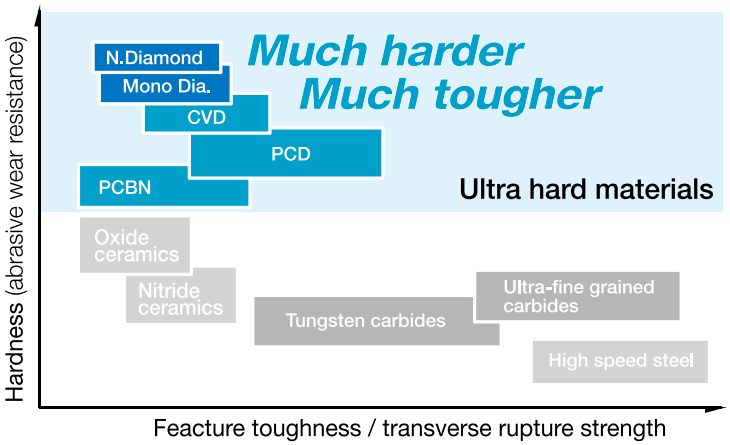
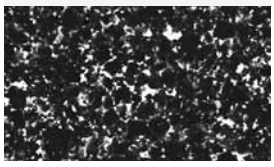
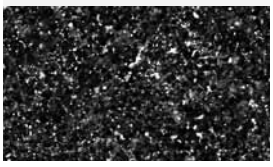
Advantages of diamond tools

Today's modern industrial society continues to push the development and uses of new and advanced materials, and high precision machining to new heights. Along with the improvements in producing processes and difficulties that arise from machining new and advanced materials, there is an increasing demand for new forms of cutting tools that go beyond the conventional cutting tools such as those made out of high speed steel, tungsten carbides, cermets, and ceramics.

Polycrystalline Diamond (PCD), is a synthetic diamond product that is produced by sintering selected diamond particles with a metal matrix using very sophisticated temperature and high pressure technology.



Characteristics of diamond types

	PCD	PCBN	CVD diamond	Mono diamond natural diamond
Definition	Polycrystalline diamond	Polycrystalline cubic boron nitride	Polycrystalline diamond (chemical vapor deposition method)	Single crystal diamond
Applicable work material	Non-ferrous such as Al, copper alloys, etc. & nonmetallic such as wood working, advanced composite, etc.	Ferrous material such as cast iron, hardened steel, super alloy meterial, etc.	Non-ferrous such as Al, copper alloys, etc. & nonmetallic such as wood working, advanced composite, etc.	Superior edge quality for nonmetallic material
Hardness (Hv, GPa)	50 ~ 70	30 ~ 40	70 ~ 80	80 ~ 100
Magnified structure				

PCD by its nature, is high in uniform hardness, and also more abrasive and shock resistant in all directions than natural diamonds because of its random-oriented structure of the diamond particles.

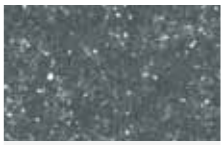
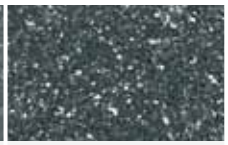
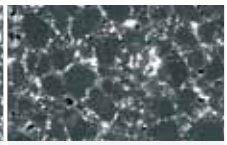
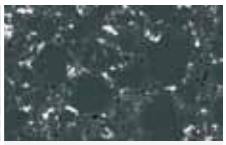
Polycrystalline cubic boron nitride (PCBN) is an artificially synthesized material. except for diamond, PCBN is the hardest material. however, unlike diamond, PCBN is stable under conditions of high temperature (up to 1000°c), normally seen when machining hardened ferrous or super alloy materials. PCBN tools permit metal cutting with feed and speed rates that are much higher than conventional cutting tools.

Diamond tools advantage

- Good surface finish
- High accuracy
- Longer tool life
- Lower stock management
- Fast material removal rate
- Lower energy cost
- Eco friendly

Poly Crystalline Diamond

PCD distinction & application

Grit size	Ultra Fine	Fine	Medium	Coarse	Multi modal
Micro structure (1000 x)					
Type	Carbide backed	Carbide backed	Carbide backed	Carbide backed	Carbide backed
Grain size	0.5 ㎛	3~4 ㎛	8~10 ㎛	20~25 ㎛	30+2 ㎛
Diamond (%)	85	90	90	94	94
Grade	EP20	EP51	EP55	EP58	EP29
Surface finish	Better → → → → → → →				Worse
Wear resistance	Worse → → → → → → →				Better
Application	Wood working Copper alloy Rubber / Acryl_glass (Si <13%) Al-Si alloy (Si >13%) Tungsten carbide Ceramic (sintered/unsintered) M.M.C / CFRP / glass fiber General purpose				

