The Solution for Carbide Tool Manufactures

CARBIDE BLANKS

AXISMATERIA LTD.

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AXISMATERIA LTD.

INTRODUCTION

The Next-Generation Technology To Create Tomorrow's Society

Tungsten carbide is the hardest artificial material after diamond, which is essential as a cutting-tool material for automobiles, and mobile devices such as computers and smartphones.
Recently, cutting tool maker's requests are becoming more precise and detailed, therefore the demand for carbide cutting tools such as drills and endmills are not only increasing, but also becoming widely utilized in various fields such as die molds, crushing machine tools, and so on.
AXISMATERIA is the Japanese tungsten carbide blanks manufacture, and we are the leading manufacturer of in particular small diameter blanks for PCB drills* in the world because of our advanced technology in metallurgy and thorough quality control.
To meet our customer's various expectations, we work closely with our parent companies R&D laboratory, which is the most advanced science and technology of metallurgy, and also we have the state-of-the-art equipment to ensure products are being manufactured to their exact specifications.
We will continue exceed our customers expectations, and be contribute to our society.

*Drills used in manufacturing Printed Circuit Boards

CARBIDE BLANKS

CONTENTS

COMPANY PROFILE

AXISMATERIA was founded in 2000, by our parent companies Sumitomo-Electric Hardmetal Ltd., and A.L.M.T. Corp., both of whom are subsidiaries of Sumitomo-Electric industries, Ltd.
Our mission is to supply the highest tungsten carbide rods for outside carbide-tool companies as well as our parent companies. Recently 90% of our sales come from the outside companies.
We have produced mainly the super small diameter carbide rods for PCB drills since our foundation, and we control the world's top market share thanks to the evaluation of our technology for producing outstanding quality blanks. We prioritize the advancement of high qualities carbide blanks, therefore we have a metallurgy laboratory named PMIC (Powder Metallurgy Innovation Center), belonging to Sumitomo-Electric Hardmetal Ltd., and we closely co-operate with our parent company in R&D. Our next goal is to expand our high technology to standard carbide rod, die-molds, and so on.
The stable procurement of raw material is a key issue to our business continuity, therefore Sumitomo Electric Hardmetal group focuses on recycling tungsten scraps, diversifying material suppliers, and managing overall production from refining to carbonizing in Sumitomo Electric group.

AXISMATERIA LTD.

General Information

Company name	AXISMATERIA LTD.,
Established	August 2000
Capital	490 million yen 60% Sumitomo Electric Hardmetal Corp. 40% A.L.M.T. Corp.
CEO	Yoshimitsu Sawazono
Industry	Manufacture and sales of carbide blanks
Head office	1, Takumidai, Ono, Hyogo, 675-1322, Japan
Employees	300 people (July.2019)

History

1928	Successfully produced the Tungsten carbide for drawing die.
1931	Began production for Tungsten carbide tools, "IGETALLOY™."
2000	Axismateria established.
2005	Started transferring production line from Sumitomo Itami works.
2010	Completed transfer from Itami.
2012	Powder Metallurgy Innovation Center (PMIC) established.
2016	A2 building constructed.

Corporate Mission

[We will be the company that aspire to provide for the needs of our customers]

We provide not only satisfaction, but also aim to have a strong impression with our products and services.

[We will sincerely fulfill our corporate social responsibility and ensure our employees satisfaction]

We aspire to be the company that motivates their employees to do the best, improving their skills and building their confidence through our company. We promote compliance with laws and ordinances, environmental protection, and everyone's safety.

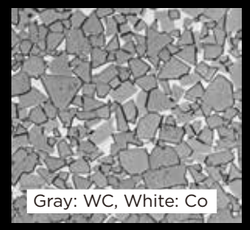
[We promise to fulfill our supply responsibilities to our customers with top quality.]

What Is Tungsten Carbide?

Tungsten 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) or TaC (Tantalum-carbide) as needed. It is an optimal raw material for cutting tool: it has high hardness, high strength at high temperatures, so it is used in a high-temperature, high-speed environment thanks to those characteristics.

