
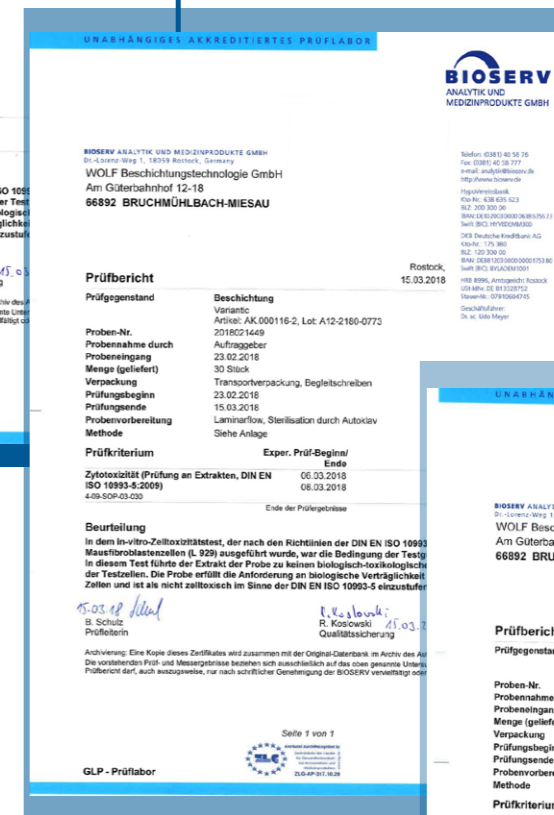
Punching and forming

Material	Punching&Cutting	Fine Blanking	Cold Forming	Massive Forming	Hot Forming
steel	EX-plus, TICN	EX-plus, TICN	TIN, TICN	VAR, TICN	EX, EX-plus
stainless steel	EX, EX-plus	EX, EX-plus	EX-plus, TICN	VAR, EX, TICN	EX, EX-plus
high-strength steel	EX, SIS	EX, SIS	VAR, EX	EX, VAR	EX, EX-plus
zinc coated steel	EX, EX-plus, EX-S	EX, EX-plus, EX-S	EX, EX-plus, EX-S	EX, EX-S, VAR	EX, EX-plus
aluminum alloys	EX-S, DLC	EX-S, DLC	EX-S, DLC	EX-S, DLC	EX-S, EX-plus
copper, brass, bronze	EX-S, CRN	EX-S, CRN	EX-S, CRN	EX-S, CRN	EX-S, CRN
titanium alloys	EX-plus, EX-S	EX-plus, EX-S	EX-plus, EX-S	EX-plus, EX-S	EX-plus, EX-S

Plastics Technology

Category of plastic	Type of plastic	Recommended
polyolefines	PE, PP, PB	CRN, DLC
chlorine-based polymerisates	PVC	CRN
styrol-based polymerisates	PS, SAN, SB, ABS, ASA	TIN
acetal resins	POM	CRN
polyacrylate	PMMA	TIN
polyamides	PA6, PA66, PA12	TIN, CRN
linear polyesters	PC, ABS, PBT	CRN, TIN
blends	PC/ABS, PC/PBT	CRN, TIN
polyimides	PEI, PAI, PMI	CRN, DLC
polyarylenethene	PEEK, PPS, PSU, PES, PPE, PPO	CRN
fluorine-based polymerisates	PTFE, PVDF	CRN
elastomeres	PUR, TPU, TPE, EPDM, NBR, FDM	CRN
duroplasts	PF, MF, MP, UF, UP, EP	CRN

Bioserv Certificates



INTEGRITY COOPERATION INNOVATION

HUNANBOYUN-DONGFANG
POWDER METALLURGY CO., LTD.





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