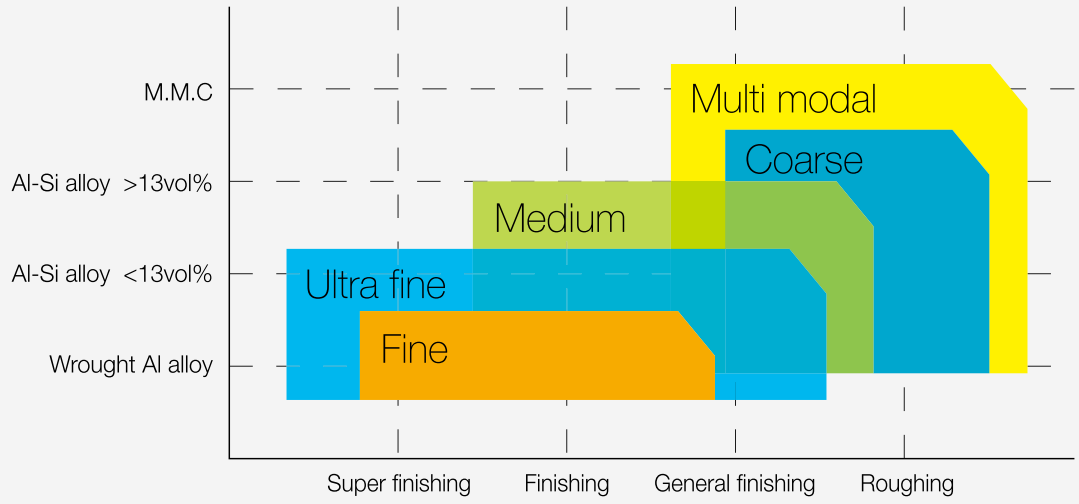
EHWA PCD grade

Grade	Binder	Diamond vol. (%)	Grit size (㎛)	Characteristic
EP10	W+Co	85	1.5	Excellent sharp edge, superb sharpness cutting edge
EP20	W+Co	85	0.5	Excellent surface finish, ultra fine grade and fine grade
EP51	W+Co	90	3~4	Excellent surface finish
EP13	W+Co	92	5~6	General purpose, excellent WEDM
EP55	W+Co	90	8~10	General purpose
EP75	W+Co	90	6~8	General purpose, excellent WEDM
EP750	W+Co	90	8+2	Multi-modal, good wear resistance
EP58	W+Co	94	20~25	Excellent wear resistance
EP59	W+Co	95	25+2	Multi-modal, good wear resistance
EP29	W+Co	94	30+2	Multi-modal, good wear resistance, adequate for difficult-to-cut-materials
EP69	W+Co	95	50+α	Multi-modal, good wear resistance, adequate for difficult-to-cut-materials

EHWA PCD working parameter

Materials	Ultra fine	Fine	Medium	Coarse	Multi modal	Vc (m/min)	f (mm/rev)	ap (㎛)
Al alloy (Si <13%)	EP10, EP20		EP13, EP55, EP75			~ 3,000	~ 0.2	~ 3
Al alloy (Si >13%)			EP750	EP58	EP29, EP59, EP69	~ 3,000	~ 0.2	~ 3
Copper alloy	EP10, EP20	EP51	EP13			~ 1,000	~ 0.2	~ 3
Carbide / ceramic			EP55, EP75, EP750	EP58	EP29, EP59, EP69	10~30	~ 0.2	~ 0.5
Engineering plastic	EP10, EP20		EP13, EP55, EP75		EP29, EP59, EP69	~ 1,000	~ 0.4	~ 2
Wood		EP51	EP55, EP75, EP750			~ 4,000	~ 0.4	-
Ti alloy	EP20					50~100	~ 0.3	~ 0.5

Application range by PCD grade



Applicable work material

Nonferrous material		Nonmetallic material	
Al alloy	High Si >13% / low-medium Si <13% / metal matrix composites	**Wood working**	High density fiberboard /chipboard / hardboard / laminates
Copper alloy	Brass / bronze / zinc	**Advanced composite**	Graphite-epoxy / carbon fiber / fiberglass plastic / engineering plastic
Tungsten carbide	Sintered / unsintered	**Ceramic & stone**	Sintered / unsintered / granite / imitation marble
Ti alloy		**Quartz**	