Tungsten Carbide's Micrograph

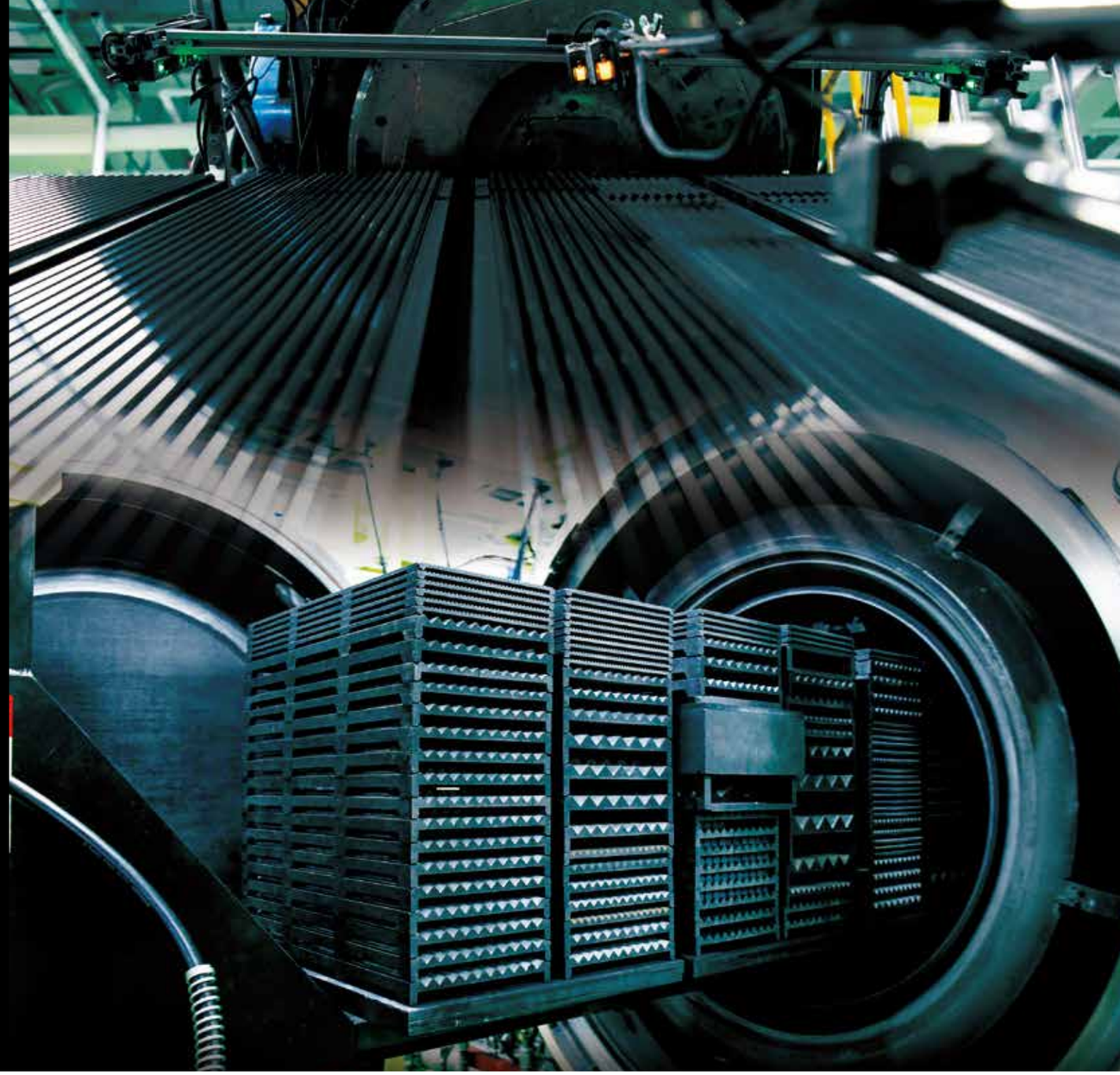
▼ Typical Tungsten Carbide-Phase



Gray: WC, White: Co

Tungsten carbide characteristic
(comparing WC-Co7% tungsten 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:4.9×10-6dea-1)	1/2 times
High thermal diffusion	←	High thermal conductivity (κ:0.19cal/cm sec.℃)	5 times (than high speed steel)
High thermal transformation resistance	→	High heat resistance	
High corrosion resistance	→	Possible to produce anti-corrosion alloy	

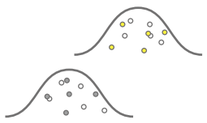


Applications of Tungsten Carbide

The above characteristics are utilized in the cutting edges of tools, and die molds. In comparison with common heat-treated steel tools, tungsten carbide tools can withstand overwhelming machining speed and have longer tool-life than before, therefore the amount of tungsten carbide tools are increasing year on year.
Tungsten 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 Tungsten Carbide

1 Raw Material

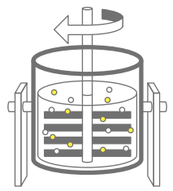


Main material	WC
Metal binder	Co,Ni
Others	TiC,TaC

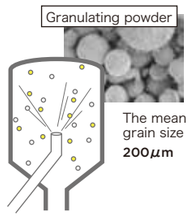
Materials form ore
Materials from recycling

2 Ready-to-press Powder

Crushing & Mixing



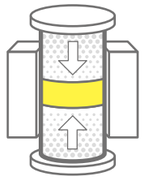
Drying & Granulating



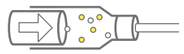
The mean grain size 200μm

3 Pressing / Extruding

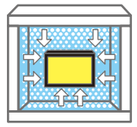
Pressing



Extruding

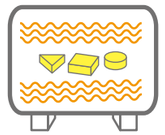


CIP
(Cold Isostatic Pressing)



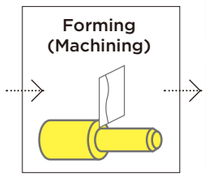
4 Forming (some of the products)

Semi-Sintering

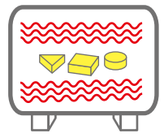


400-700°C
(750-1290°F)

Forming (Machining)



5 Sintering



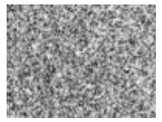
1400-1500°C
(2550-2730°F)

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

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

7 Inspecting

Phisical properties
Dimensional & visual inspection

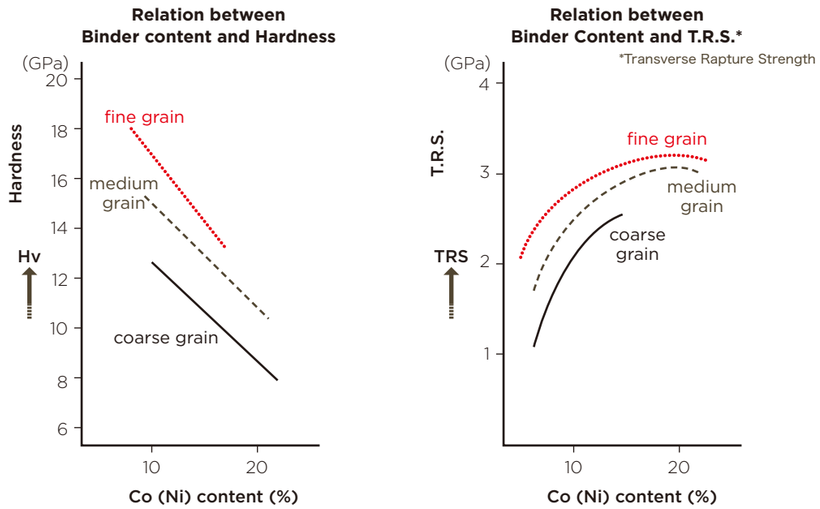


Ultra fine grain structure's micrograph

8 Packing & Shipping

Characteristics of Tungsten Carbide

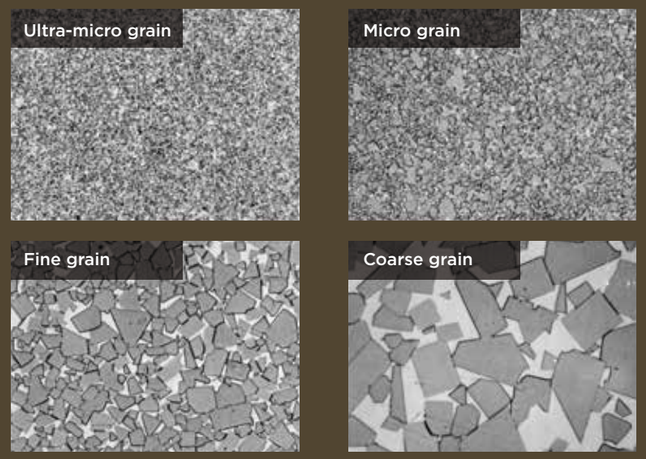
Relation between Composition and Characteristics



The characteristic of carbide blanks (hardness & TRS) is effected by the amount of metal binder or grain size of tungsten carbide (WC).

