SUMITOMO

CARBIDE - CBN - DIAMOND

Global Support, Global Solutions.

The Solution for
Carbide Tool Manufactures

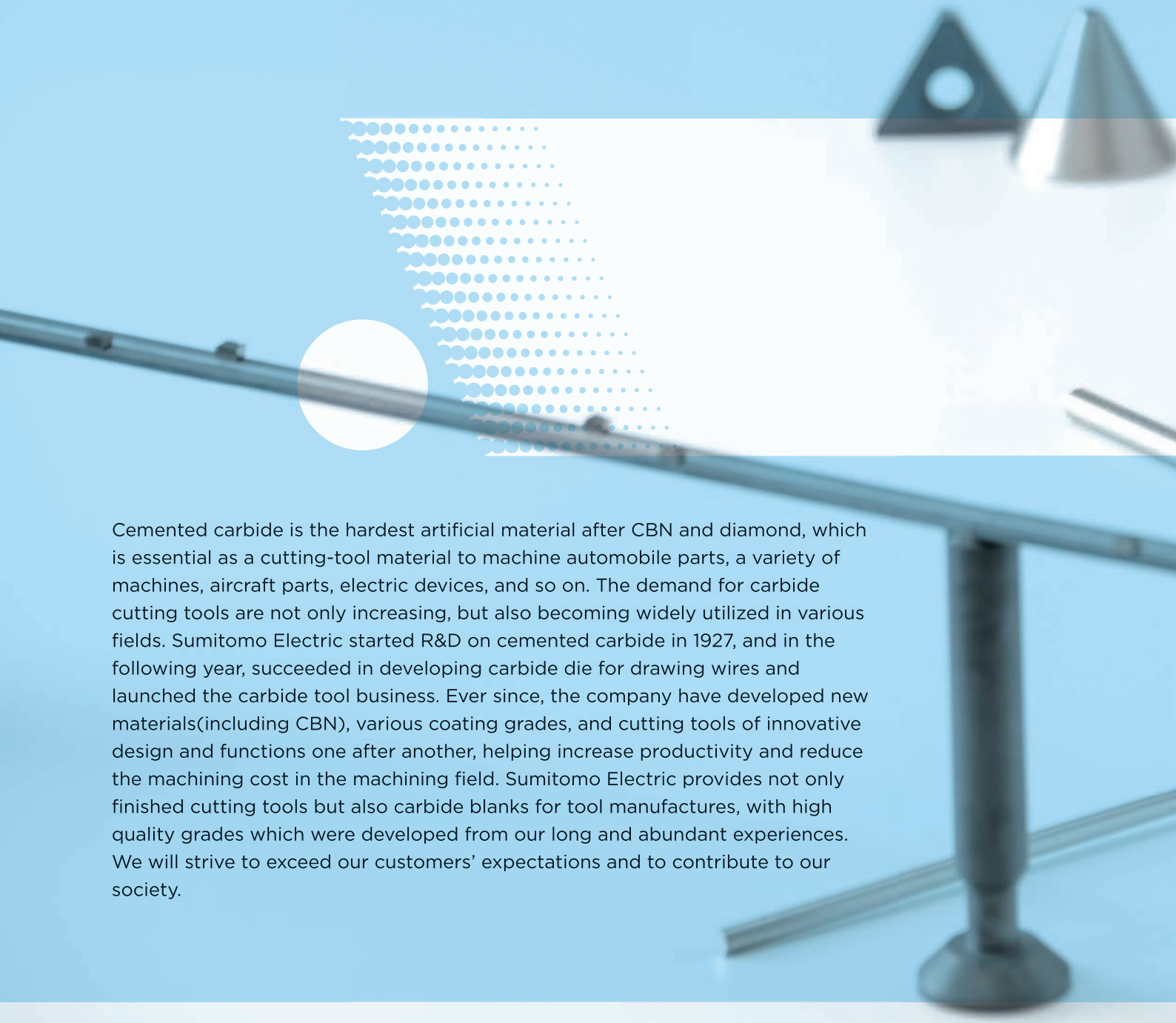
CARBIDE BLANKS

Rev. 2

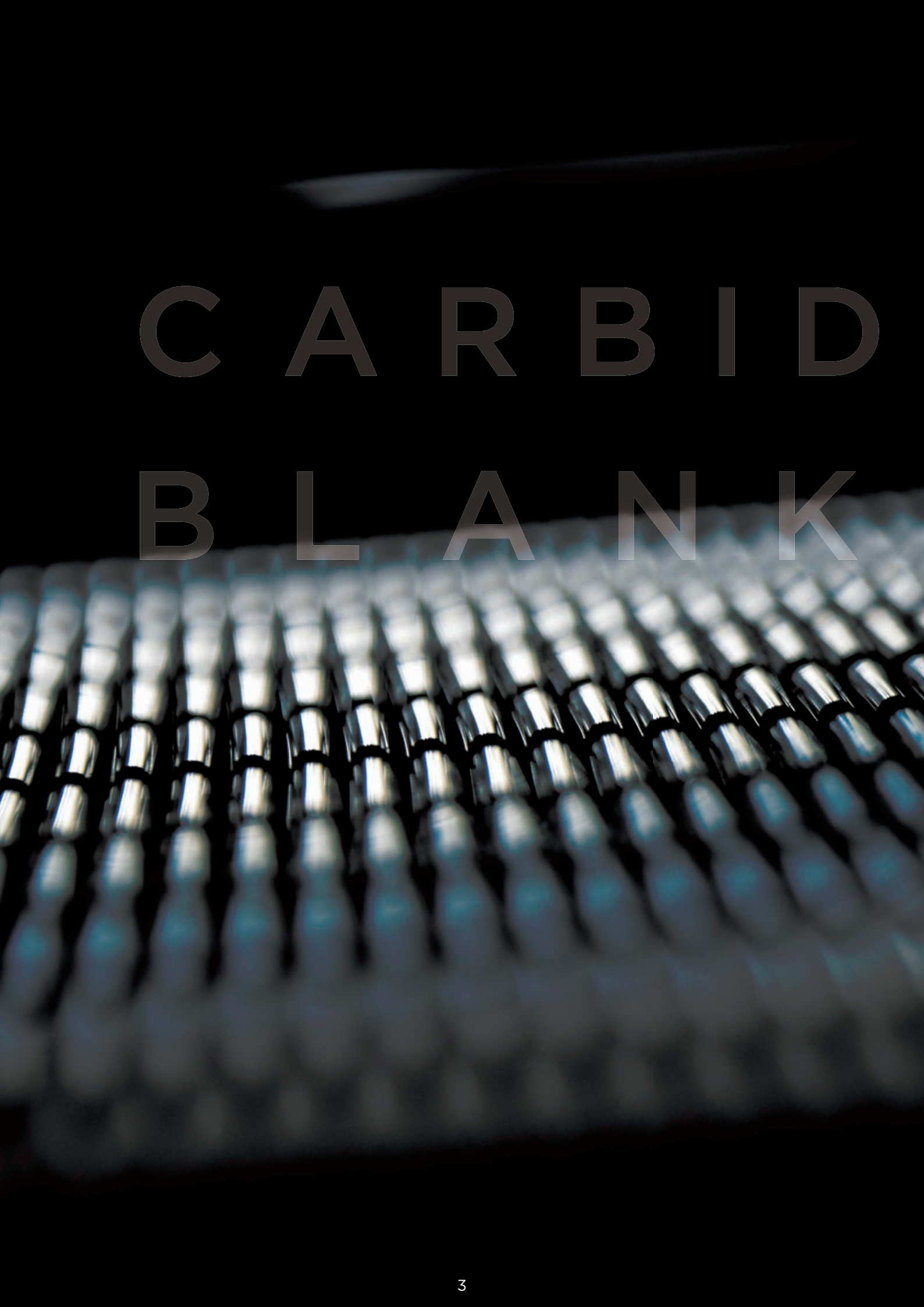
SUMITOMO
ELECTRIC
GROUP

INTRODUCTION

The Next-Generation Technology To Create Tomorrow's Society



Cemented carbide is the hardest artificial material after CBN and diamond, which is essential as a cutting-tool material to machine automobile parts, a variety of machines, aircraft parts, electric devices, and so on. The demand for carbide cutting tools are not only increasing, but also becoming widely utilized in various fields. Sumitomo Electric started R&D on cemented carbide in 1927, and in the following year, succeeded in developing carbide die for drawing wires and launched the carbide tool business. Ever since, the company have developed new materials(including CBN), various coating grades, and cutting tools of innovative design and functions one after another, helping increase productivity and reduce the machining cost in the machining field. Sumitomo Electric provides not only finished cutting tools but also carbide blanks for tool manufactures, with high quality grades which were developed from our long and abundant experiences. We will strive to exceed our customers' expectations and to contribute to our society.


CARBID
BLANK

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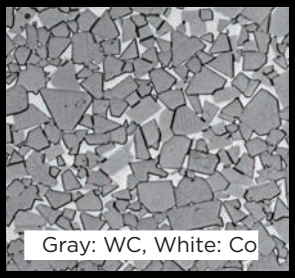
What Is Cemented Carbide?

Cemented carbide was invented in Germany in 1923. It is made from mainly WC (the powder combining with tungsten and carbon), and contain molten cobalt as a binder, and also includes TiC (Titanium-carbide) and/or TaC (Tantalum-carbide) as needed. It is an optimal raw material for cutting tool: it has high hardness, high strength at high temperature, so it is used in a high-temperature, high-speed environment thanks to those characteristics.

Cemented Carbide's Micrograph

▼ Typical Cemented Carbide-Phase



Cemented Carbide Characteristic
(comparing WC-Co7% cemented carbide to high-speed steel)

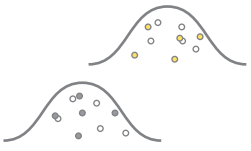
High wear-resistance	←	High hardness (Hv:15GPa)	2 times (than high speed steel)
Low elastic deformation	←	High Young's modulus (E:620GPa)	3 times
Low plastic deformation	←	High compressive strength (σ:5.3GPa)	2 times
Low thermal expansion coefficient	→	Linear expansion coefficient (α:4.9×10^{-6}dea^{-1})	1/2 times
High thermal diffusion	←	High thermal conductivity (κ:0.19cal/cm·sec·°C)	5 times (than high speed steel)
High thermal transformation resistance	→	High heat resistance	
High corrosion resistance	→	Possible to produce anti-corrosion alloy	

Applications of Cemented Carbide

The above characteristics are utilized in the cutting edges of tools, and die molds. In comparison with common heat-treated steel tools, cemented carbide tools can withstand overwhelming machining speed and have longer tool-life than before, therefore the amount of cemented carbide tools are increasing year on year. Cemented carbide tools are utilized in various different fields, such as manufacturing of car engine, transmission, aircraft engine, generator, construction machine, die mold and other electronic devices.

Production Process of Cemented Carbide

1 Raw Material

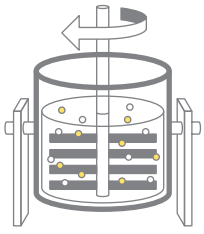


Main material	**WC**
Metal binder	**Co,Ni**
Others	**TiC,TaC**

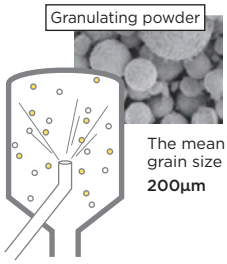
Materials from ore
Materials from recycling

2 Ready-to-press Powder

Crushing & Mixing

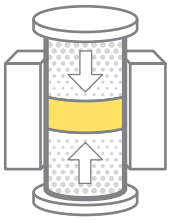


Drying & Granulating

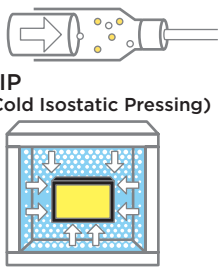


3 Pressing / Extruding

Pressing

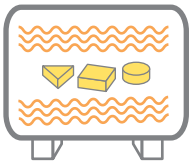


Extruding



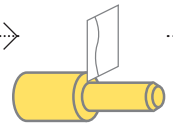
4 Forming (some of the products)

Semi-Sintering

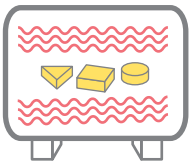


400-700°C
(750-1290°F)

Forming (Machining)



5 Sintering



1400-1500°C
(2550-2730°F)

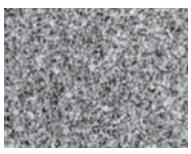
6 HIP (Hot Isostatic Pressing) *some of the products

1400-1500°C
(2550-2730°F)
100-1000 atmospheric
with gas pressure

7 Inspecting

Physical properties

Dimensional & visual inspection



Ultra fine grain structure's micrograph

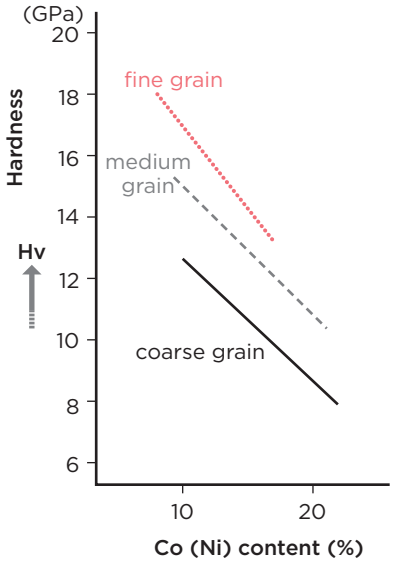
8

Packing & Shipping

Characteristics of Cemented Carbide

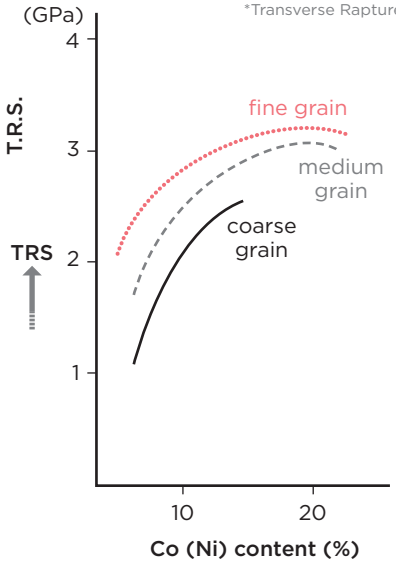
Relation between Composition and Characteristics