Polycrystalline Cubic Boron Nitride

Characteristic of PCBN

Contents	CBN vol. (%)	Grit size (㎛)	Binder phase	Strength & toughness	Thermal conductivity	Chemical stability	Wear resistance
Low contents	40~70	0.5~5	Ceramics (TIC, TIN..)	■■□□	■■□□	■■■■	■■■□
High contents	70~95	10~20	Metal (Co, WC...)	■■■■	■■■■	■■□□	■■■■

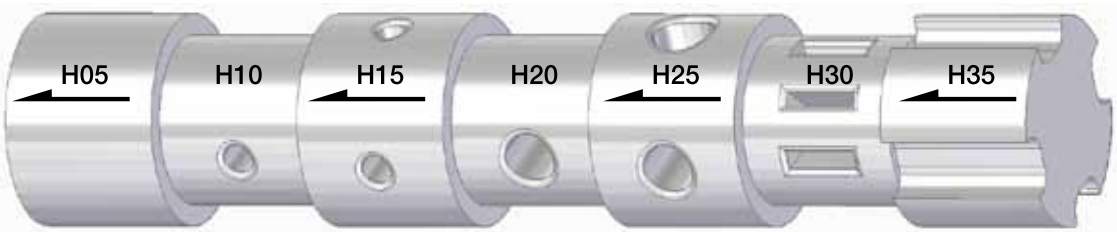
EHWA PCBN grade

■ Carbide backed ■ Solid tip

	Grade	CBN vol%	Type	Application
Low contents	EB19X	40%	Carbide Backed	H05 (high speed machining)
	EB29X(EB29S)		Carbide Backed, Solid	H05 (high speed machining)
	EB28X(EB28S)		Carbide Backed, Solid	H05 (standard)
	EB180		Carbide Backed	H05~H15
	EB570(EB57S)		Carbide Backed, Solid	H05~H15 , bearing steel
	EB160		Carbide Backed, Solid	H05~H15 , bearing steel
	EB560(EB56S)		Carbide Backed, Solid	H05~H20
	EB550(EB55S)		Carbide Backed, Solid	H15~H25
	EB150		Carbide Backed	H15~H25
	EB190		Carbide Backed	H05~H30
	EB73		Carbide Backed	H25~H35
	EB54X	70%	Solid	H25~H35
	EB170		Carbide Backed	P/M Valve seat
	EB14		Carbide Backed	P/M Valve seat
High contents	EB130	75%	Carbide Backed	Powder metal(low alloyed)
	EB710		Carbide Backed	Chilled iron, p/m(low alloyed)
	EB120		Carbide Backed	Ductile cast iron, chilled iron
	EB22		Carbide Backed	Chilled iron, p/m(low alloyed)
	EB11		Carbide Backed	Cast iron(Standard), heavy interrupt
	EB51		Carbide Backed	Cast iron(Standard)
	EB71		Carbide Backed & Double side	Cast iron(Standard)
	EB210		Carbide Backed	Cast iron(high interrupt)
	EB71X		Carbide Backed	Chilled iron, p/m(low alloyed)
	EB100X		Solid	White iron, cast iron heavy milling
	EB50		Solid	Grey Cast iron(rough)
	EB1000		Solid	Grey Cast iron (rough & finish)
	HBN		Solid	Grey Cast iron(Standard)
	HBN-T		Solid	Grey Cast iron(rough)
	HBN-W	95%	Solid	Grey Cast iron(rough)
	HBN-N		Solid	Grey Cast iron(rough)
	HBN-R		Solid	Grey cast iron(iron roll)

Interruption of hard steel turning

H05 : Continuous / **H15 :** Light Interruption / **H25 :** Medium Interruption / **H35 :** Heavy Interruption



EHWA PCBN working parameter

	Continuous cutting	Interrupt cutting			Working parameter		
		Light	Medium	Heavy	Vc (m/min)	f (mm/rev)	ap (mm)
H Hardened steel	EB19X, EB29X(S)				150~300	0.05~0.15	0.05~0.15
	EB28X(S)				120~280	0.05~0.2	0.05~0.2
	EB180, EB570(S)				100~230	0.05~0.15	0.05~0.2
	EB160, EB560(S)				80~200	0.05~0.2	0.05~0.2
	EB550(S), EB150				80~180	0.05~0.2	0.05~0.3
	EB190				70~170	0.05~0.2	0.05~0.3
	EB54X, EB73				70~120	0.05~0.15	0.05~0.2
	EB51, EB210				50~100	0.05~0.15	0.05~0.2
K Cast iron	EB51, EB71				300~1000	0.1~0.5	0.1~2
	EB210, EB71X				300~1500	0.05~0.3	0.1~2
	EB50, EB1000				150~1500	0.1~0.5	0.1~4
	EB100X				150~1000	0.1~0.3	0.1~4
	HBN-W, HBN-T				300~1000	0.1~0.5	0.1~4
	HBN, HBN-N				300~1000	0.1~0.5	0.1~4
P/M High alloyed	EB28X(S)				100~250	0.05~0.2	0.05~0.2
	EB170, EB14				100~200	0.05~0.2	0.05~0.2
	EB550(S)				50~150	0.05~0.25	0.05~0.2
P/M Low alloyed	EB51, EB71				50~150	0.05~0.3	0.05~0.2
	EB710, EB130, EB22				50~150	0.05~0.3	0.05~0.2
	EB120, EB71X				50~150	0.05~0.3	0.05~0.2