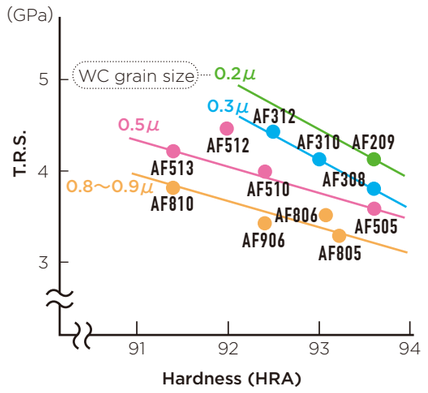
As Co content increases, hardness of carbide blanks decreases, but conversely, TRS increases. On the contrary, as Co content decreases, the hardness increases.

The microstructure by different WC grain



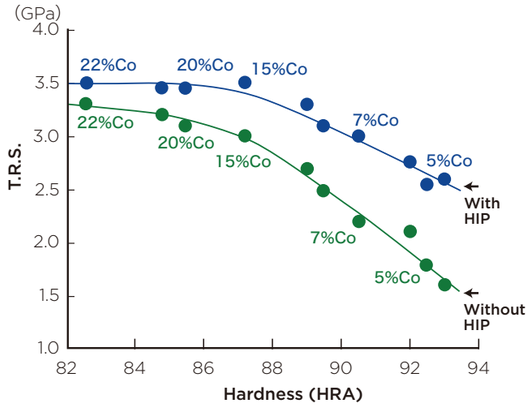
Carbide grades with ultra-micro grain or fine grain are commonly used for endmills and drills.

Relation between grain size of WC and hardness or TRS



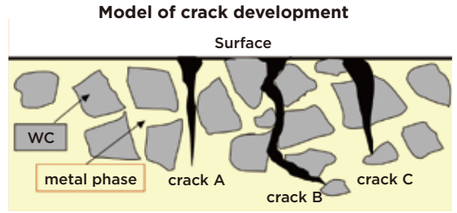
By using smaller grain size of WC, carbide shows higher hardness and TRS, but fracture toughness becomes lower.
(Reference: "Relation between WC grain size and fracture toughness")

Improvement of TRS by HIP

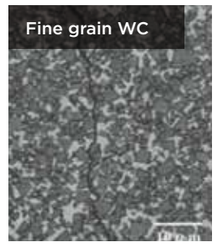


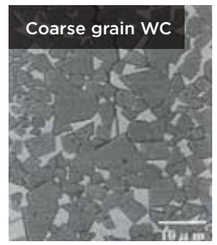
All of our carbide rods are treated by HIP to eliminate micro pore and improves TRS. (HIP is the process to treat carbide with high temperature and pressure.)

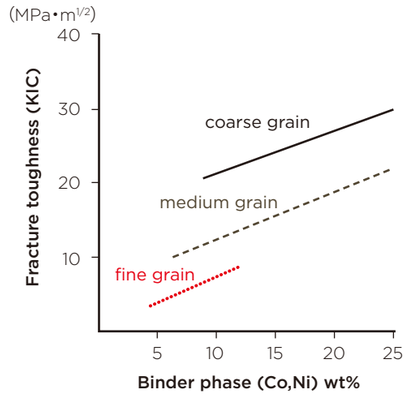
Relation between WC grain size and fracture toughness



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 p19-20.)

BLANKS FOR ROUND TOOLS

Blanks for Round Tools

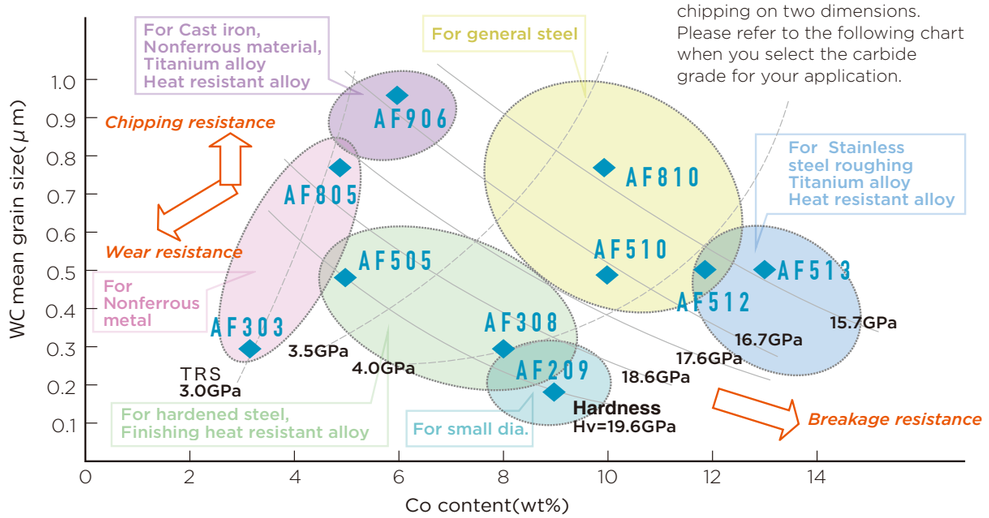
Specifications of Grade for Round Tools

Class	Grade	ISO	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	AF209	Z10	0.2	9	4.0	93.5	20.4	5.5	610
	AF308	Z10	0.3	8	3.8	93.6	19.4	6.0	610
	AF310*	Z20	0.3	10	4.1	93.0	18.1	7.3	590
	AF312	Z20	0.3	12	4.4	92.5	17.3	8.3	570
Micro Grain	AF505*	Z01	0.5	5	3.6	93.6	20.1	6.7	650
	AF510	Z20	0.5	10	4.0	92.4	17.0	8.2	-
	AF512	Z20	0.5	12	4.4	92.0	16.3	9.0	-
	AF513	Z30	0.5	13	4.2	91.4	15.6	8.6	560
Fine Grain	AF805	K01	0.8	5	3.3	93.2	17.7	6.3	660
	AF806*	K10	0.8	6	3.5	93.0	17.6	7.5	640
	AF810	K30	0.8	10	3.8	91.4	15.2	9.9	-
	AF906	K10	0.9	6	3.4	92.4	17.3	6.5	-

(*) Grade only for cutting tools for PCB

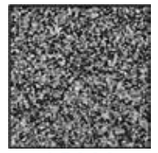
Carbide Grade for Endmills

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.