Relation between Binder content and Hardness



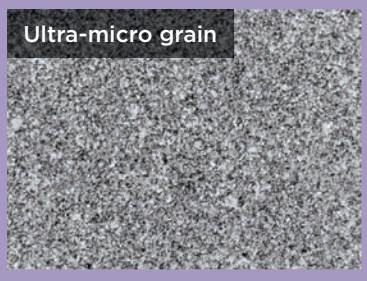
Relation between Binder Content and T.R.S.*

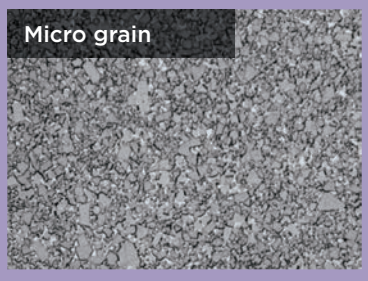
*Transverse Rapture Strength

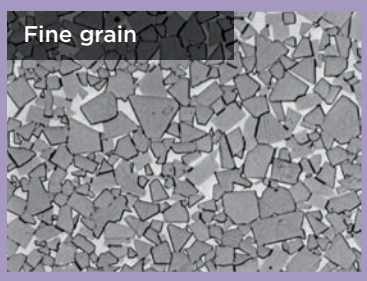


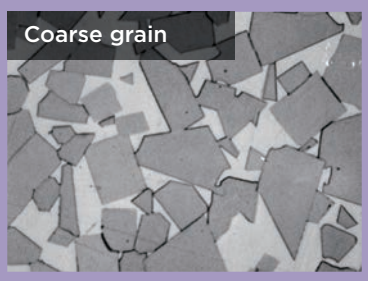
The characteristic of carbide blanks (hardness & TRS) is effected by the amount of metal binder or grain size of cemented carbide (WC).
As Co content increases, hardness of cemented carbide decreases, but conversely, TRS increases.

The microstructure by different WC grain



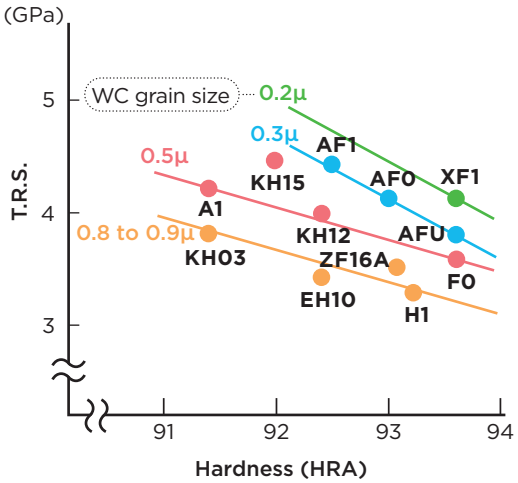






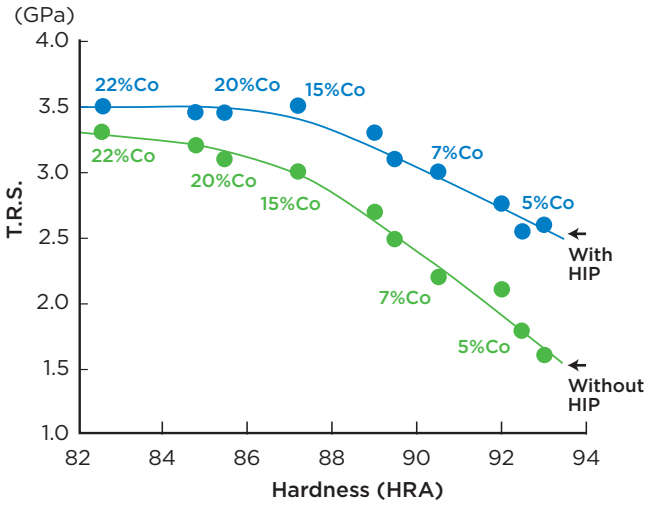
Carbide grades with ultra-micro grain, micro grain and fine grain are commonly used for endmills and drills.

Relation between grain size of WC and hardness or TRS



By using smaller grain size of WC, carbide shows higher hardness and TRS, but fracture toughness becomes lower.

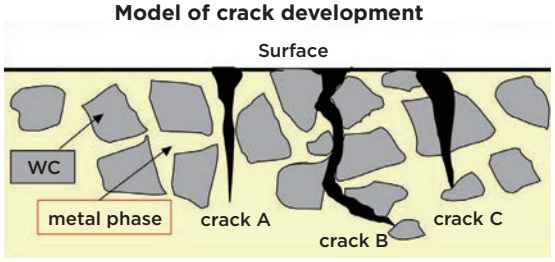
Improvement of TRS by HIP



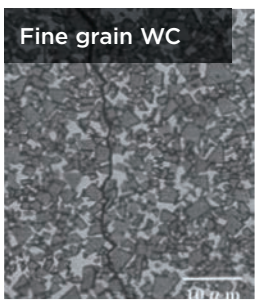
All of our carbide rods are treated by HIP to eliminate micro pore and improves TRS. (HIP is the process to treat carbide with high temperature and pressure.)

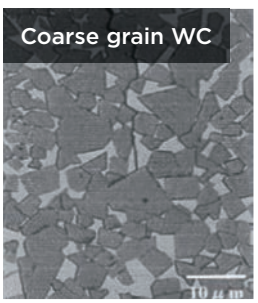
Relation between WC grain size and fracture toughness

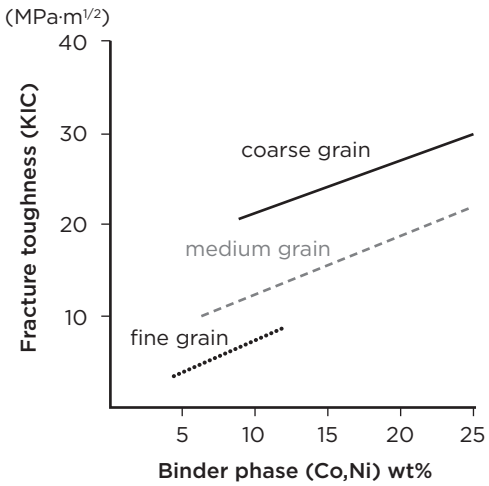
Model of crack development



A : Crack development in binder phase
B : Crack development in binder phase –boundary surface of WC
C : Crack development in WC







Carbide grade with coarse grain is effective for prevention of progress of cracks. It provide protection against chipping of cutting edges.

A long history of reliable performance and quality

Blanks for Round Tools

We produce not only simple round rods, but also formed round tool blanks with double helical coolant holes, central coolant hole, central coolant hole with some lateral holes. Moreover, we can form chamfering, multi-stepping, fluting and center-hole machining before sintering as the near net shape of customer's request.
(Forming rods: Refer to P17-18.)

D TOOLS

Blanks for Round Tools

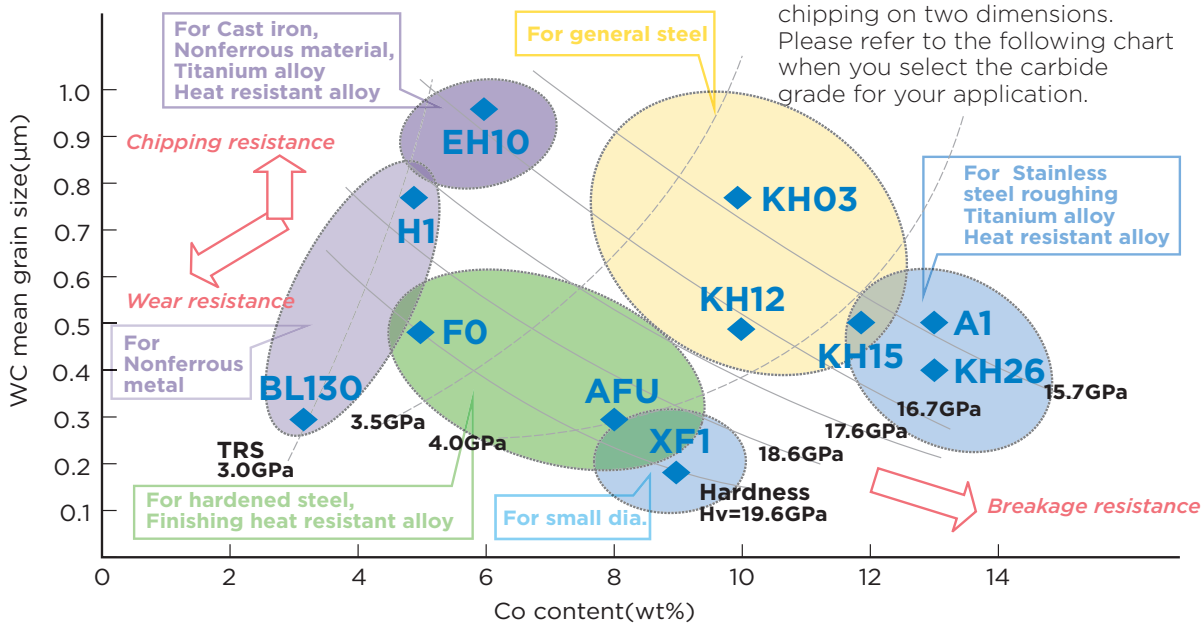
Properties of Grade for Round Tools

Class	Grade	ISO Code	Properties						
			Grain Size (μm)	Cobalt Content (wt%)	TRS (GPa)	HRA (HRA)	Hv (HV)	Fracture Toughness (MPa·m$^{1/2}$)	Young's Modulus (GPa)
Ultra Micro Grain	**XF1**	—	0.2	9.0	4.0	93.5	20.4	5.5	610
	AFU	—	0.3	8.0	3.8	93.6	19.4	6.0	610
	AF0*	—	0.3	10.0	4.1	93.0	18.1	7.3	590
	AF1	—	0.3	12.0	4.4	92.5	17.3	8.3	570
Micro Grain	**F0***	—	0.5	5.0	3.6	93.6	20.1	6.7	650
	KH12	—	0.5	10.0	4.0	92.4	17.0	8.2	580
	KH15	—	0.5	12.0	4.4	92.0	16.3	9.0	580
	A1	—	0.5	13.0	4.2	91.4	15.6	8.6	560
	KH26	—	0.4	13.0	4.3	92.0	16.3	9.5	550
Fine Grain	**H1**	**K01**	0.8	5.0	3.3	93.2	17.7	6.3	660
	ZF16A*	**K10**	0.8	6.0	3.5	93.0	17.6	7.5	640
	KH03	**K20**	0.8	10.0	3.8	91.4	15.2	9.9	580
	EH10	**K10**	0.9	6.0	3.4	92.4	17.3	6.5	630

*Grade only for cutting tools for PCB

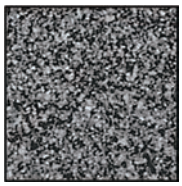
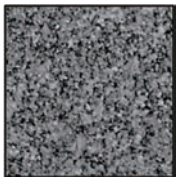
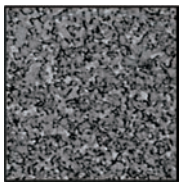
Carbide Grade for Endmills

The graph shows 3 dimensions of wear resistance, breakage resistance, and resistance to chipping on two dimensions. Please refer to the following chart when you select the carbide grade for your application.



Blanks for Round Tools

Grade Recommendation by Application

Ultra Micro Grain	Micro Grain	Fine Grain
		
AF1	**KH12**	**KH03**
Grain Size : 0.3μm	Grain Size : 0.5μm	Grain Size : 0.8μm

Grade	Application			Work Material								
	Endmill	Drill	Drill 30°helical coolant hole	Soft Steel	General Steel	Hardened Steel	Stainless Steel	Titanium Alloy	Heat Resistant Alloy	Cast iron	Aluminium Alloy	Copper Alloy
XF1	●	●		○	○	◎	○		○			
AFU	●			○	○	◎						
AF1	●	●		○	○							
KH26	●			◎	◎	○	◎	◎	◎			
KH12	●			◎	◎	○	○	○	◎			
			●	◎	◎	○	○	○	○	○	○	○
KH15	●			◎	◎	○	○	○	○			
A1	●	●		○	○		○					
H1	●	●								◎	◎	◎
KH03	●			○	○	○	○	○	○			
			●	◎	◎	○	○	◎	◎	○		
EH10	●	●				○	○	◎	◎	◎	○	○

For more information on 30°helical coolant hole blanks, Refer to page 15-16.

Grade	Application	Work Material								
	Reamer	Soft Steel	General Steel	Hardened Steel	Stainless Steel	Titanium Alloy	Heat Resistant Alloy	Cast iron	Aluminium Alloy	Copper Alloy
A1	●	○	○							
H1	●	○	○	○	○			◎	◎	◎
EH10	●	○	○	○	○	◎	◎	◎	○	○

Application of Blanks for PCB Drills

Grade	Form		Diameter		
	Solid	Composite	Ultra Small Diameter (to ø0.15)	Small Diameter (to ø0.45)	General Diameter (ø0.5 to)
XF1	●	●	◎	○	
AFU	●	●		◎	
AF0	●	●	○	◎	
F0	●				◎
ZF16A	●	●		○	○

● : Standard stocked item
◎ : Most recommended
○ : Recommended

Round Rods

Inventory

We keep round rod stocks of the chart below marked as ● to the shorten delivery time.