EHWA PCBN working parameter

Low CBN contents

Hardened steel

Tool steel / die steel / hardened steel /
Bearing steel / Hi-Cr, Mo steel

Work example
Gear / transmission / shaft / bearing / die / punch

Powder metal

Sintered metal

Work example
Valve seat / valve guide / con-rod / oil-pump / gear

High CBN contents

Cast iron

Gray cast iron / Ni-hard cast iron / Alloy cast iron /
Chilled cast iron / Nodular cast iron

Work example Engine block / brake disc /
brake drum / cluch plate / roll / pump / Impeller

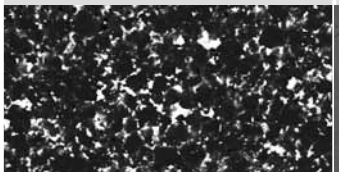
Super alloy

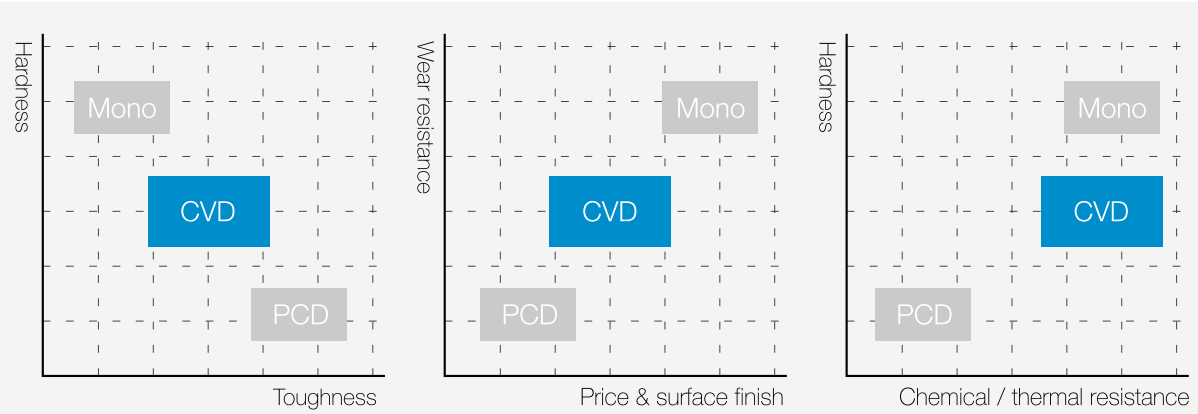
Inconel 718,901,600 / rene76,77,95 / stellite

Work example
Turbine / turbine disc / turbine blade / turbine vane

Chemical Vapoured Deposition diamond

General properties of CVD diamond

Property	PCD	CVD (Poly crystalline diamond)	Mono (Single crystalline diamond)
Thermal conductivity	560	560	2,000
Hardness (Gpa)	50~70	70~80	80~100
Toughness (Mpa-m1/2)	8~9	8~9	3~4
Tensile strength (Gpa)	1,260	1,260	2,000
Micro structure (1000 x)			



EHWA CVD diamond grade

Grade	ED501	ED502
Wear resistance	■■■□	■■■■
Toughness	■■■□	■■□□

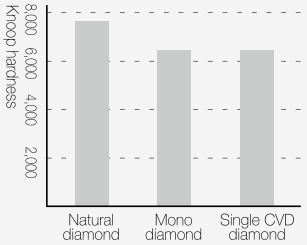
Applicable work material

Nonferrous material	Nonmetallic material
Al alloy High Si >13% / low-medium Si <13% / metal matrix composites	**Wood working** High density fiberboard / Chipboard / Hardboard / Laminates
Copper alloy Brass / bronze / zinc	**Advanced composite** Graphite-epoxy / Carbon-fiber / Fiberglass plastic / Engineering plastic
Tungsten carbide Sintered / unsintered	**Ceramic & Stone** Sintered / Unsintered / Granite / Imitation marble
	Quartz