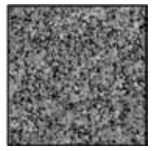
Grade Recommendation by Application

Ultra Micro Grain



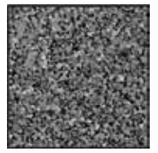
AF312
Grain Size 0.3μm

Micro Grain



AF510
Grain Size 0.5μm

Fine Grain



AF810
Grain Size 0.8μm

Grade	Application		Work Material								
	Endmill	Drill	Soft Steel	General Steel	Hardened Steel	Stainless Steel	Titanium Alloy	Inconel	Cast iron	Aluminium Alloy	Copper Alloy
AF209	●	●	○	○	◎	◎		◎			
AF308	●		○	○	◎						
AF312	●	●	○	○							
AF510	●		◎	◎	○	○	○	○			
		●	◎	◎	○	○	○	○	○	○	○
AF512	●		◎	◎	○	◎	◎	◎			
AF513	●	●	○	○		○					
AF805	●	●							◎	◎	◎
AF810	●		○	○	○	○	◎	◎			
		●	◎	◎	○	○	◎	◎	○		
AF906	●	●			○	○	◎	◎	◎	○	○

● = We have also 30°helical coolant hole blanks.(Refer to p17-18.)

Grade	Application	Work Material								
	Reamer	Soft Steel	General Steel	Hardened Steel	Stainless Steel	Titanium Alloy	Inconel	Cast iron	Aluminium Alloy	Copper Alloy
AF513	●	○	○							
AF805	●	○	○	○	○			◎	◎	◎
AF906	●	○	○	○	○	◎	◎	◎	○	○

Application of Blanks for PCB Drills

Grade	Form		Diameter		
	Solid	Composite	Ultra Small Diameter (～Φ0.15)	Small Diameter (～Φ0.45)	General Diameter (Φ0.5～)
AF209	●	●	◎	○	
AF308	●	●		◎	
AF310	●	●	○	◎	
AF505	●				◎
AF806	●	●		○	○

PRODUCT

Blanks for Round Tools

Round Rods

Inventory

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

■ Stocked Grade

AF308	AF312	AF510
AF513	AF805	AF906

■ Stocked Item

Cat. No.	Diameter (mm)		Length (mm)		Grade					
	Nominal Diameter	Tolerance	Nominal Length	Tolerance	AF308	AF312	AF510	AF513	AF805	AF906
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			●	●	●	●	●	●
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			●	●	●	●	●	●
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			●	●	●	●	●	●
AR170310	17.0									
AR180310	18.0				●	●	●	●	●	●
AR190310	19.0									
AR200310	20.0				●	●	●	●	●	●

Unstocked items are available by order.

Standards of Round Rods

Available size

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

Grade	Diameter 0	5	10	15	20	25	30	35
AF310								
AF505	～Φ3							
AF806								
AF209								
AF303			～Φ16					
AF308							～Φ35	
AF312								
AF512					～Φ25			
AF510								
AF513							～Φ35	
AF805					～Φ25			
AF810							～Φ35	
AF906								
Length	Φ3～Φ25 Dia: 10L～330L					Φ25～Φ35 Dia: 10L～170L		

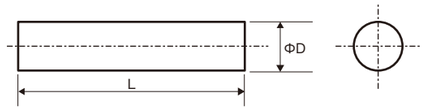
Tolerance

■ 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)
310≦L≦330	+6.0 -0

0.15

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



Round Rods with Helical Coolant Holes

The producible grade is AF510 and AF810.

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

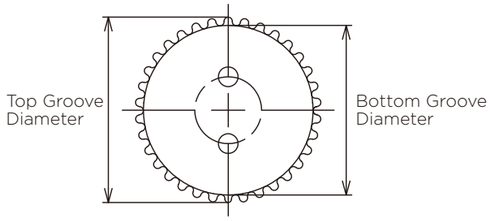
We can form chamfering and centering over φ5.6mm diameter.

Stepping is unavailable.

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

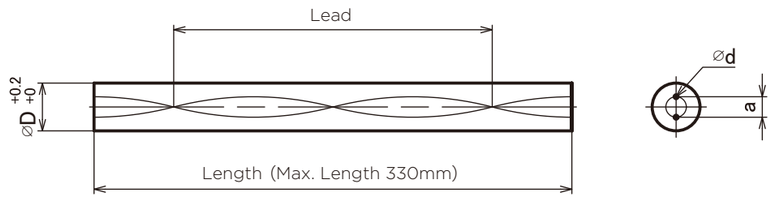
Round rods with helical coolant hole has helical grooves on the surface. In the right chart, the diameter of top groove and bottom groove are expressed as “top groove diameter” and “bottom groove diameter” respectively.