Stocked Grade

AFU	AF1	KH26	KH12
KH15	A1	H1	EH10

Stocked Item

Cat. No.	Diameter (mm)		Length (mm)		Grade							
	Nominal Diameter	Tolerance	Nominal Length	Tolerance	AFU	AF1	KH26	KH12	KH15	A1	H1	EH10
AR010310	1.0	+0.3 +0.2	310	+6.0 -0		●				●	●	●
AR015310	1.5					●				●	●	●
AR020310	2.0					●				●	●	●
AR025310	2.5					●				●	●	●
AR030310	3.0	+0.5 +0.3	310	+6.0 -0	●	●	●	●	●	●	●	●
AR035310	3.5				●	●		●		●	●	●
AR040310	4.0				●	●	●	●	●	●	●	●
AR045310	4.5				●	●		●		●	●	●
AR050310	5.0				●	●		●		●	●	●
AR055310	5.5				●	●		●		●	●	●
AR060310	6.0				●	●	●	●	●	●	●	●
AR065310	6.5				●	●		●		●	●	●
AR070310	7.0				●	●		●		●	●	●
AR075310	7.5				●	●		●		●	●	●
AR080310	8.0				●	●	●	●	●	●	●	●
AR090310	9.0	+0.6 +0.3	310	+6.0 -0	●	●		●		●	●	●
AR100310	10.0				●	●	●	●	●	●	●	●
AR110310	11.0					●				●	●	●
AR120310	12.0				●	●	●	●	●	●	●	●
AR130310	13.0											
AR140310	14.0				●	●		●	●	●	●	●
AR150310	15.0											
AR160310	16.0	+0.7 +0.3	310	+6.0 -0	●	●	●	●	●	●	●	●
AR170310	17.0											
AR180310	18.0				●	●		●	●	●	●	●
AR190310	19.0											
AR200310	20.0				●	●		●	●	●	●	●

Unstocked items are available by order.
The above marked items are semi-standard stock, Please inquire about stock availability and delivery when ordering.

Standards of Round Rods

Available size

size availability is depending on the grade. Please refer to the map below.

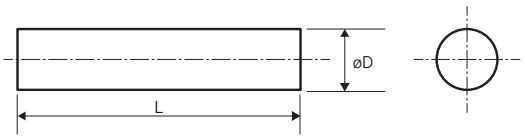
Grade	Diameter						
	5	10	15	20	25	30	35
AF0	ø3						
F0	ø3						
ZF16A	ø3						
XF1		ø12					
BL130			ø16				
AFU							ø35
AF1					ø25		
KH26	ø3		ø16				
KH12					ø25		
KH15					ø25		
A1							ø35
H1					ø25		
KH03							ø35
EH10							ø35
Length	ø3 to ø25 Dia: 10L to 330L				ø25 to ø35 Dia: 10L to 170L		

Tolerance

Diameter (mm)	
1.0 ≤ D < 3.0	+0.3 +0.2
3.0 ≤ D ≤ 8.0	+0.5 +0.3
8.0 < D ≤ 15.0	+0.6 +0.3
15.0 < D ≤ 35.0	+0.7 +0.3

Length		Tolerance
10 ≤ L < 310	±0.5% (Minimum Tolerance: ±0.1)	0.15
310 ≤ L ≤ 330	+6.0 -0	

In some cases, this standard is different depending on the grade or diameter.



Round Rods with Helical Coolant Holes

The producible grade is KH12 and KH03.

Although standard length is 310mm or 330mm, another shorter size is available by order.

We can form chamfering and centering over ø5.6mm diameter.

Stepping is unavailable.

How to read our Cat. No.

Common — **AR** **H** **056** **XXX**

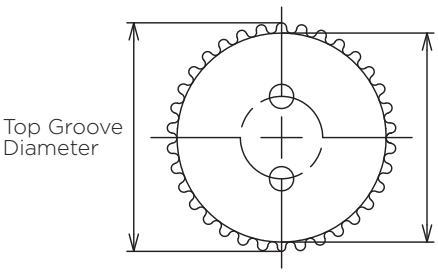
- **H** — Helix Angle, Number of OH,
  - **1H** : 2 holes, 15°
  - **H** : 2 holes, 30° For Straight Drills
  - **D** : 2 holes, 30° For Step Drills
  - **4H** : 2 holes, 42°
- **XXX** — Length (ex: **"310"**= 310mm **"330"**= 330mm)
- **056** — Diameter (ex: **"056"**= ø5.6 **"106"**= ø10.6)

ex: ARH056330 = ø5.6x330mm 2holes, 30° For Straight Drills

*1 Diameter (the Top and Bottom Diameter of Helical Groove)

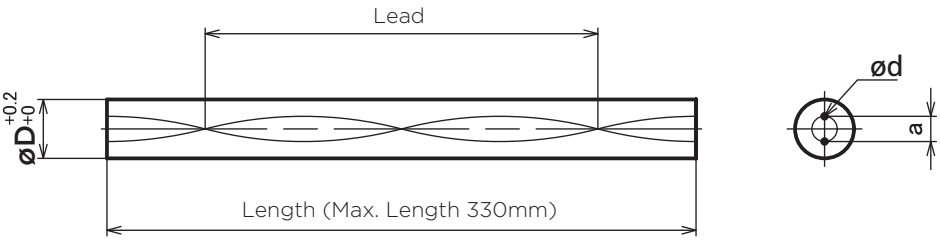
Round rods with helical coolant hole has helical grooves on the surface. In the right chart, the diameter of top groove and bottom groove are expressed as "top groove diameter" and "bottom groove diameter" respectively.

Diagram of the Cross Section



*2 Form

with Double Helical Oil Holes



*Diameter tolerance of round rods with 15° helical coolant holes is "+0.4/-0".

Round Rods with Helical Coolant Holes

Dimentions

(mm)

Helix Angle	Number of OH	Cat. No.	Diameter øD *1		Hole Diameter **ød**		Hole Pitch **a**		Lead Allowance	Producible Grade	
			Top Groove	Bottom Groove						**KH12**	**KH03**
15°	2	**AR1H056XXX**	5.55	5.25	0.71	±0.1	2.5	0/-0.3	54.8 to 63.0	—	
		AR1H066XXX	6.55	6.25	0.83	±0.1	2.5	±0.2	65.7 to 75.6	—	
		AR1H076XXX	7.55	7.25	0.95	±0.1	3.3	±0.2	76.7 to 88.2	—	
		AR1H086XXX	8.55	8.25	1.06	±0.1	3.6	±0.2	87.6 to 100.8	—	
		AR1H096XXX	9.55	9.25	1.18	±0.2	4.2	±0.2	98.6 to 113.4	—	
		AR1H106XXX	10.55	10.25	1.30	±0.2	4.6	±0.2	109.6 to 126.0	—	
		AR1H116XXX	11.55	11.25	1.30	±0.2	5.0	±0.2	120.5 to 138.6	—	
		AR1H126XXX	12.55	12.25	1.42	±0.2	5.4	±0.2	131.5 to 151.2	—	
		AR1H136XXX	13.55	13.25	1.54	±0.2	5.7	±0.2	142.4 to 163.8	—	
		AR1H146XXX	14.55	14.25	1.66	±0.2	6.3	±0.2	153.4 to 176.4	—	
		AR1H156XXX	15.55	15.25	1.77	±0.2	6.9	±0.2	164.3 to 189.0	—	
		AR1H166XXX	16.55	16.25	1.89	±0.2	7.5	±0.2	175.3 to 201.6	—	
30° For Straight Drills	2	**ARH036XXX**	3.6	3.3	0.47	±0.05	1.50	0/-0.1	15.7 to 17.0		
		ARH046XXX	4.6	4.3	0.59	+0.05/-0.1	1.7	0/-0.2	20.9 to 22.7		
		ARH056XXX	5.6	5.3	0.71	±0.1	2.4	0/-0.3	26.2 to 28.4		
		ARH066XXX	6.6	6.3	0.83	±0.1	2.8	±0.2	31.4 to 34.0		
		ARH076XXX	7.6	7.3	0.95	±0.1	3.2	±0.2	36.6 to 39.7		
		ARH086XXX	8.6	8.3	1.06	±0.1	3.6	±0.2	41.9 to 45.4		
		ARH096XXX	9.6	9.3	1.18	±0.2	4.0	±0.2	47.1 to 51.0		
		ARH106XXX	10.6	10.3	1.30	±0.2	4.4	±0.2	52.3 to 56.7		
		ARH116XXX	11.6	11.3	1.30	±0.2	4.4	±0.2	57.5 to 62.4		
		ARH126XXX	12.6	12.3	1.42	±0.2	4.8	±0.2	62.8 to 68.1		
		ARH136XXX	13.6	13.3	1.54	±0.2	5.2	±0.2	68.0 to 73.7		
		ARH146XXX	14.6	14.3	1.66	±0.2	5.6	±0.2	73.2 to 79.4		
		ARH156XXX	15.6	15.3	1.77	±0.2	6.0	±0.2	78.5 to 85.1		
		ARH166XXX	16.6	16.3	1.89	±0.2	6.4	±0.2	83.7 to 90.7		
		ARH176XXX	17.6	17.3	2.01	±0.2	6.8	±0.2	88.9 to 96.3		—
		ARH176XXX-1			1.75	±0.2	8.5	±0.2		—	
		ARH186XXX	18.6	18.3	2.13	±0.2	7.2	±0.2	94.1 to 102.0		—
		ARH186XXX-1			2.00	±0.2	9.2	±0.2		—	
		ARH196XXX	19.6	19.3	2.28	±0.2	7.6	±0.2	99.3 to 107.7		—
		ARH196XXX-1			2.00	±0.2	9.7	±0.2		—	
		ARH206XXX	20.6	20.3	2.36	±0.2	8.0	±0.2	104.6 to 113.4		—
		ARH206XXX-1			2.00	±0.2	9.9	±0.2		—	
30° For Step Drills	2	**ARD036XXX-1**	3.6	3.3	0.23	±0.05	0.8	-0.1/-0.2	15.7 to 17.0		
		ARD036XXX-2			0.35	±0.05	1.2	0/-0.2	15.7 to 17.0		
		ARD046XXX	4.6	4.3	0.35	±0.05	1.2	0/-0.2	20.9 to 22.7		
		ARD056XXX	5.6	5.3	0.47	±0.05	1.5	0/-0.3	26.2 to 28.4		
		ARD066XXX	6.6	6.3	0.47	±0.1	2.0	±0.2	31.4 to 34.0		
		ARD076XXX	7.6	7.3	0.59	±0.1	2.0	±0.2	36.6 to 39.7		
		ARD086XXX	8.6	8.3	0.71	±0.1	2.4	±0.2	41.9 to 45.4		
		ARD096XXX	9.6	9.3	0.83	±0.1	2.8	±0.2	47.1 to 51.0		
		ARD106XXX	10.6	10.3	0.95	±0.1	3.2	±0.2	52.3 to 56.7		
		ARD116XXX	11.6	11.3	0.95	±0.1	3.2	±0.2	57.5 to 62.4		
		ARD126XXX	12.6	12.3	1.06	±0.1	3.6	±0.2	62.8 to 68.1		
		ARD136XXX	13.6	13.3	1.06	±0.1	3.6	±0.2	68.0 to 73.7		
		ARD146XXX	14.6	14.3	1.18	±0.2	4.0	±0.2	73.2 to 79.4		
		ARD156XXX	15.6	15.3	1.30	±0.2	4.4	±0.2	78.5 to 85.1		
		ARD166XXX	16.6	16.3	1.42	±0.2	4.8	±0.2	83.7 to 90.7		
42°	2	**AR4H033XXX-1**	3.3	3.2	0.20	±0.05	0.5	±0.05	10.1 to 10.8	—	
		AR4H033XXX-2			0.14	±0.03	0.5	0/-0.1	10.1 to 10.8	—	

Blank: Made-to-order item —mark: Not available

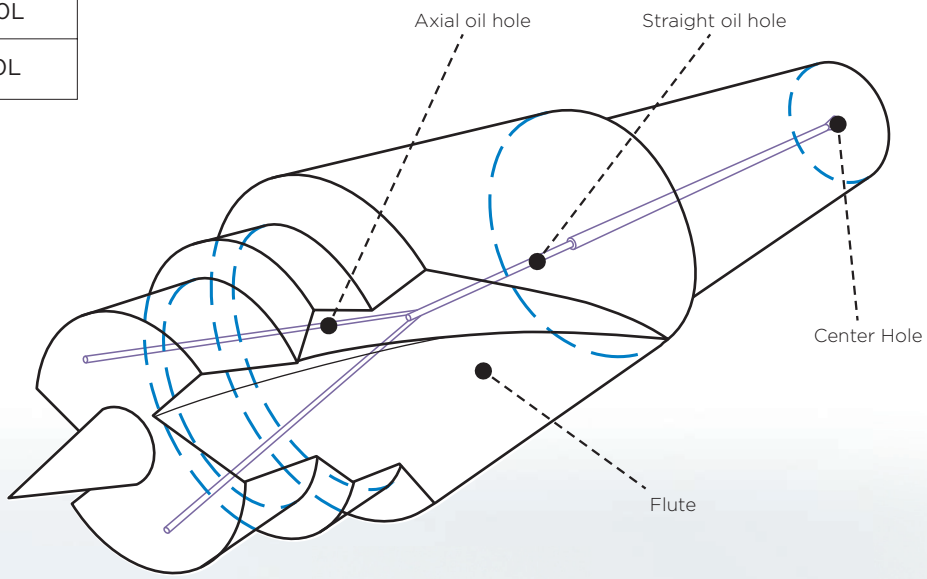
Formed Round Rods

Grades to Be Formed

Diameter	ø3 to ø16	**XF1 KH26**	ø3 to ø25	**AF1 KH12 KH15 H1**	ø3 to ø35	**AFU A1 KH03 EH10**

Available Size

Length	ø3 to ø25	to 330L
	ø25 to ø35	to 170L



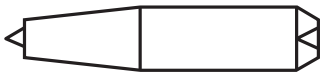
Formed rods as near net shape are available on request.