Single Crystalline Diamond

Application

- Non-ferrous metal
- Acrylic
- Lens
- Microscopic pattern
- FPD (flat panel display)
- BLU (back light unit)



Natural diamond

- Excellent surface finish
- Colorless
- Longest tool life, excellent wear
- Highest thermal conductivityresistance

Mono diamond

- Available alternative to natural diamond
- Yellow color
- High pressure, High temperature synthesis
- Enhanced and more consistent performance

Single CVD diamond

- Similar to natural diamond
- Colorless
- Superior edge quality for ultra precision machining applications
- Highly consistent material properties

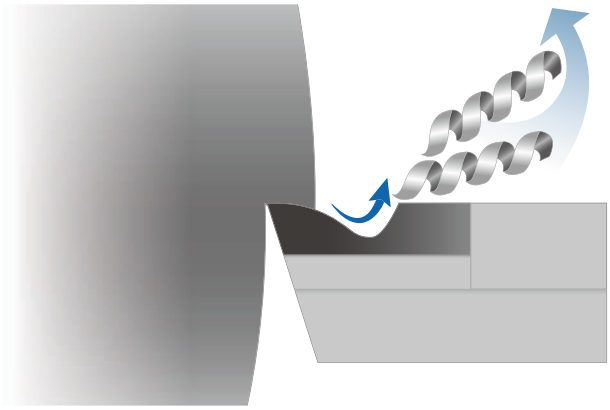
Coating Type

Coating grade (Ehwa code)	Color	Hardeness (Hv)	Temperature (℃)	Characteristic
TIN	Gold	2,300	600	Mono layer Traditionally used for wear part Easily identify used edge
TA	Purple grey	3,400	900	Good heat resistance Good wear resistance Traditionally used for cutting tool
AC	Silver grey	3,200	1,100	Better heat resistance Higher hot hardness Higher oxidation resistance
EL	Dark grey	3,500	1,000	Better wear resistance Better chemical resistance Good performer for hardened steel & bearing steel
NEW TNP	Light dark grey	3,500	1,000	Excellent wear resistance Excellent heat resistance Very good surface finish Best performer for hardened steel & bearing steel

Application Area

EHWA coating	Cast iron	Hardened steel (HRC45~)	Bearing steel	Powder metal (45HRC~)
TIN	TIN			
TA	TA			
AC		AC		AC
EL			EL	
TNP		TNP		

PCD/CVD
Chip breaker

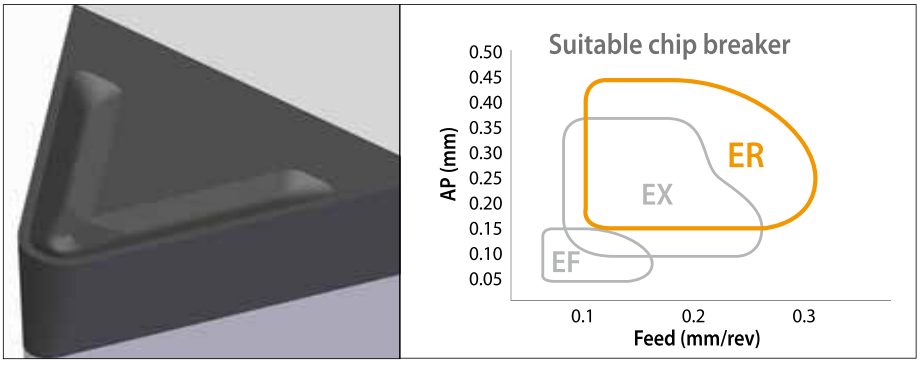


EHWA's 3D chip breaker

· Easy to control long chips
· Smooth and stable cutting at low & high feed rates
· Easy chip control for a variety of cutting conditions
· Various chip breaker design for CCGW, DCGW, VBGW, TCGW etc.