Diagram of the Cross Section

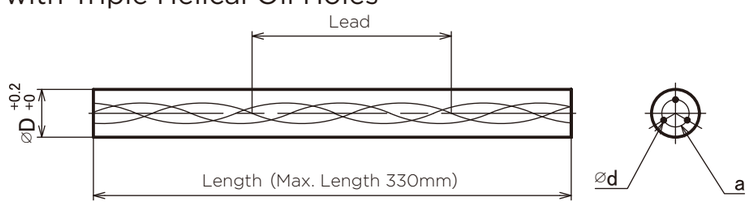


※2 Form

① with Double Helical Oil Holes



② with Triple Helical Oil Holes



Dementions

Number of OH	Helix Angle	Diameter ⌀D※1 Top Groove	Diameter ⌀D※1 Bottom Groove	Lead Allowance	Hole Diameter ⌀d	Hole Pitch a	Producible Grade AF 510	Producible Grade AF 810	Cat. No. L=310	Cat. No. L=330	Form ※2
2	15°	5.6	5.25	54.8 ～ 63.0	0.71 ±0.1	2.5 0/-0.3		○	AR1H056310	AR1H056330	
		6.6	6.25	65.7 ～ 75.6	0.83 ±0.1	2.5 ±0.2		○	AR1H066310	AR1H066330	
		7.6	7.25	76.7 ～ 88.2	0.95 ±0.1	3.3 ±0.2		○	AR1H076310	AR1H076330	
		8.6	8.25	87.6 ～ 100.8	1.06 ±0.1	3.6 ±0.2		○	AR1H086310	AR1H086330	
		9.6	9.25	98.6 ～ 113.4	1.18 ±0.2	4.2 ±0.2		○	AR1H096310	AR1H096330	
		10.6	10.25	109.6 ～ 126.0	1.30 ±0.2	4.6 ±0.2		○	AR1H106310	AR1H106330	
		11.6	11.25	120.5 ～ 138.6	1.30 ±0.2	5.0 ±0.2		○	AR1H116310	AR1H116330	
		12.6	12.25	131.5 ～ 151.2	1.42 ±0.2	5.4 ±0.2		○	AR1H126310	AR1H126330	
		13.6	13.25	142.4 ～ 163.8	1.54 ±0.2	5.7 ±0.2		○	AR1H136310	AR1H136330	
		14.6	14.25	153.4 ～ 176.4	1.66 ±0.2	6.3 ±0.2		○	AR1H146310	AR1H146330	
		15.6	15.25	164.3 ～ 189.0	1.77 ±0.2	6.9 ±0.2		○	AR1H156310	AR1H156330	
		16.6	16.25	175.3 ～ 201.6	1.89 ±0.2	7.5 ±0.2		○	AR1H166310	AR1H166330	
	30° For Straight Drills	3.6	3.3	15.7 ～ 17.0	0.47 ±0.05	1.50 0/-0.1	○	○	ARH036310	ARH036330	①
		4.6	4.3	20.9 ～ 22.7	0.59 +0.05/-0.1	1.7 0/-0.2	○	○	ARH046310	ARH046330	
		5.6	5.3	26.2 ～ 28.4	0.71 ±0.1	2.4 0/-0.3	○	○	ARH056310	ARH056330	
		6.6	6.3	31.4 ～ 34.0	0.83 ±0.1	2.8 ±0.2	○	○	ARH066310	ARH066330	
		7.6	7.3	36.6 ～ 39.7	0.95 ±0.1	3.2 ±0.2	○	○	ARH076310	ARH076330	
		8.6	8.3	41.9 ～ 45.4	1.06 ±0.1	3.6 ±0.2	○	○	ARH086310	ARH086330	
		9.6	9.3	47.1 ～ 51.0	1.18 ±0.2	4.0 ±0.2	○	○	ARH096310	ARH096330	
		10.6	10.3	52.3 ～ 56.7	1.30 ±0.2	4.4 ±0.2	○	○	ARH106310	ARH106330	
		11.6	11.3	57.5 ～ 62.4	1.30 ±0.2	4.4 ±0.2	○	○	ARH116310	ARH116330	
		12.6	12.3	62.8 ～ 68.1	1.42 ±0.2	4.8 ±0.2	○	○	ARH126310	ARH126330	
		13.6	13.3	68.0 ～ 73.7	1.54 ±0.2	5.2 ±0.2	○	○	ARH136310	ARH136330	
		14.6	14.3	73.2 ～ 79.4	1.66 ±0.2	5.6 ±0.2	○	○	ARH146310	ARH146330	
		15.6	15.3	78.5 ～ 85.1	1.77 ±0.2	6.0 ±0.2	○	○	ARH156310	ARH156330	
		16.6	16.3	83.7 ～ 90.7	1.89 ±0.2	6.4 ±0.2	○	○	ARH166310	ARH166330	
		17.6	17.3	88.9 ～ 96.3	2.01 ±0.2	6.8 ±0.2	○		ARH176310	ARH176330	
					1.75 ±0.2	8.5 ±0.2		○	ARH176310-1	ARH176330-1	
		18.6	18.3	94.1 ～ 102.0	2.13 ±0.2	7.2 ±0.2	○		ARH186310	ARH186330	
					2.00 ±0.2	9.2 ±0.2		○	ARH186310-1	ARH186330-1	
		19.6	19.3	99.3 ～ 107.7	2.28 ±0.2	7.6 ±0.2	○		ARH196310	ARH196330	
					2.00 ±0.2	9.7 ±0.2		○	ARH196310-1	ARH196330-1	
		20.6	20.3	104.6 ～ 113.4	2.36 ±0.2	8.0 ±0.2	○		ARH206310	ARH206330	
					2.00 ±0.2	9.9 ±0.2		○	ARH206310-1	ARH206330-1	
	30° For Step Drills	3.6	3.3	15.7 ～ 17.0	0.23 ±0.05	0.8 -0.1/-0.2	○	○	ARD036310-1	ARD036330-1	
				15.7 ～ 17.0	0.35 ±0.05	1.2 0/-0.2	○	○	ARD036310-2	ARD036330-2	
		4.6	4.3	20.9 ～ 22.7	0.35 ±0.05	1.2 0/-0.2	○	○	ARD046310	ARD046330	
		5.6	5.3	26.2 ～ 28.4	0.47 ±0.05	1.5 0/-0.3	○	○	ARD056310	ARD056330	
		6.6	6.3	31.4 ～ 34.0	0.47 ±0.1	2.0 ±0.2	○	○	ARD066310	ARD066330	
		7.6	7.3	36.6 ～ 39.7	0.59 ±0.1	2.0 ±0.2	○	○	ARD076310	ARD076330	
		8.6	8.3	41.9 ～ 45.4	0.71 ±0.1	2.4 ±0.2	○	○	ARD086310	ARD086330	
		9.6	9.3	47.1 ～ 51.0	0.83 ±0.1	2.8 ±0.2	○	○	ARD096310	ARD096330	
		10.6	10.3	52.3 ～ 56.7	0.95 ±0.1	3.2 ±0.2	○	○	ARD106310	ARD106330	
		11.6	11.3	57.5 ～ 62.4	0.95 ±0.1	3.2 ±0.2	○	○	ARD116310	ARD116330	
		12.6	12.3	62.8 ～ 68.1	1.06 ±0.1	3.6 ±0.2	○	○	ARD126310	ARD126330	
		13.6	13.3	68.0 ～ 73.7	1.06 ±0.1	3.6 ±0.2	○	○	ARD136310	ARD136330	
		14.6	14.3	73.2 ～ 79.4	1.18 ±0.2	4.0 ±0.2	○	○	ARD146310	ARD146330	
		15.6	15.3	78.5 ～ 85.1	1.30 ±0.2	4.4 ±0.2	○	○	ARD156310	ARD156330	
		16.6	16.3	83.7 ～ 90.7	1.42 ±0.2	4.8 ±0.2	○	○	ARD166310	ARD166330	
	42°	3.6	3.2	10.1 ～ 10.8	0.20 ±0.05	0.5 ±0.05		○	AR4H036310-1	AR4H036330-1	
			3.2	10.1 ～ 10.8	0.14 ±0.03	0.5 0/-0.1		○	AR4H036310-2	AR4H036330-2	
3	30°	5.6	5.3	26.2 ～ 28.4	0.40 ±0.05	2.8 0/-0.3		○	ARZ056310	ARZ056330	②
		6.6	6.3	31.4 ～ 34.0	0.50 ±0.05	3.4 ±0.2		○	ARZ066310	ARZ066330	
		7.6	7.3	36.6 ～ 39.7	0.59 ±0.10	4.0 ±0.2		○	ARZ076310	ARZ076330	
		8.6	8.3	41.9 ～ 45.4	0.65 ±0.10	4.6 ±0.2		○	ARZ086310	ARZ086330	
		9.6	9.3	47.1 ～ 51.0	0.77 ±0.20	5.3 ±0.2		○	ARZ096310	ARZ096330	
		10.6	10.3	52.3 ～ 56.7	0.85 ±0.20	6.0 ±0.2		○	ARZ106310	ARZ106330	
		11.6	11.3	57.5 ～ 62.4	0.94 ±0.20	6.7 ±0.2		○	ARZ116310	ARZ116330	
		12.6	12.3	62.8 ～ 68.1	1.03 ±0.20	7.4 ±0.2		○	ARZ126310	ARZ126330	
		13.6	13.3	68.0 ～ 73.7	1.11 ±0.20	8.2 ±0.2		○	ARZ136310	ARZ136330	
		14.6	14.3	73.2 ～ 79.4	1.20 ±0.20	9.0 ±0.2		○	ARZ146310	ARZ146330	
		15.6	15.3	78.5 ～ 85.1	1.28 ±0.20	9.8 ±0.2		○	ARZ156310	ARZ156330	
		16.6	16.3	83.7 ～ 90.7	1.37 ±0.20	10.6 ±0.2		○	ARZ166310	ARZ166330	