Formed Round Rods

Formed Example

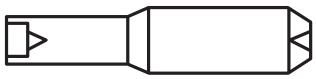
Producible Measurement : Diameter 3mm to 35mm / Length up to 320mm

Taper



V-Groove/Point angle

Spot Face

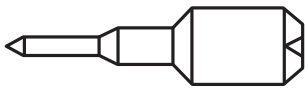


Straight oil hole/ axial oil hole

Through hole: Maximum Length 320L
Blind hole: Maximum Length 170L

*Maximum length is different by diameter.
*Minimum diameter: ø0.8

Multi-step



Flute* (Accommodate for right handed and flute)

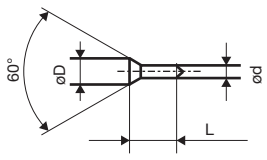
* Maximum length: 220L
We can form helical angle flute, straight flute, and flat face.
Please contact us about helical flute specifications.

We can form
Other specific shape.
Please feel free to contact us.

Standard Dimensions

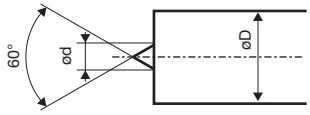
Female Center

Diameter(ø)	øD	ød	L
3.0 to 3.5	1.3	0.8	1.43
3.6 to 6.3	1.5	1.0	1.63
6.4 to 10.0	2.0	1.5	2.23
10.1 to	3.0	2.0	3.87



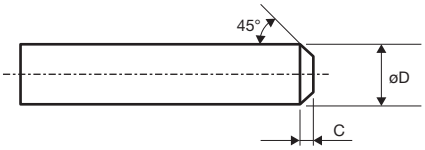
Male Center

Diameter øD	ød
3.0 to 5.0	3.0
5.1 to 10.0	4.0
10.1 to 20.0	5.0
20.1 to	6.0



Chamfer

Diameter øD	C
3.0 to 5.0	0.5
5.1 to 10.0	1.0
10.1 to 15.0	1.5
15.1 to 20.0	1.8
20.1 to 25.0	2.0
25.1 to	2.5



These tables show our standard. we can provide other forms according to your request.

The various carbide materials developed
from abundant experience as a tool manufacture

Blanks for various cutting too
wear resistant tools, dies & m

BLANKS FOR VARIOU
WEAR RESISTANT TO
DIES & MOLDS

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US CUTTING TOOLS,
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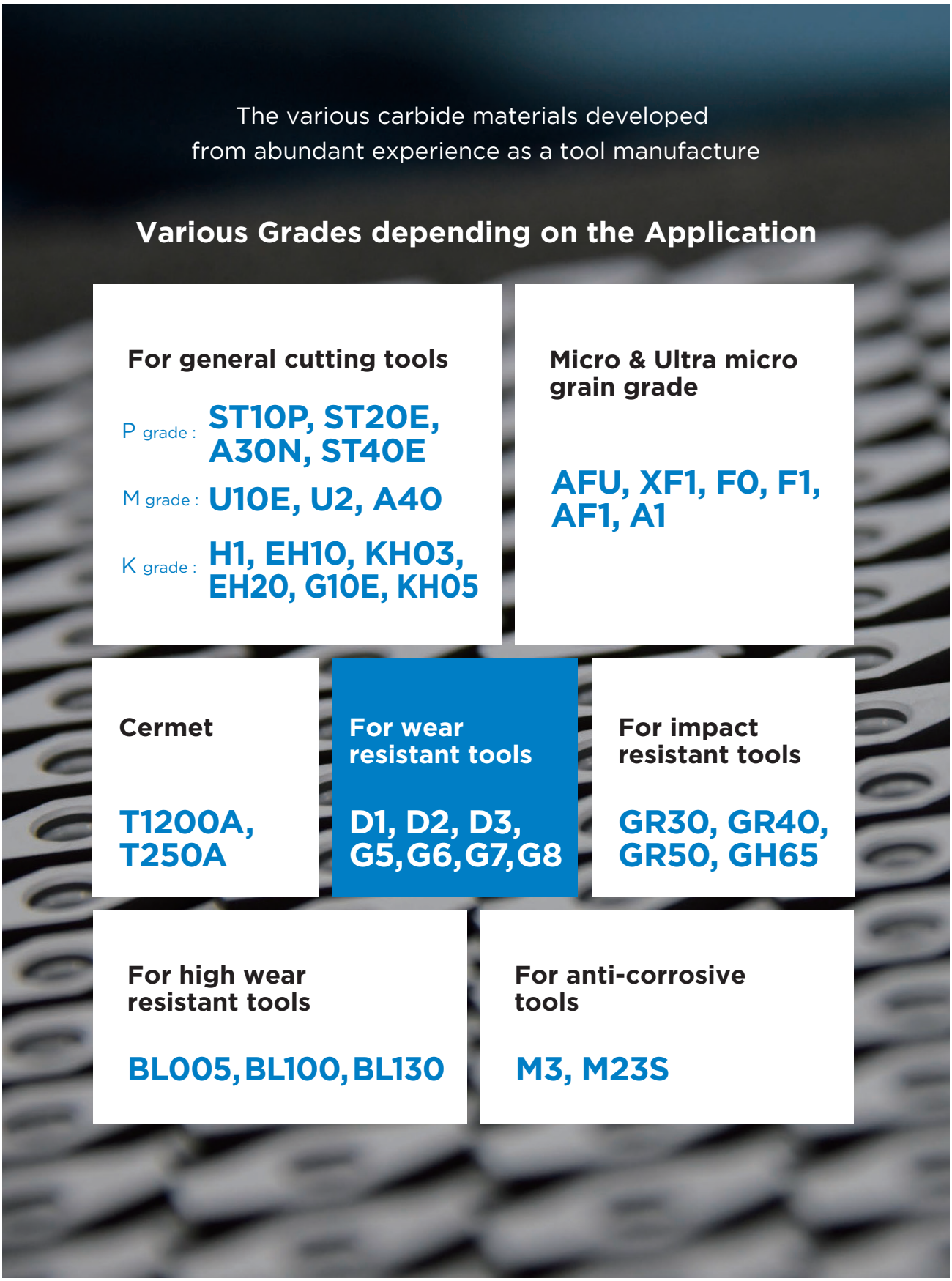


The various carbide materials developed
from abundant experience as a tool manufacture

Various Grades depending on the Application

For general cutting tools

P grade : **ST10P, ST20E, A30N, ST40E**

M grade : **U10E, U2, A40**

K grade : **H1, EH10, KH03, EH20, G10E, KH05**

Micro & Ultra micro grain grade

AFU, XF1, F0, F1, AF1, A1

Cermet

T1200A, T250A

For wear resistant tools

D1, D2, D3, G5, G6, G7, G8

For impact resistant tools

GR30, GR40, GR50, GH65

For high wear resistant tools

BL005, BL100, BL130

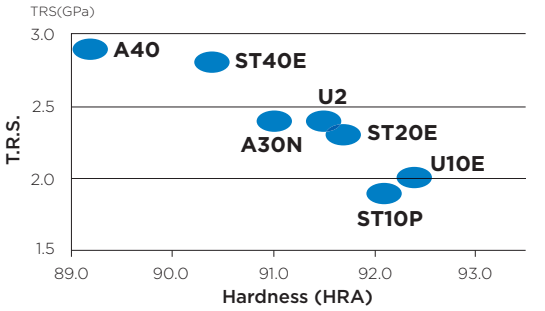
For anti-corrosive tools

M3, M23S

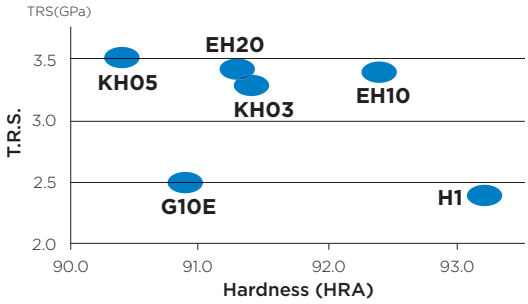
Blanks for various cutting tools, wear resistant tools, dies & molds

Grade Map

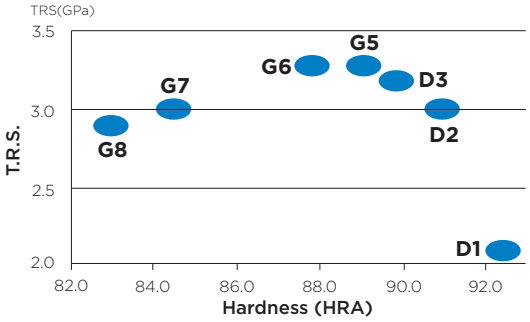
For general cutting tools (P & M grade)



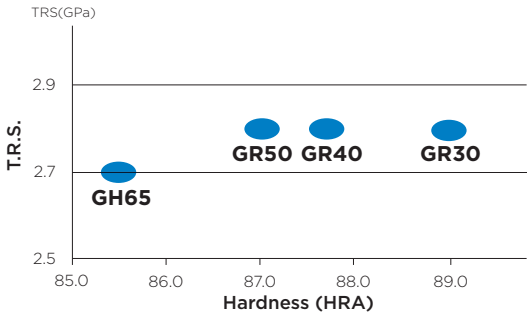
For general cutting tools (K grade)



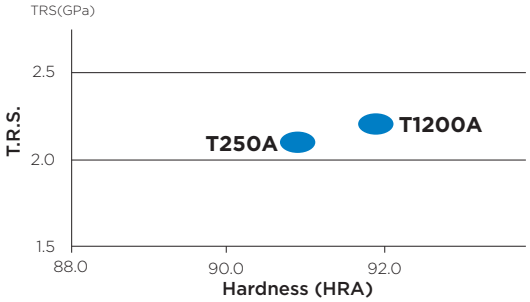
For wear resistant tools



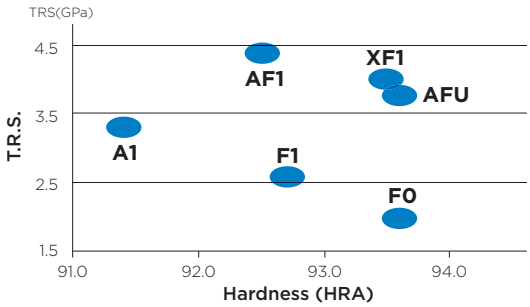
For impact resistant tools



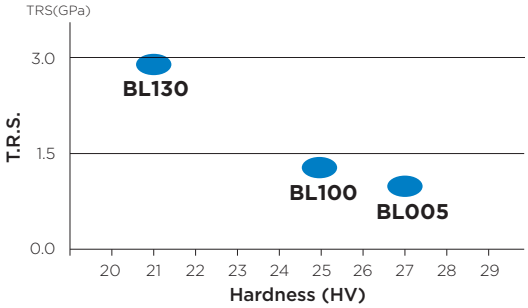
Cermet



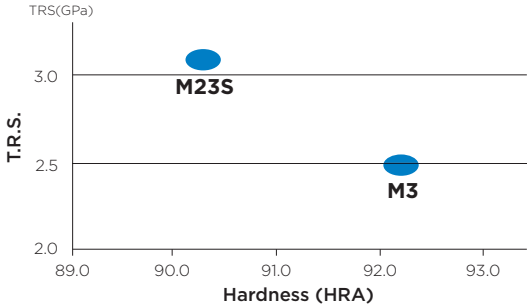
Micro & Ultra micro grain grade



For high wear resistant tools



For anti-corrosive tools



Grade Property (Typical Value)

Application	Classification	ISO Code	Grade	Specific Gravity	Grain Size	Binder Content	Hardness	
					(μm)	(wt%)	HRA	Hv(GPa) @RT
For general cutting tools	P grade	P10	**ST10P**	10.5	2.0	9.0	92.1	16.0
		P20	**ST20E**	11.9	2.0	8.5	91.7	15.8
		P30	**A30N**	11.6	3.4	11.5	91.0	14.9
		P40	**ST40E**	13.2	2.0	11.5	90.4	14.3
	M grade	M10	**U10E**	12.9	2.0	5.5	92.4	16.9
		M20	**U2**	13.2	2.0	8.0	91.5	15.6
		M40	**A40**	13.2	1.4	15.0	89.2	12.9
	K grade	K10	**H1**	15.1	0.8	5.0	93.2	17.7
		K10	**EH10**	14.9	0.9	6.0	92.4	17.3
		K10	**G10E**	14.8	2.5	6.0	90.9	15.4
		K20	**EH20**	14.9	2.5	6.0	91.3	15.8
		K20	**KH03**	14.5	0.8	10.0	91.4	15.2
		K40	**KH05**	14.2	0.8	13.0	90.4	13.6
	Cermet	P10	**T1200A**	6.7		15.0	91.9	15.6
		P30	**T250A**	7.1		16.5	90.9	14.0
For wear & impact resistant tools	Wear resistant tools	—	**D1**	14.9	1.2	6.0	92.4	16.7
		—	**D2**	14.9	2.0	7.0	90.9	15.0
		—	**D3**	14.7	2.0	10.0	89.8	13.7
		—	**G5**	14.3	2.0	12.0	89.0	13.1
		—	**G6**	14.1	2.0	15.0	87.8	11.9
		—	**G7**	13.6	3.0	20.0	84.5	9.3
		—	**G8**	13.2	3.0	25.0	83.0	8.2
	Impact resistant tools	—	**GR30**	14.9	3.3	8.0	89.0	12.9
		—	**GR40**	14.6	4.0	9.5	87.7	11.8
		—	**GR50**	14.5	4.0	10.5	87.0	11.2
		—	**GH65**	14.0	4.0	15.5	85.5	10.2
For special application	Micro fine grain	—	**F0**	14.9	0.5	5.0	93.6	20.1
		—	**F1**	14.5	0.5	8.5	92.7	18.0
		—	**A1**	14.1	0.5	13.0	91.4	15.6
	Ultra micro fine grain	—	**AFU**	14.6	0.3	8.0	93.6	19.4
		—	**AF1**	14.1	0.3	12.0	92.5	17.3
		—	**XF1**	14.5	0.2	9.0	93.5	20.4
For high wear resistant tools		—	**BL005**	15.5	0.2	0.5		27.0
		—	**BL100**	15.4	0.3	0.5		25.3
		—	**BL130**	15.2	0.3	3.0	94.2	21.0
For anti-corrosive tools		—	**M3**	14.3	0.8	9.5	92.2	16.9
		—	**M23S**	14.8	2.0	8.0	90.3	14.2
For lenses forming mold		—	**BL005L**	15.5	0.2	0.5	—	27.0
		—	**BL130L**	15.2	0.3	3.0	94.2	21.0
		—	**AF1L**	14.1	0.3	12.0	92.5	17.3

The above is our standard grades. Please feel free to contact us for other grades.