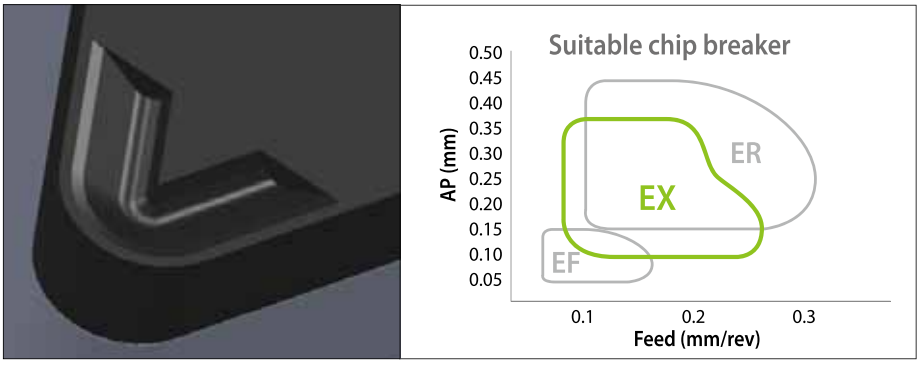
Various PCD chip breaker | ER, EX, EF, ES

ER type



· Excellent chip control for heavy depth of cut
· Perfect chip control by specially designed chip breaker

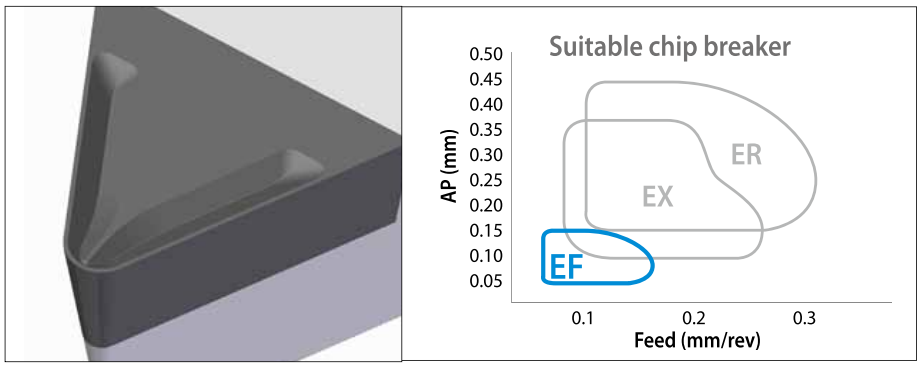
EX type



· Excellent chip control for medium depth of cut
· Special design enhancing cutting edge
· Outstanding chip-resistance at roughing & semi finishing

PCD/CVD
Chip breaker

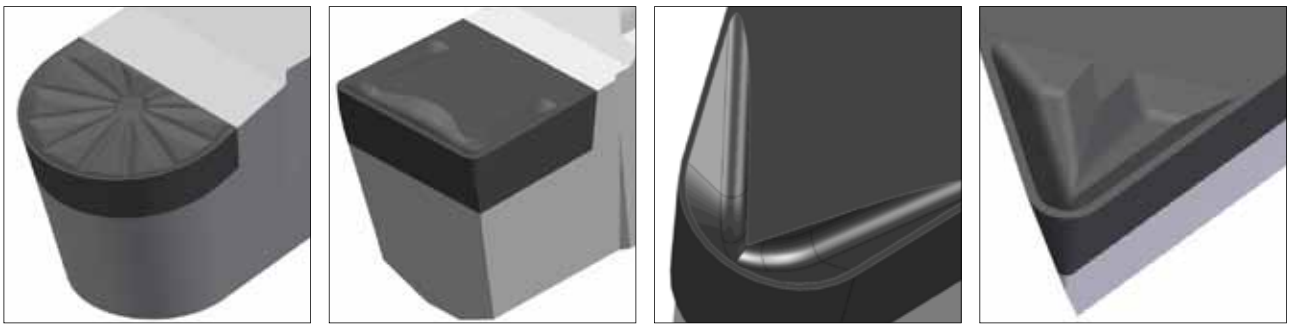
EF type



· Excellent chip control for smaller depths of cut
· Standard design for finishing

ES type

Customized design



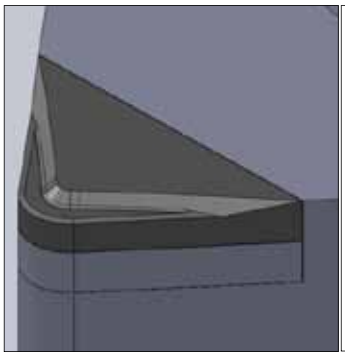
Needed information for ES design

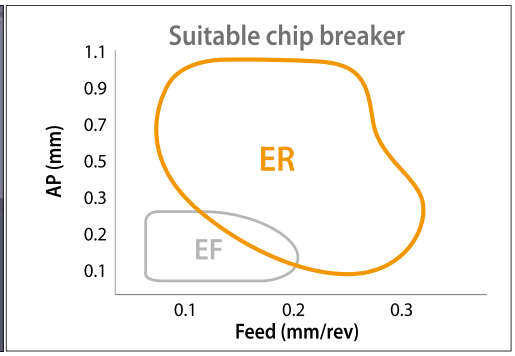
Tool/work piece information		Cutting condition	
Tool spec	VCGW160408	Cutting speed (m/min)	1,800
Holder spec	SVVCN2525-16	RPM (rev/min)	2,500
Part name	Aluminium wheel	Feed (mm/rev)	0.15
Workpiece material	ADC12	Depth of cut (mm)	0.3