(mm)

Formed Round Rods

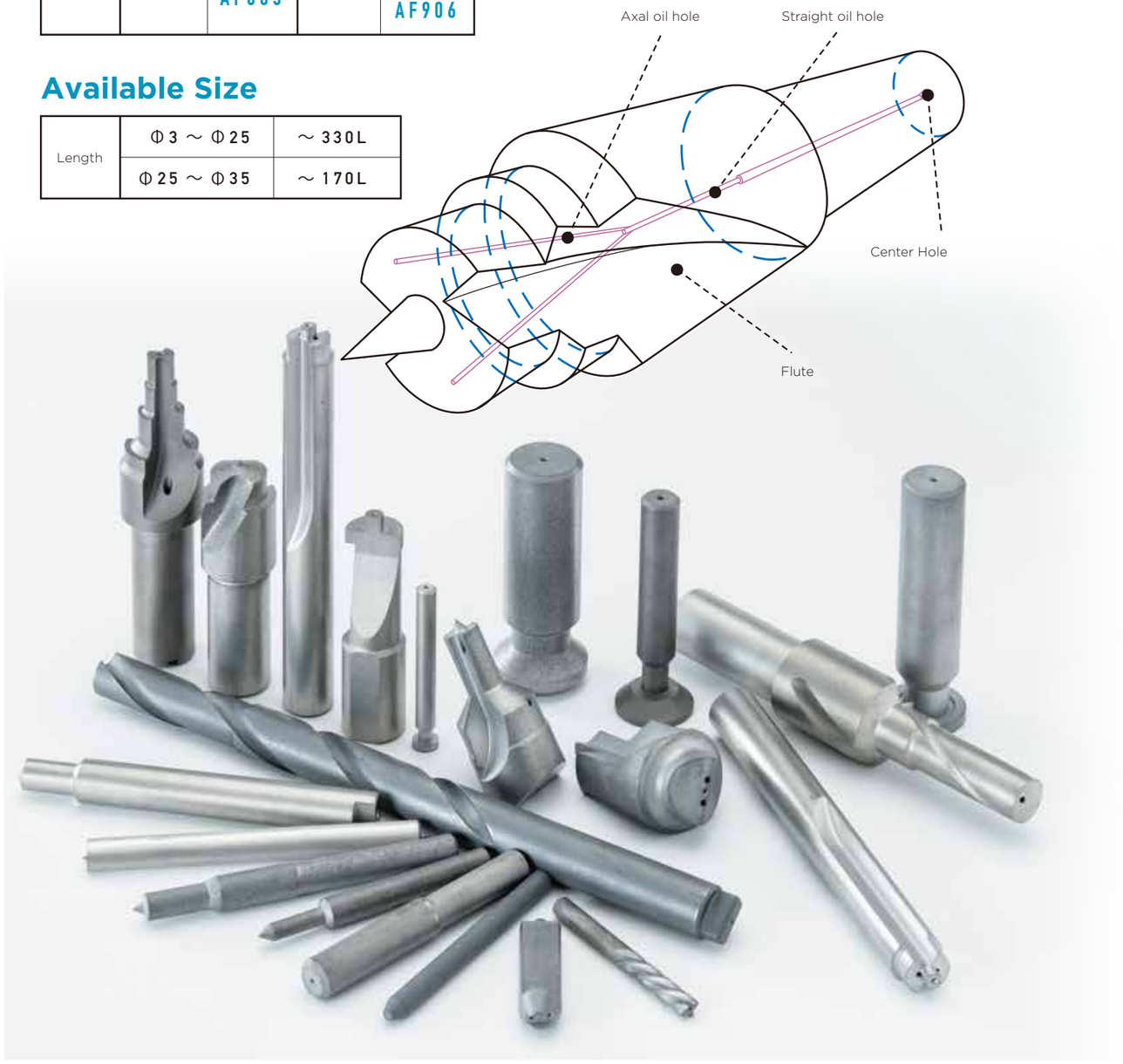
Formed rods as near net shape are available on request.

Grades to Be Formed

Diameter	Φ3 ~ Φ25	AF312 AF510 AF805	Φ3 ~ Φ35	AF308 AF513 AF810 AF906

Available Size

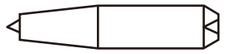
Length	Φ3 ~ Φ25	~ 330L
	Φ25 ~ Φ35	~ 170L



Formed Example

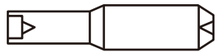
Producible Measurement : Diameter 3mm to 35mm / Length up to 320mm

■ **Taper**



■ **V-Groove/Point angle**

■ **Spot Face**

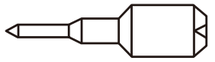


■ **Straight oil hole/ axal oil hole**

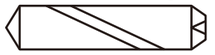
Through hole: Maximum Length 320L
Blind hole: Maximum Length 170L

*Maximum length is different by diameter.
*Minimum diameter: Φ0.8

■ **Multi-step**



■ **Flute*** (Accommodate for right handed and flute)



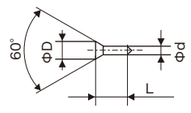
* Maximum length: 220L
We can form helical angle flute, straight flute, and flat face.
Please contact us about helical flute specifications.