Grade Property (Typical Value)

**By indentation method

			T.R.S.	Fracture Toughness K1c **	Compressive Strength	Impact Strength	Young's Modulus	Thermal Conductivity (RT)	Poisson's Ratio	Thermal Expansion Coefficient
	Hv(GPa) @600°C	Hv(GPa) @800°C	(GPa)	(MPa·m$^{1/2}$)	(GPa)	(x10^{-4}GPa·m)	(GPa)	(W/(m·K))	ν	(x10^{-6}/K) (to 400°C)
	8.9	5.9	1.9	8.1	4.9		470	0.22	14	6.2
	8.7	5.7	2.3				510	0.22	31	6.2
	8.3	5.2	2.4	9.1			520	0.22	31	6.5
	8.7	5.1	2.8				530	0.22	59	6.0
	9.8	6.6	2.0		5.9		560	0.21	46	5.6
	9.6	6.0	2.4	8.5			550	0.22	55	5.7
	7.4	4.3	2.9	11.5			520	0.23	65	6.2
	12.9	8.2	2.4	6.3	6.1		650	0.21	109	4.7
	12.0	7.3	3.4	6.5			640	0.21	105	4.5
	10.8	6.6	2.5	8.5	5.7		620	0.21	105	5.0
	10.0	5.9	3.4				620	0.21	84	4.5
	10.3	5.6	3.3	9.9			580	0.22	76	5.3
	9.0	4.4	3.5	10.8			550	0.22	78	5.7
			2.2	7.0			440	0.22	15	7.9
	8.7	5.8	2.1	8.5			390	0.27	26	7.9
	12.0	7.4	2.1	6.5			630	0.21		5.0
	10.4	6.0	3.0	8.3	5.5	0.72	640	0.21	98	5.7
			3.2	10.3			590	0.22	96	5.4
	7.7	4.2	3.3	13.5	4.8	0.81	580	0.22	96	6.3
	7.3	3.9	3.3	17.5	4.4	0.77	540	0.23	71	5.9
	4.3	2.6	3.0	18.5		0.73	490	0.24	97	6.6
			2.9	20.0	3.2	0.89	460	0.24	63	7.1
	7.9	4.7	2.8				610	0.21		5.1
	5.9	3.9	2.8		4.5	0.47	520	0.22	76	5.0
	5.3	3.7	2.8		4.3	0.62	520	0.22	76	5.5
			2.7				530	0.23		5.9
			2.0	6.7			650	0.21	47	5.0
	12.8	6.9	2.6	7.8			600	0.22	47	5.3
	9.5	4.7	3.3	8.6			560	0.23	42	5.7
			3.8	6.0			610	0.22	52	5.3
			4.4	8.3			570	0.22	36	5.5
			4.0	5.5			610	0.22	38	5.4
			1.0	3.5			670	0.21	37	4.5
	20.3	17.5	1.3	4.5			680	0.21	47	4.2
	14.5	9.6	2.9	5.4			660	0.20	56	4.5
	11.1	6.1	2.5	8.0			570	0.22	59	5.5
	9.0	5.3	3.1	8.5	4.9	0.99	600	0.22	85	5.9
			1.0	3.5			670	0.21	37	4.5
	14.5	9.6	2.9	5.4			660	0.20	56	4.5
			4.4	8.3			570	0.22	36	5.5

*These TRS values are different from the values described on page11.
If higher TRS value is required, please contact us.

Application of each Grade

ISO Code			Grade	Property		Application																					
						General Cutting Tool (Work Material)					Ware resistant		Circular saw				Slitter & Blade			Die & Mold							
													Wood cutting		Metal cutting												
				T.R.S GPa	Hardness HRA	General steel	Cast iron	Stainless steel	Exotic material	Nonferrous metal	Wear resistance	Impact resistance	Wood	Particle board	General steel	Stainless steel	General cutting	Metal cutting	Crushing	Press mold	Plastic injection mold	Powder compacting mold	Forging mold	Glass lens mold	Nozzle	Anti-corrosiveness
For general cutting tools	P grade	P10	**ST10P**	1.9	92.1	○																					
		P20	**ST20E**	2.3	91.7	◎		○																			
		P30	**A30N**	2.4	91.0	○									○												
		P40	**ST40E**	2.8	90.4	○		○																			
	M grade	M10	**U10E**	2.0	92.4	○	○	○																			
		M20	**U2**	2.4	91.5	○	○	○																			
		M40	**A40**	2.9	89.2	○	○	○																			
	K grade	K10	**H1**	2.4*	93.2		○											○									
		K10	**EH10**	3.4	92.4		◎			◎								◎									
		K10	**G10E**	2.5	90.9		◎		◎																		
		K20	**EH20**	3.4	91.3		○																				
		K20	**KH03**	3.3*	91.4		○		◎											◎	◎						
		K40	**KH05**	3.5	90.4		○													○	○						
	Cermet	P10	**T1200A**	2.2	91.9	◎		◎																			
		P30	**T250A**	2.1	90.9	◎		◎																			
For wear & impact resistant tools	Ware resistance	—	**D1**	2.1	92.4						○										○	○					
		—	**D2**	3.0	90.9						◎										◎	◎					
		—	**D3**	3.2	89.8						◎										○	○	○				
		—	**G5**	3.3	89.0						◎							○			◎	◎	◎				
		—	**G6**	3.3	87.8						◎										○	○	◎				
		—	**G7**	3.0	84.5						○												○				
		—	**G8**	2.9	83.0						○												○				
	Impact resistance	—	**GR30**	2.8	89.0							◎							○				○				
		—	**GR40**	2.8	87.7							◎							○				○				
		—	**GR50**	2.8	87.0							◎							◎				○				
		—	**GH65**	2.7	85.5							◎							○				◎				
For Specific Purpose	Micro fine grain	Micro grain	**F0**	2.0*	93.6	○					○						○	○									
			F1	2.6	92.7	○					○						○	○									
			A1	3.3*	91.4						○						◎	○		○							
		Ultra micro grain	**AFU**	3.8	93.6						○						○	○									
			AF1	4.4	92.5						○						○	○		◎							
			XF1	4.0	93.5															○							
	Circular saw	P grade carbide	**K82S**	2.1	91.7										○	○											
			A30N	2.4	91.0										◎	◎											
			A30S	2.5	91.0										○	○											
			K72S	2.6	90.0										○	○											
			A35S	2.4	90.4										○	○											
		Cermet	**YC01F**	2.3	92.4										◎	◎											
			KA30	1.8	92.1										○	○											
			YC03F	2.2	91.6										◎	◎											
			YC05F	2.5	91.1										◎	◎											
		K grade carbide	**GK21A**	3.1	90.5								◎														
		High wear resistance	**BL720**	2.9	93.4									◎													
			BL220	2.9	92.8									○													
			BL230	2.5	92.0									○													
	For high wear resistance		**BL005**	1.0	—						○														◎		
			BL100	1.3	—						○													◎	◎		
			BL130	2.9	94.2	○					○						○										
	For anti-corrosiveness		**M3**	2.5	92.2						○																◎
			M23S	3.1	90.3						○																◎
	For lenses forming mold		**BL005L**	1.3	—																			◎			
			BL130L	2.9	94.2																		◎	○			
			AF1L	4.4	92.5																		◎	○			

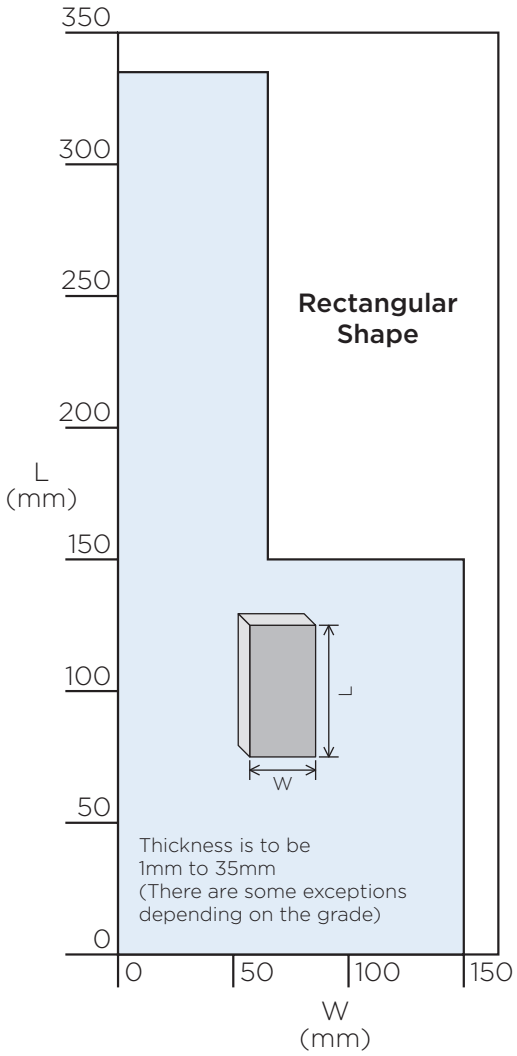
*These TRS values are different from the values described on page11.
If higher TRS value is required, please contact us.

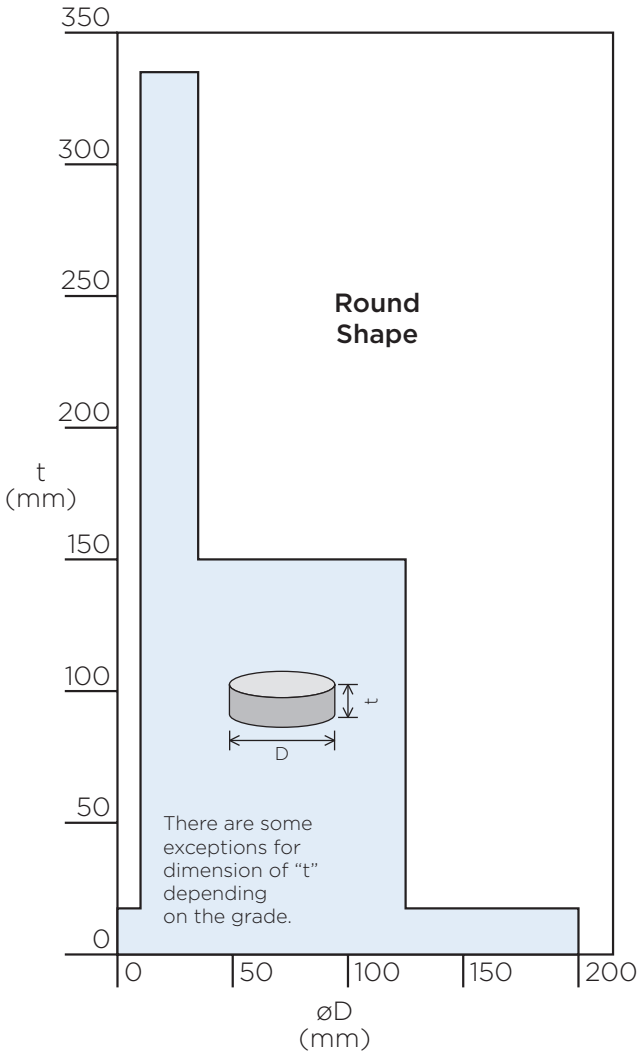
(—)Please refer to page 23
for the hardness of BL005 and BL100

◎:Most recommended
○:Recommended

Application of each Grade

Producible Blank for General Cutting Tools, Wear & Impact Resistant Tools





Please use the above charts only as a guide.
Please contact us for the detail.