PCBN
Chip breaker

Various PCBN chip breaker | ER, EF, ES

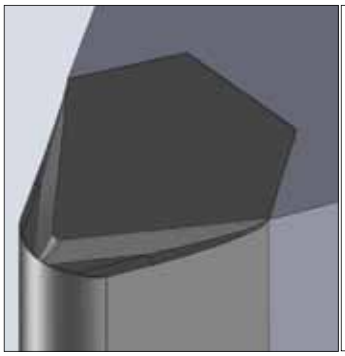
ER type

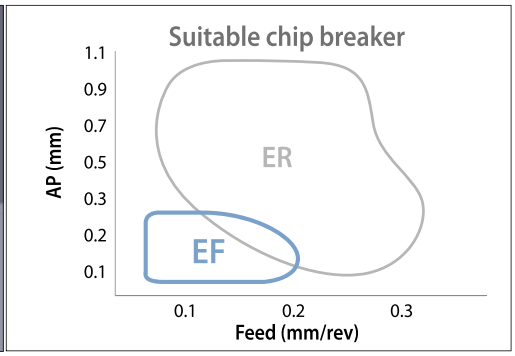




· Excellent chip control for heavy depth of cut
· Special design enhancing cutting edge
· Round coner easily curling chip

EF type

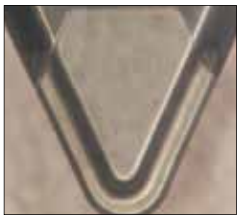




· Excellent chip control for small depth of cut
· Standard design for finishing

ES type

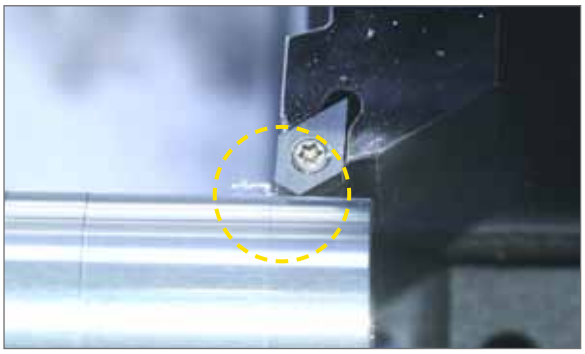
Customized design



Needed information for ES design

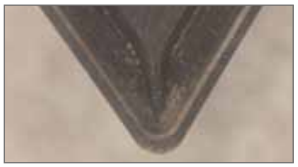
Tool/work piece information		Cutting condition	
Tool spec	CNGA120408	Cutting speed (m/min)	850
Holder spec	DCLN R/L3232	RPM (rev/min)	1,000
Part name	Brake disk	Feed (mm/rev)	0.3
Workpiece material	FC250	Depth of cut (mm)	0.4

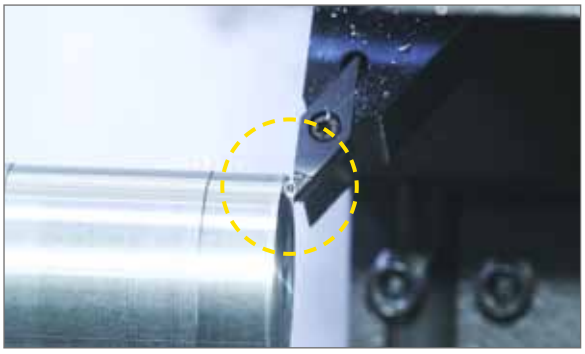
PCD/CVD
Case history



DCGW11T308 _ER

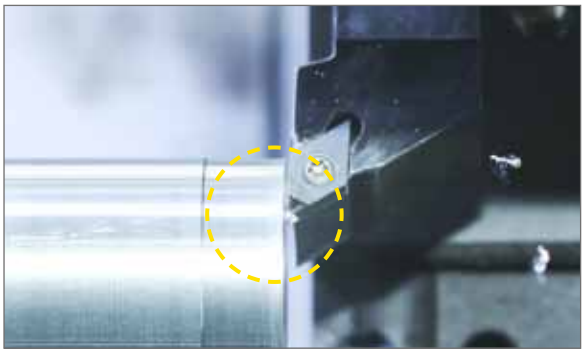
- **Work :** Al alloy
- **Vc** : ≒500 m/min
- **D.O.C** : 0.5 mm
- **Feed** : 0.15 mm/rev