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

Standard Dimensions

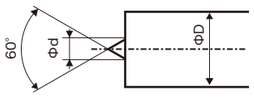
■ Female Center

Diameter(Φ)	ΦD	Φd	L
3.0 ~ 3.5	1.3	0.8	1.43
3.6 ~ 6.3	1.5	1.0	1.63
6.4 ~ 10.0	2.0	1.5	2.23
10.1 ~	3.0	2.0	3.87



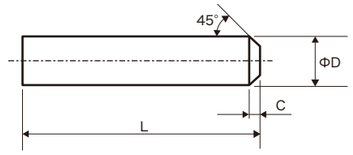
■ Male Center

Diameter ΦD	Φd
3.0 ~ 5.0	3.0
5.1 ~ 10.0	4.0
10.1 ~ 20.0	5.0
20.1 ~	6.0



■ Chamfer

Diameter ΦD	measurement
3.0 ~ 5.0	0.5
5.1 ~ 10.0	1.0
10.1 ~ 15.0	1.5
15.1 ~ 20.0	1.8
20.1 ~ 25.0	2.0
25.1 ~	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 tools, wear resistant tools, dies & molds

BLANKS FOR VARIOUS CUTTING TOOLS,
WEAR RESISTANT TOOLS,
DIES & MOLDS

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

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

Various Grades depending on the Application

For general cutting tools

P grade : **AP** series

M grade : **AM** series

K grade : **AK/AF** series

Micro & Ultra micro grain grade

AF series

Cermet

AT series

For wear resistant tools

AV series

For impact resistant tools

AG series

For high wear resistant tools

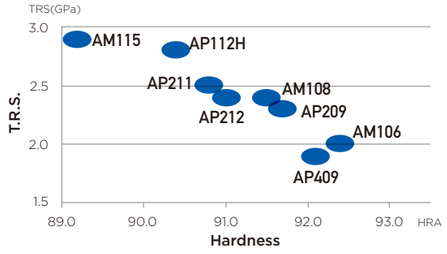
AK/AF series

For anti-corrosive tools

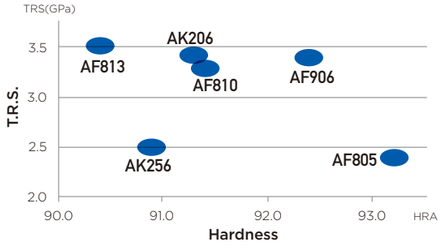
AE series

Grade Map

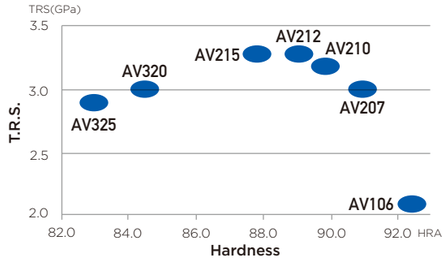
For general cutting tools (P & M grade)



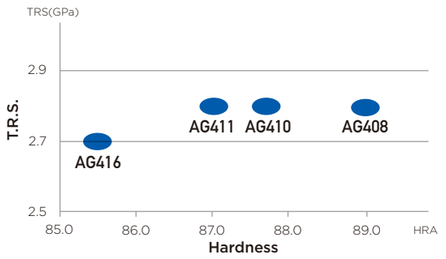
For general cutting tools (K grade)



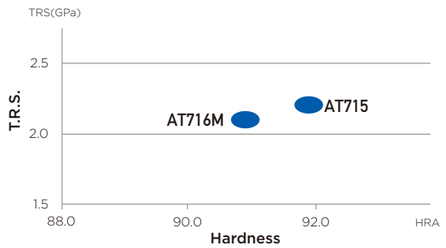
For wear resistant tools



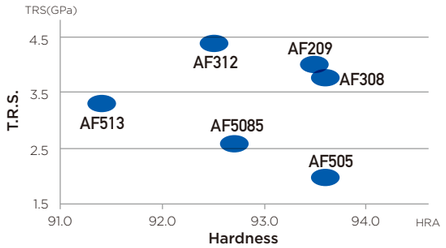
For impact resistant tools



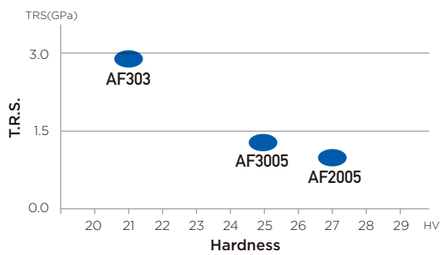
Cermet



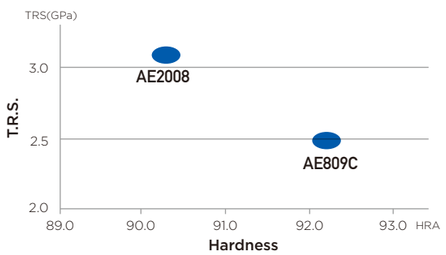
Micro & Ultra micro grain grade



For high wear resistant tools



For anti-corrosive tools



PRODUCT

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

Grade Property (Typical Value)