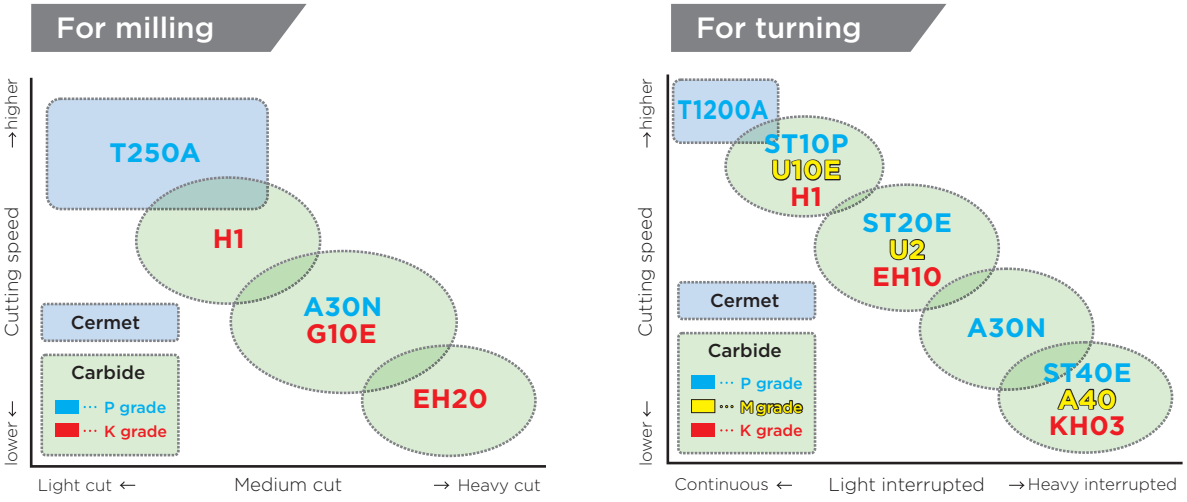
Measurement (mm)	Tolerance
5 or less	±0.10 mm
over5 bellow10	±0.15 mm
over10 bellow20	±0.20 mm
over20 bellow30	±0.25 mm
over30 bellow40	±0.30 mm
over40 bellow50	±0.35 mm
over50	±0.7%

Blanks for General Cutting Tools

Application Example

Brazed tools / Tools for auto-lathe / Drills
Endmills / Reamers

Applicable Grades



Blanks for Wear & Impact Resistant tools

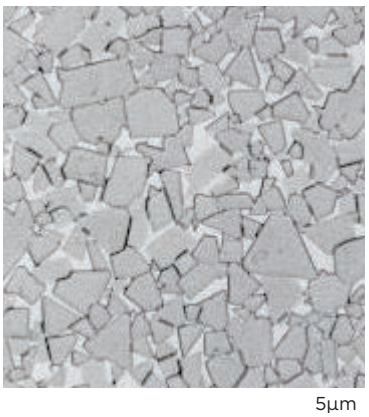
Application Example

Punches / Die molds / Sleeves
Crushing tools / Sliding parts

Microstructure of Typical Grades

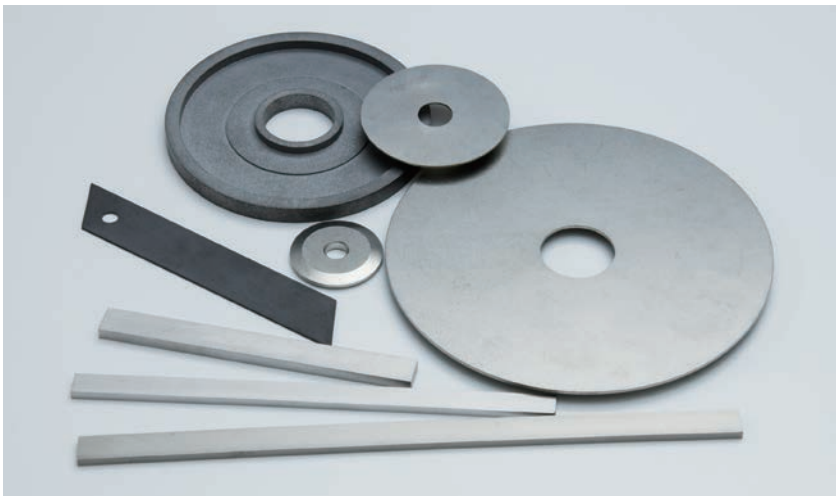
Ultra micro grain
AF1

Medium grain
G5



coarse grain
GR50

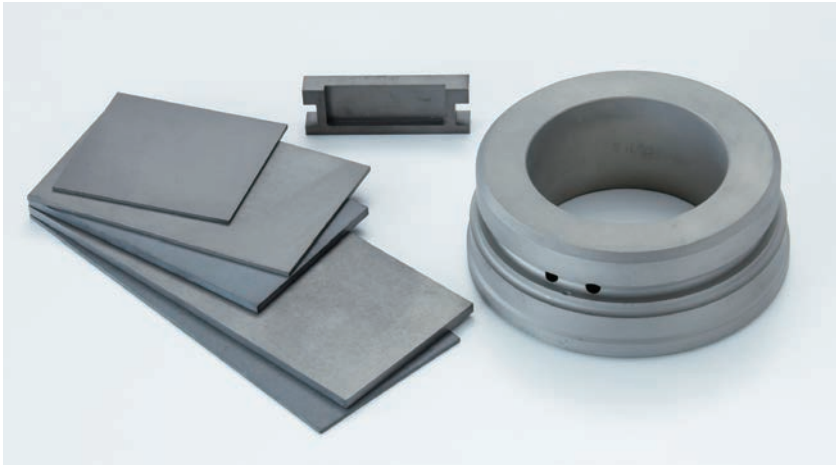
Blanks for Slitters & Blades / Die & Mold



Application Example

Slitters & blades for textile,
Food, Electric / Electronics parts,
Resin, Automotive parts, Rubber, etc.

Blade for crushing application.



The die & mold demand spreads with the expansion of the new products such as smart phones or tablet terminals.

On the other hand the performance enhancement of the die & mold is pursued with miniaturization and the densification of molding materials.

We have many customers who support our carbide material for die & mold including AF1 which shows stable high efficiency.

Ultra micro grain grade **AF1** This is the ultra micro grain grade with 0.3 grain which enables us to get sharp cutting edges. AF1 has the extreme high TRS and hardness which bring a long tool life for precision die & molds.	Micro Grain Grade **KH03 / KH05** They are well balanced grades of both hardness and TRS, recommended for punches and dies.
General grades for wear resistant tools **D1 / D2 / D3 / G5 / G6 / G7 / G8** The above shows general carbide grades for wear resistant tools. It is a turn of D1, D2, D3, G5, and G6 from abrasion resistant high one Please choose the suitable grade depending on the requirement.	Grade for impact resistant tools **GR30 / GR40 / GR50 / GH65** They are grades to resist high impact force such as cold forging. Please refe\r to the bellow chart to choose the suitable grade.

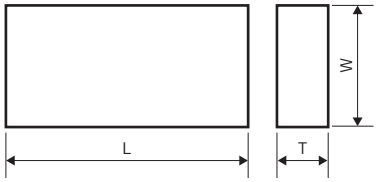
Blanks for Die & Mold

Grades for Die & Mold and its Application

Applicable Grade			Press mold							Plastic injection mold				Powder compacting mold		Drawing die & Plug	Cold forging die
			Lead frame (Aluminum, Cupper)		Connector (Blanking, Bending) (Phosphor Bronze)		Connector (Blanking, Bending) (SUS)		Motor core								
Classification		Grade	Punch	Die	Punch	Die	Punch	Die	Punch Die	Pot	Plunger	Gate	LF fixing pin	Punch	Die		
Micro grain grade	Fine grain	KH03		◎		◎	○	◎		◎		◎					
		KH05		○		○		○		○		○					
	Micro grain	F0	○		○												
		F1	○		○												
		A1	○		○												
	Ultra micro grain	AFU	○		○												
		AF1	◎		◎		◎										
		XF1	○		○												
Wear resistant grade	—	D1								○		○				○	
	—	D2								○		○			○	○	
	—	D3														○	
	—	G5							○		○		○	○			○
	—	G6							○		○		○	○			○
	—	G7															○
		G8															○
Impact resistant grade	—	GR30															○
	—	GR40															○
	—	GR50															○
	—	GH65															○

◎:Most recommended ○:Recommended

Fig 1



Stock

Dimensions (mm)

Cat. No.	T		L		W		Grade				Fig
	Nominal Dimensions	Tolerance	Nominal Dimensions	Tolerance	Nominal Dimensions	Tolerance	A1	AF1	KH03	KH05	
0B10060012	1.2	+0.5 +0.2	100	+1.5 0	60	+1.0 0	●	●	●	●	1
0B10060015	1.5						●	●	●	●	1
0B10060020	2.0						●	●	●	●	1
0B10060025	2.5						●	●	●	●	1
0B10060030	3.0						●	●	●	●	1
0B10060040	4.0						●	●	●	●	1
0B15060020	2.0	+0.5 +0.2	150	+1.5 0	60	+1.0 0	●	●	●	●	1
0B15060025	2.5						●	●	●	●	1
0B15060030	3.0						●	●	●	●	1
0B15060035	3.5						●	●	●	●	1
0B15060040	4.0						●	●	●	●	1
0B15060045	4.5						●	●	●	●	1
0B15060050	5.0						●	●	●	●	1
0B15060055	5.5						●	●	●	●	1
0B15060060	6.0						●	●	●	●	1
0B15060070	7.0						●	●	●	●	1
0B15060080	8.0						●	●	●	●	1
0B15060090	9.0						●	●	●	●	1
0B15060100	10.0						●	●	●	●	1

Plates with top and bottom faces ground can be made to order.

Binder-less Carbide Blanks for Lens Forming Mold

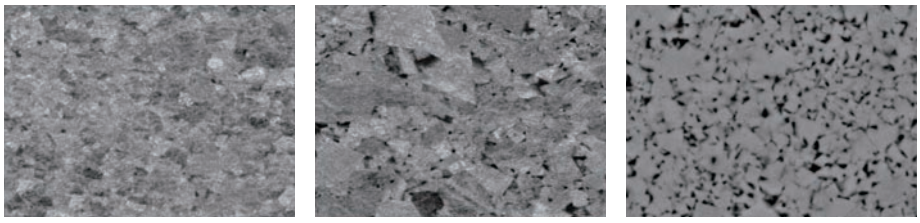
High hardness and high surface quality are realized adopting ultra micro gain WC and minimal Co content.

Grade Property

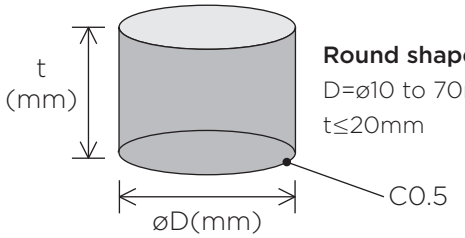
Grade		Grain size (μm)	Co content (wt%)	Specific gravity	Hardness		T.R.S. (GPa)	KIC (MPa $m^{1/2}$)	Thermal expansion coefficient(×10^{-6}/°C)			Characteristics			
					HRA	Hv (GPa)			400°C	600°C	800°C	Hardness	Low thermal expansion	Surface quality	Grind ability
Minimal Co content	**BL100L**	0.3	0.5	15.4	—	25.3	1.3	4.5	4.2	4.5	4.8	◎	◎	◎	△
Low Co content	**BL130L**	0.3	3	15.2	94.2	21.0	2.9	5.4	4.5	4.8	5.2	○	○	○	○
Ultra micro grain WC	**AF1L**	0.3	12	14.1	92.5	17.3	4.4	8.3	5.5	5.8	6.3	△	△	◎	◎

Microstructure

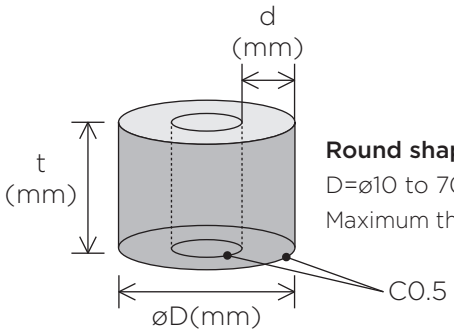
WC grain is grey and Co is black in the following photo.



Producible Blank Dimensions.



Round shape without hole :
D=ø10 to 70mm
t≤20mm



Round shape with hole :
D=ø10 to 70mm
Maximum thickness(t or d)≤20mm

A chamfer of about C0.5 on the inside and outside diameter of the bottom surface is added to prevent chipping.

Producible dimensions are restricted comparing with other grades.
*If you have a requirement which is other than the above producible dimensions, please contact us.

Anti-Corrosive Carbide Blanks

Please try our anti-corrosive carbide which has sufficient successful results for a long time.

For belt cleaner or high pressure plant parts which are used under high corrosive environment.

In addition to high wear resistance and anti-corrosiveness, carbide products which is required to be no magnetism for molding or cutting magnetic materials.

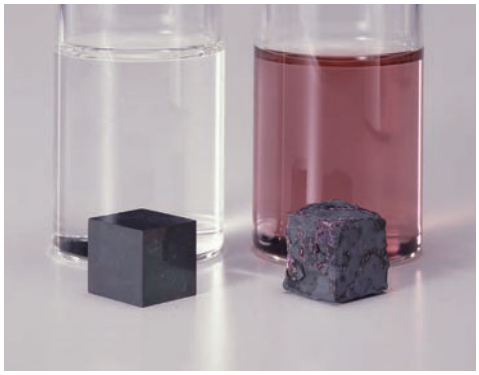
Anti-Corrosive Non Magnetic Carbide **M23S**	Anti-Corrosive Carbide **M3**
Characteristic : Carbide grade with WC-Ni-Cr which shows excellent anti-corrosiveness and no magnetism **Application** : Belt cleaner, Waste water treatment equipment parts, Die & mold for the magnetic powdery molding	**Characteristic** : Carbide grade with WC-Co-Ni-Cr which shows excellent anti-corrosiveness with high hardness and T.R.S. **Application** : Belt cleaner, Plant parts used under high corrosive environment with high pressure Pump parts for sea water

Properties of M23S and M3

Corrosion-resistance expresses the elution weight of the cemented carbide in the acid solution

Type	Grade	Property			Corrosive resistance (Weight reduction by corrosion g/m2·Hr)		
		S.G.	Hardness (HRA)	T.R.S. (GPa)	5%HCl 25°C24Hr	36%HCl 50°C8Hr	10%HNO3 25°C24Hr
Anti-corrosive nonmagnetic carbide	**M23S**	14.8	90.3	3.1	0.15	0.49	0.07
Anti-corrosive carbide	**M3**	14.3	92.2	2.5	0.30	1.97	16.5
Ordinal Carbide for Comparison	**G5**	14.3	89.0	3.3	0.17	3.5	37.1

Anti corrosiveness



Anti-corrosive carbide　　Ordinal carbide

Non magnetism

Nonmagnetic carbide　　Ordinal carbide

High Wear Resistant Carbide Blanks (Binder-less Carbide)

It is necessary to reduce the content of Co which is binder metal in addition to the miniaturization of the grain size of WC in order to improve the hardness of the alloy.
We succeeded in the development of the carbide grade which largely improved the hardness by reducing Co content of the binder metal to the maximum while using WC of the ultra micro fine grain for a main ingredient, and maintaining necessary carbide strength.
It is mainly used for molds for glass lens and water blast nozzles.