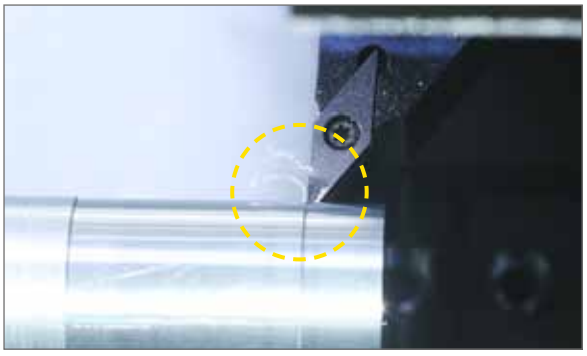
VCGW110302 _EF

- **Work** : Al alloy
- **Vc** : ≒500 m/min
- **D.O.C** : 0.1 mm
- **Feed** : 0.1 mm/rev



DCGW11T304 _EX

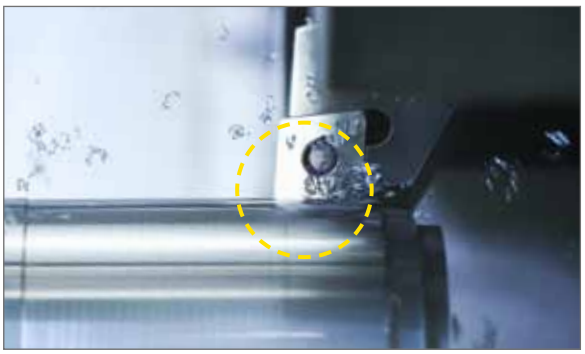
- **Work** : Al alloy
- **Vc** : ≒800 m/min
- **D.O.C** : 0.2 mm
- **Feed** : 0.15 mm/rev



VBGW160408 _ES

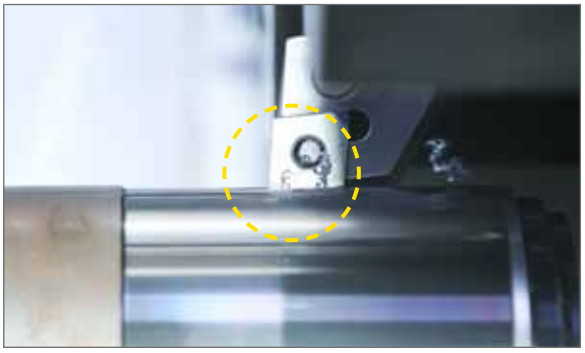
- **Work** : Al alloy
- **Vc** : ≒1500 m/min
- **D.O.C** : 0.2 mm
- **Feed** : 0.3 mm/rev

PCBN
Case history



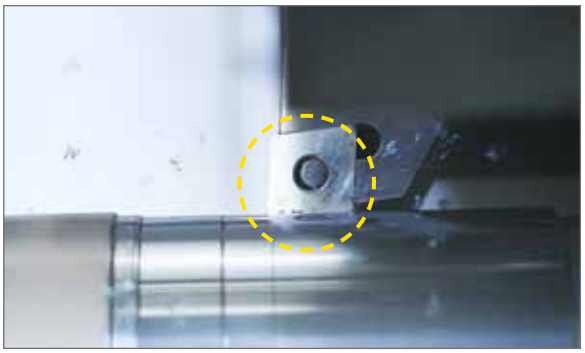
CNGA120408 _ER

· **Work** : SCM420 steel
· **Vc** : ≒150 m/min
· **D.O.C** : 0.25 mm
· **Feed** : 0.1~0.3 mm/rev



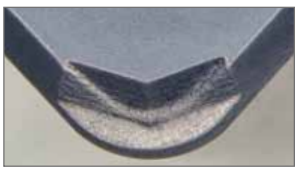
CNGA120408 _EF

· **Work** : SCM420 steel
· **Vc** : ≒150 m/min
· **D.O.C** : 0.1 mm
· **Feed** : 0.1~0.3 mm/rev



CNGA120408 _ES

· **Work** : Scm420 steel
· **Vc** : ≒150 m/min
· **D.O.C** : 0.2 mm
· **Feed** : 0.1~0.15 mm/rev



WNGA080408 _ES

· **Work** : Scm420 steel
· **Vc** : ≒100 m/min
· **D.O.C** : 0.15 mm
· **Feed** : 0.1 mm/rev