Application

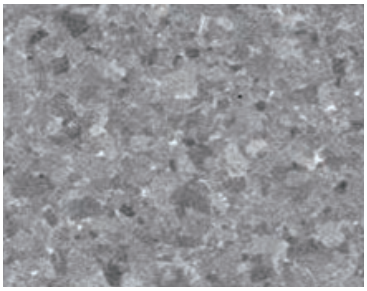
Water jet nozzle / Mold for glass lens / Sliding parts

Applicable Grade

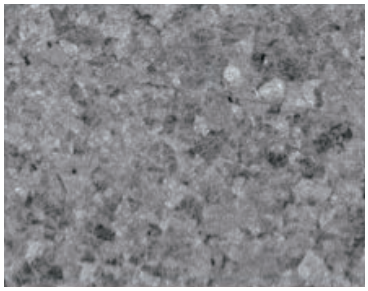
BL005 / BL100

	Co content (wt%)	Hardness HV(GPa)
BL005	0.5	27.0
BL100	0.5	25.3

Microstructure



BL005



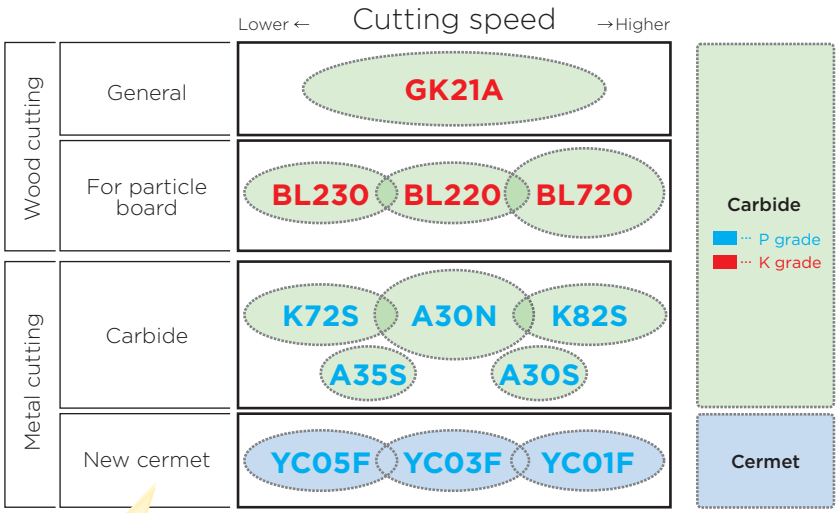
BL100

Carbide Saw Tip Blanks

Application

Metal cutting
Wood cutting
Particle board cutting

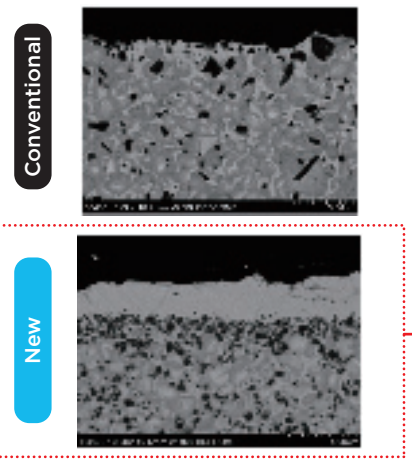
Applicable Grade



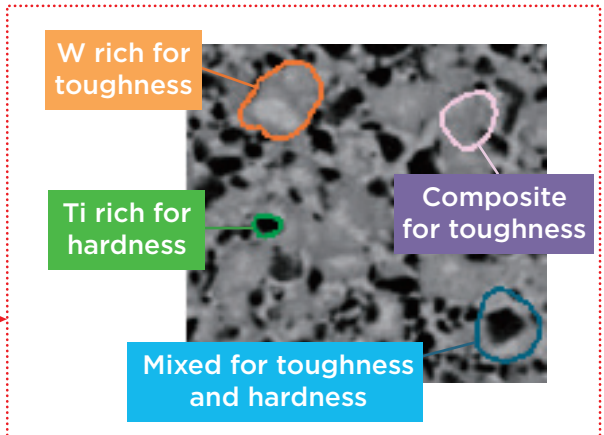
New cermet

Microstructure and physical properties are remarkably improved

Microstructure



Hybrid structure

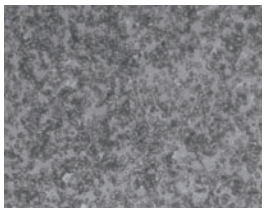


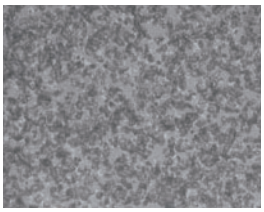
1. Thick binder layer → High stability of brazing
2. Hybrid structure → Improvement of physical properties

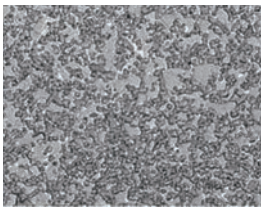
Property of Saw Tip Carbide

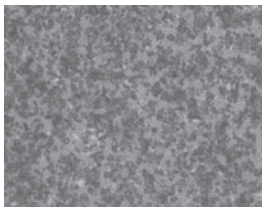
Classification	ISO code	Grade	S.G.	Grain size	Binder Content	Hardness				T.R.S.	Fracture toughness K1c	Young's modulus	Poisson's Ratio	Thermal conductivity (RT)	Coecient of Thermal Expansion 0~400℃
				(μm)	(wt%)	HRA	Hv(GPa)	Hv(GPa) @600˚C	Hv(GPa) @800˚C	(GPa)	(MPam$^{1/2}$)	(GPa)	ν	(W/(m·K))	(x10^{-6}/K)
P grade carbide	P20	**K82S**	12.1	3.4	9.0	91.7	16.1	8.9	5.7	2.1	—	510	0.22	35	6.2
	P30	**A30N**	11.6	3.4	11.5	91.0	14.9	8.3	5.2	2.4	9.1	520	0.22	31	6.5
	P30	**A30S**	11.8	3.4	11.0	91.0	14.8			2.5	8.8				
	P40	**K72S**	12.4	3.6	12.0	90.0	13.9	7.9	4.6	2.6	10.5	510	0.22	44	6.1
	P40	**A35S**	12.7	3.9	11.5	90.4	14.4			2.4	9.5				
Cermet	P20	**YC01F**	7.4	—	15.0	92.4	15.8			2.3	6.5	440	0.22	16	8.0
	P30	**KA30**	7.2	—	15.5	92.1	14.5	8.9	5.9	1.8	8.0	430	0.22	12	7.8
	P30	**YC03F**	7.5	—	19.0	91.6	14.5	8.7	5.5	2.2	7.5	420	0.23	15	8.1
	P40	**YC05F**	7.3	—	21.5	91.1	14.5	8.5	5.0	2.5	8.0	420	0.23	16	8.3
K grade carbide	—	**GK21A**	14.6	2.4	8.0	90.5	14.3	8.5	5.1	3.1	9.7	610	0.22		5.2
High wear resistance	—	**BL720**	15.3	1.4	2.0	93.4	19.4	13.6	9.9	2.9	5.2	690	0.20	92	4.5
	—	**BL220**	15.4	2.0	2.0	92.8	18.1	14.0	10.0	2.9	5.4	690	0.20	99	4.5
	—	**BL230**	15.3	2.0	3.0	92.0	16.8	12.0	7.8	2.5	6.0	670	0.21	122	4.6

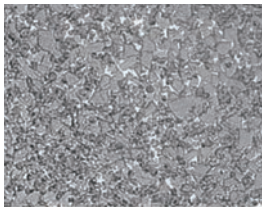
By indentation method

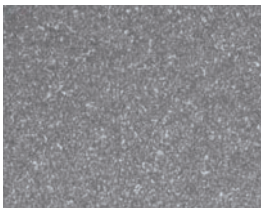

K82S 5μm

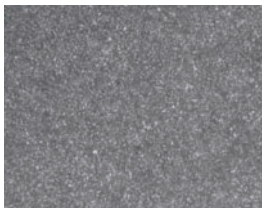

A30N 5μm

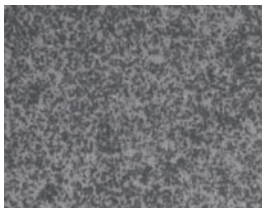

A30S 5μm

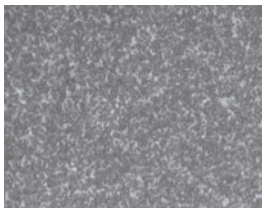

K72S 5μm

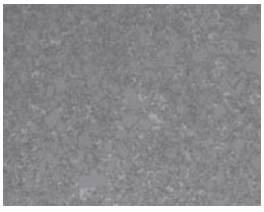

A35S 5μm

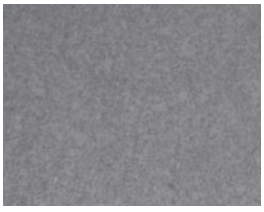

YC01F 5μm

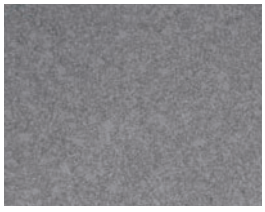

KA30 5μm


YC03F 5μm


YC05F 5μm


GK21A 5μm


BL720 5μm

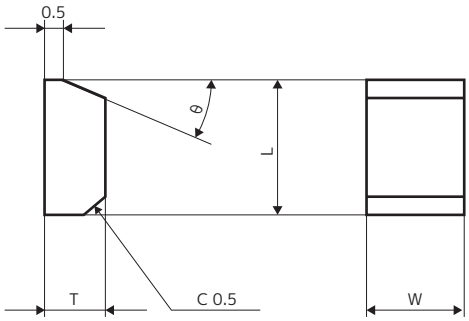

BL220 5μm


BL230 5μm

Description of Saw Tip Blanks

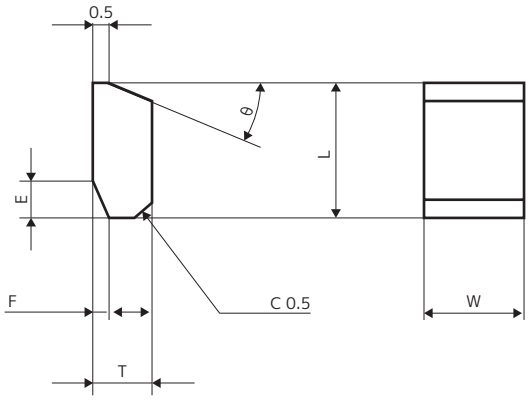
Standard Line-up

SW type



Description	θ
SW L - T - W	0°
SWA L - T - W	10°
SWB L - T - W	15°
SWC L - T - W	20°

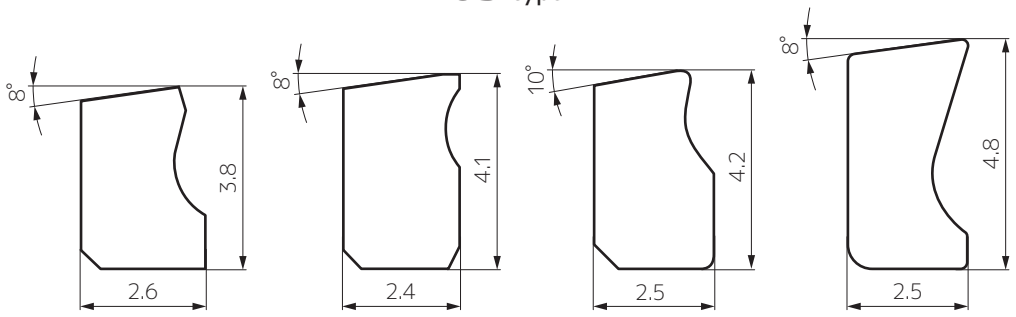
SWP type



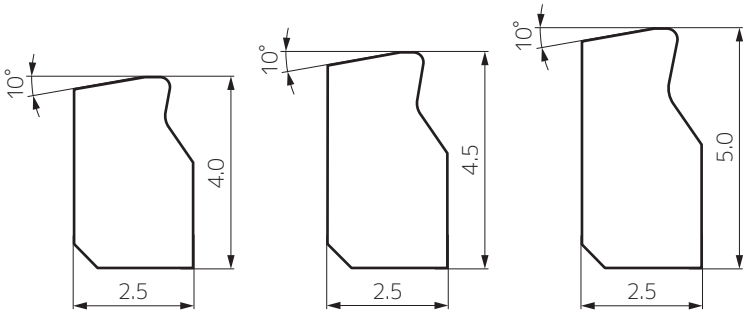
Description	θ
SWP L - T - W	0°
SWPA L - T - W	10°
SWPB L - T - W	15°
SWPC L - T - W	20°
SWPD L - T - W	25°

With a Chipbreaker

CB type



CB38-26-W　CB41-24-W　CB42-25-W　CB48-25-W



CB40-25-W　CB45-25-W　CB50-25-W

(mm)

W : 1.5 to 5.5

$1.5 \leq W \leq 4.9^{+0.15}_{-0}$

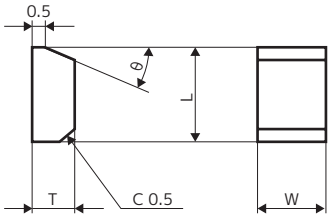
$4.9 < W \leq 5.5^{+0.2}_{-0}$

Available Dimensions for Saw Tip Blanks

SW type (θ=0°)

No.	Description	Carbide grade				Cermet & Fine grain grade			
		L		T		L		T	
1	SW 52 - 10 - W	5.20	+0.3 -0.0	1.00	+0.2 -0.0	5.01	+0.3 -0.0	0.96	+0.2 -0.0
2	SW 60 - 18 - W	6.00		1.80		5.78		1.73	
3	SW 65 - 15 - W	6.50		1.50		6.26		1.44	
4	SW 65 - 20 - W	6.50		2.00		6.26		1.92	
5	SW 65 - 25 - W	6.50		2.50		6.26		2.40	
6	SW 70 - 20 - W	7.00		2.00		6.74		1.92	
7	SW 75 - 25 - W	7.50		2.50		7.23		2.40	
8	SW 80 - 25 - W	8.00		2.50		8.00		2.50	
9	SW 100 - 30 - W	10.00		3.00		9.63		2.88	
10	SW 50 - 20 - W	5.00	±0.1	2.00	±0.1	5.00	±0.1	2.00	±0.1
11	SW 60 - 20 - W	6.15		2.05		6.00		2.00	
12	SW 60 - 30 - W	6.00		3.00		5.78		2.89	
13	SW 70 - 35 - W	7.00		3.50		6.74		3.37	
14	SW 70 - 50 - W	7.00		5.00		6.83		4.88	
15	SW 80 - 30 - W	8.00		3.00		8.00		3.00	
16	SW 90 - 50 - W	9.00		5.00		8.78		4.88	
17	SW 105 - 30 - W	10.50		3.00		10.50		3.00	
18	SW 110 - 50 - W	11.00		5.00		10.73		4.88	
19	SW 130 - 40 - W	13.00		4.00		12.68		3.90	
20	SW 130 - 50 - W	13.00		5.00		12.68		4.88	
21	SW 155 - 40 - W	15.50		4.00		15.12		3.90	
22	SW 155 - 50 - W	15.50		5.00		15.50		5.00	
23	SW 70 - 25 - W	7.18	±0.15	2.56	±0.1	7.00	±0.15	2.50	±0.1
24	SW 70 - 30 - W	7.00		3.00		6.74		2.89	
25	SW 105 - 35 - W	10.76	±0.2	3.59	±0.1	10.50	±0.2	3.50	±0.1
26	SW 180 - 50 - W	18.00		5.00		17.56		4.88	
27	SW 200 - 50 - W	20.00		5.00		19.51		4.88	

SW type



Description	θ
SW L - T - W	0°
SWA L - T - W	10°
SWB L - T - W	15°
SWC L - T - W	20°

(mm)

W : 1.5 to 5.5

$1.5 \leq W \leq 4.9^{+0.15}_{-0}$

$4.9 < W \leq 5.5^{+0.2}_{-0}$

Available Dimensions for Saw Tip Blanks

SWA type (θ=10°)

No.	Description	Carbide grade				Cermet & Fine grain grade			
		L		T		L		T	
1	SWA 50 - 15 - W	5.00	+0.3 -0.0	1.50	+0.2 -0.0	4.81	+0.3 -0.0	1.44	+0.2 -0.0

SWB type (θ=15°)

No.	Description	Carbide grade				Cermet & Fine grain grade			
		L		T		L		T	
1	SWB 45 - 18 - W	4.50	+0.3 -0.0	1.80	+0.2 -0.0	4.50	+0.3 -0.0	1.80	+0.2 -0.0
2	SWB 50 - 16 - W	5.19		1.66		5.00		1.60	
3	SWB 50 - 18 - W	5.13		1.85		5.00		1.80	
4	SWB 60 - 18 - W	6.00		1.80		6.00		1.80	
5	SWB 60 - 30 - W	6.16		3.08		6.00		3.00	
6	SWB 65 - 20 - W	6.50		2.00		6.50		2.00	
7	SWB 70 - 30 - W	7.18		3.08		7.00		3.00	
8	SWB 80 - 30 - W	8.21		3.08		8.00		3.00	
9	SWB 90 - 30 - W	9.00		3.00		8.67		2.89	

SWC type (θ=20°)

No.	Description	Carbide grade				Cermet & Fine grain grade			
		L		T		L		T	
1	SWC 50 - 15 - W	5.00	+0.3 -0.0	1.50	+0.2 -0.0	5.00	+0.3 -0.0	1.50	+0.2 -0.0
2	SWC 55 - 20 - W	5.50		2.00		5.30		1.92	
3	SWC 60 - 17 - W	6.00		1.70		6.00		1.70	
4	SWC 60 - 20 - W	6.00		2.00		6.00		2.00	
5	SWC 70 - 22 - W	7.00		2.20		7.00		2.20	
6	SWC 70 - 25 - W	7.00		2.50		7.00		2.50	
7	SWC 70 - 30 - W	7.00		3.00		6.74		2.89	
8	SWC 75 - 25 - W	7.50		2.50		7.23		2.40	
9	SWC 80 - 20 - W	8.00		2.00		7.71		1.92	
10	SWC 80 - 25 - W	8.00		2.50		7.71		2.40	
11	SWC 90 - 30 - W	9.00		3.00		8.67		2.88	
12	SWC 110 - 30 - W	11.00		3.00		10.59		2.88	

Available Dimensions for Saw Tip Blanks

SWP type (θ=0°)

No.	Description	Carbide grade				Cermet & Fine grain grade				E		F	
		L		T		L		T					
1	SWP 90 - 30 - W	9.34	±0.15	3.11	±0.1	9.00	±0.15	3.00	±0.1	1.5	±0.15	1.5	±0.15
2	SWP 100 - 35 - W	10.00	±0.1	3.50		10.00	±0.1	3.50		2.0		0.5	
3	SWP 130 - 35 - W	13.49	±0.2	3.63		13.00	±0.2	3.50		2.0		0.5	

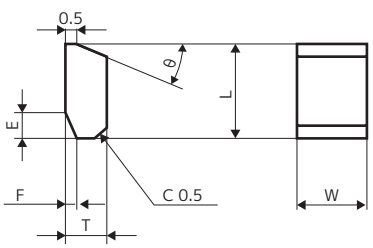
SWPA type (θ=10°)

No.	Description	Carbide grade				Cermet & Fine grain grade				E		F	
		L		T		L		T					
1	SWPA 32 - 18 - W	3.20	+0.3 -0.0	1.80	+0.2 -0.0	3.08	+0.3 -0.0	1.73	+0.2 -0.0	0.30	±0.15	0.30	±0.15
2	SWPA 58 - 24 - W	5.94		2.46		5.80		2.40		1.00		0.50	
3	SWPA 65 - 20 - W	6.50		2.00		6.26		1.92		2.00		0.50	
4	SWPA 70 - 22 - W	7.00		2.20		7.00		2.20		2.00		0.70	
5	SWPA 75 - 24 - W	7.88		2.52		7.50		2.40		2.00		0.70	
6	SWPA 77 - 27 - W	8.09		2.84		7.70		2.70		2.00		0.70	

SWPB type (θ=15°)

No.	Description	Carbide grade				Cermet & Fine grain grade				E		F	
		L		T		L		T					
1	SWPB 40 - 20 - W	4.15	+0.3 -0.0	2.08	+0.2 -0.0	4.00	+0.3 -0.0	2.00	+0.2 -0.0	1.00	±0.15	0.50	±0.15
2	SWPB 45 - 15 - W	4.50		1.50		4.50		1.50		1.00		0.50	
3	SWPB 50 - 15 - W	5.00		1.50		5.00		1.50		1.00		0.50	
4	SWPB 50 - 17 - W	5.00		1.70		4.94		1.68		1.00		0.50	
5	SWPB 55 - 15 - W	5.50		1.50		5.30		1.45		1.00		0.50	
6	SWPB 55 - 18 - W	5.50		1.80		5.50		1.80		1.00		0.50	
7	SWPB 55 - 25 - W	5.50		2.50		5.37		2.44		1.00		0.50	
8	SWPB 59 - 19 - W	5.90		1.90		5.69		1.83		1.00		0.50	
9	SWPB 60 - 18 - W	6.00		1.80		6.00		1.80		1.00		0.50	
10	SWPB 60 - 20 - W	6.00		2.00		6.00		2.00		1.00		0.50	
11	SWPB 65 - 20 - W	6.50		2.00		6.50		2.00		1.00		0.50	
12	SWPB 70 - 20 - W	7.00		2.00		7.00		2.00		1.00		0.50	
13	SWPB 70 - 23 - W	7.00		2.30		7.00		2.30		1.00		0.50	
14	SWPB 70 - 25 - W	7.00		2.50		6.74		2.41		1.00		0.50	
15	SWPB 80 - 25 - W	8.00		2.50		8.00		2.50		1.00		0.50	
16	SWPB 85 - 25 - W	8.50		2.50		8.19		2.41		1.00		0.50	

SWP type



Description	θ
SWP L - T - W	0°
SWPA L - T - W	10°
SWPB L - T - W	15°
SWPC L - T - W	20°
SWPD L - T - W	25°

(mm)

W : 1.5 to 5.5

$1.5 \leq W \leq 4.9^{+0.15}_{-0}$

$4.9 < W \leq 5.5^{+0.2}_{-0}$

Available Dimensions for Saw Tip Blanks

SWPC type (θ=20°)

No.	Description	Carbide grade				Cermet & Fine grain grade				E		F	
		L		T		L		T					
1	SWPC 40 - 18 - W	4.00		1.80		4.00		1.80		0.70		0.30	
2	SWPC 50 - 15 - W	5.00		1.50		5.00		1.50		1.50		0.50	
3	SWPC 55 - 15 - W	5.50		1.50		5.30		1.45		1.50		0.50	
4	SWPC 55 - 16 - W	5.50		1.60		5.50		1.60		1.50		0.50	
5	SWPC 55 - 18 - W	5.50		1.80		5.50		1.80		1.50		0.50	
6	SWPC 55 - 21 - W	5.71		2.18		5.50		2.10		1.50		0.50	
7	SWPC 60 - 15 - W	6.00		1.50		5.78		1.44		2.00		0.50	
8	SWPC 60 - 18 - W	6.00		1.80		6.00		1.80		1.50		0.50	
9	SWPC 60 - 20 - W	6.00		2.00		6.00		2.00		1.50		0.50	
10	SWPC 60 - 20 - W	6.00		2.00		6.00		2.00		2.00		1.00	
11	SWPC 65 - 20 - W	6.50		2.00		6.50		2.00		2.00		0.50	
12	SWPC 65 - 20 - W	6.50		2.00		6.26		1.92		2.00		1.00	
13	SWPC 65 - 23 - W	6.50		2.30		6.26		2.21		2.00		0.80	
14	SWPC 65 - 25 - W	6.50		2.50		6.26		2.40		2.00		1.30	
15	SWPC 70 - 20 - W	7.00	+0.3 -0.0	2.00	+0.2 -0.0	6.74	+0.3 -0.0	1.92	+0.2 -0.0	2.00	±0.15	1.00	±0.15
16	SWPC 70 - 23 - W	7.00		2.30		7.00		2.30		2.00		0.50	
17	SWPC 77 - 25 - W	7.70		2.50		7.70		2.50		2.50		1.25	
18	SWPC 80 - 23 - W	8.00		2.30		8.00		2.30		2.00		0.50	
19	SWPC 80 - 25 - W	8.00		2.50		7.71		2.41		2.00		1.30	
20	SWPC 85 - 25 - W	8.50		2.50		8.19		2.40		2.00		1.30	
21	SWPC 90 - 25 - W	9.00		2.50		8.67		2.40		2.00		1.30	
22	SWPC 90 - 27 - W	9.00		2.70		8.67		2.60		3.00		1.30	
23	SWPC 95 - 27 - W	9.86		2.80		9.50		2.70		2.50		0.70	
24	SWPC 100 - 25 - W	10.00		2.50		10.00		2.50		3.00		1.30	
25	SWPC 100 - 27 - W	10.37		2.80		10.00		2.70		2.50		0.70	
26	SWPC 105 - 30 - W	10.50		3.00		10.11		2.88		3.50		1.50	
27	SWPC 110 - 35 - W	11.00		3.50		10.59		3.37		3.00		1.50	
28	SWPC 120 - 30 - W	12.00		3.00		11.56		2.89		2.00		1.00	
29	SWPC 140 - 30 - W	14.00		3.00		13.49		2.88		4.00		1.30	

SWPD type (θ=25°)

No.	Description	Carbide grade				Cermet & Fine grain grade				E		F	
		L		T		L		T					
1	SWPD 45 - 15 - W	4.50		1.50		4.34		1.46		1.00		0.50	
2	SWPD 60 - 15 - W	6.00		1.50		5.78		1.44		1.00		0.50	
3	SWPD 60 - 18 - W	6.00		1.80		5.78		1.73		1.00		0.50	
4	SWPD 60 - 20 - W	6.00	+0.3 -0.0	2.00	+0.2 -0.0	5.78	+0.3 -0.0	1.92	+0.2 -0.0	1.00	±0.15	0.50	±0.15
5	SWPD 62 - 19 - W	6.44		1.97		6.20		1.90		1.00		0.50	
6	SWPD 65 - 20 - W	6.50		2.00		6.50		2.00		1.00		0.50	
7	SWPD 70 - 20 - W	7.00		2.00		6.74		1.92		1.00		0.50	
8	SWPD 70 - 23 - W	7.00		2.30		6.74		2.21		1.00		0.50	

MEMO

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< SAFETY NOTES >

- Very hot or lengthy chips may be discharged while the machine is in operation. Therefore, machine guards, safety goggles or other protective covers must be used. Fire safety precautions must also be considered.
- Please handle with care as this product has sharp edges.
- Improper cutting conditions or mis-handling of the tool may result in breakages or projectiles. Therefore, please use the tool within its recommended conditions.
- When using non-water soluble cutting oil, precautions against fire must be taken and please ensure that a fire extinguisher is placed near the machine.

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