**By indentation method

Application	Classification	ISO Code	Grade	Specific Gravity	Grain Size	Binder Content		Hardness		T.R.S.	Fracture Toughness K1c **	Compressive Strength	Impact Strength	Young's Modulus	Thermal Conductivity (RT)	Thermal Expansion Coefficient
					(μm)	(wt%)		HRA	Hv(GPa)	(GPa)	(MPam$^{1/2}$)	(GPa)	(x10^{-4}GPa·m)	(GPa)	(W/(m·K))	(x10^{-6}/K) (~400°C)
For general cutting tools	P grade	P10	AP409	10.5	2.0	9.0		92.1	16.0	1.9	8.1	4.9		470	14	6.2
		P20	AP209	11.9	2.0	8.5		91.7	15.8	2.3						
		P30	AP211	11.7	3.4	11.0		90.8	14.9	2.5	9.1			520	30	
		P30	AP212	11.6	3.4	11.5		91.0	14.9	2.4	9.1			520		
		P40	AP112H	13.2	2.0	11.5		90.4	14.3	2.8						
	M grade	M10	AM106	12.9	2.0	5.5		92.4	16.9	2.0		5.9		460		
		M20	AM108	13.2	2.0	8.0		91.5	15.6	2.4	8.5				55	
		M40	AM115	13.2	1.4	15.0		89.2	12.9	2.9	11.5					
	K grade	K10	AF805	15.1	0.8	5.0		93.2	17.7	2.4*	6.3	6.1		650	109	4.7
		K10	AF906	14.9	0.9	6.0		92.4	17.3	3.4	6.5			640	105	4.5
		K10	AK256	14.8	2.5	6.0		90.9	15.4	2.5	8.5	5.7		620	105	
		K20	AK206	14.9	2.5	6.0		91.3	15.8	3.4				620	84	4.5
		K20	AF810	14.5	0.8	10.0		91.4	15.2	3.3*	9.9					
		K40	AF813	14.2	0.8	13.0		90.4	13.6	3.5	10.8					
	Cermet	P10	AT715	6.7		15.0		91.9	15.6	2.2	7.0					
		P30	AT716M	7.1		16.5		90.9	14.0	2.1	8.5					
For wear & impact resistant tools	Wear resistant tools	VM20	AV106	14.9	1.2	6.0		92.4	16.7	2.1	6.5					
		VM40	AV207	14.9	2.0	7.0		90.9	15.0	3.0	8.3	5.5	0.72	640	98	5.7
		VM50	AV210	14.7	2.0	10.0		89.8	13.7	3.2	10.3					
		VM60	AV212	14.3	2.0	12.0		89.0	13.1	3.3	13.5	4.8	0.81	580	96	6.3
		VM60	AV215	14.1	2.0	15.0		87.8	11.9	3.3	17.5	4.4	0.77	540	71	
		VC70	AV320	13.6	3.0	20.0		84.5	9.3	3.0	18.5		0.73			
		VC70	AV325	13.2	3.0	25.0		83.0	8.2	2.9	20.0	3.2	0.89	460	63	
	Impact resistant tools	VC40	AG408	14.9	3.3	8.0		89.0	12.9	2.8						
		VC50	AG410	14.6	4.0	9.5		87.7	11.8	2.8		4.5	0.47	520	76	
		VC60	AG411	14.5	4.0	10.5		87.0	11.2	2.8		4.3	0.62	520	76	
		VC70	AG416	14.0	4.0	15.5		85.5	10.2	2.7						
For special application	Micro fine grain	VF10	AF505	14.9	0.5	5.0		93.6	20.1	2.0*	6.7					
		VF20	AF5085	14.5	0.5	8.5		92.7	18.0	2.6	7.8			600		
		VF30	AF513	14.1	0.5	13.0		91.4	15.6	3.3*	8.6			560	42	
	Ultra micro fine grain	VF10	AF308	14.6	0.3	8.0		93.6	19.4	3.8	6.0				52	
		VF10	AF209	14.5	0.2	9.0		93.5	20.4	4.0	5.5					
		VF20	AF312	14.1	0.3	12.0		92.5	17.3	4.4	8.3			570	36	5.5
For high wear resistant tools		VF10	AF2005	15.5	0.2	0.5			27.0	1.0	3.5					
		VF10	AF3005	15.4	0.3	0.5			25.3	1.3	4.5					4.2
		VF10	AF303	15.2	0.3	3.0		94.2	21.0	2.9	5.4				56	4.5
For anti-corrosive tools			AE809C	14.3	0.8	9.5		92.2	16.9	2.5	8.0					
		NM40	AE2008	14.8	2.0	8.0		90.3	14.2	3.1	8.5	4.9	0.99	600	85	5.9

*These TRS values are different from the values described on page13.
If higher TRS value is required, please contact us.

PRODUCT

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

Application of each Grade

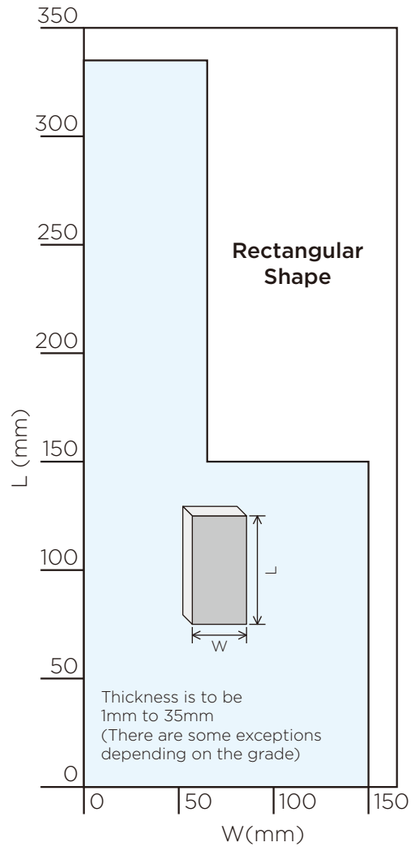
	Classification		Grade	Property		Application: General Cutting Tool (Work Material)					Ware resistant		Circular saw: Wood cutting		Circular saw: Metal cutting		Slitter & Blade			Die & Mold					Nozzle	Anti-corrosiveness
				T.R.S GPa	Hardness HRA	General steel	Cast iron	Stainless steel	Exotic material	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	Lens mold		
For general cutting tools	P grade	P10	AP409	1.9	92.1	○																				
		P20	AP209	2.3	91.7	◎		○																		
		P30	AP211	2.5	90.8	◎		◎							◎	◎										
		P30	AP212	2.4	91.0	○									○											
		P40	AP112H	2.8	90.4	○		○																		
	M grade	M10	AM106	2.0	92.4	○	○	○																		
		M20	AM108	2.4	91.5	○	○	○																		
		M40	AM115	2.9	89.2	○	○	○																		
	K grade	K10	AF805	2.4*	93.2		○											○								
		K10	AF906	3.4	92.4		◎			◎								◎								
		K10	AK256	2.5	90.9		◎		◎																	
		K20	AK206	3.4	91.3		○																			
		K20	AF810	3.3*	91.4		○		◎											◎	◎					
		K40	AF813	3.5	90.4		○													○	○					
	Cermet	P10	AT715	2.2	91.9	◎		◎																		
		P30	AT716M	2.1	90.9	◎		◎																		
For wear & impact resistant tools	Ware resistance	VM20	AV106	2.1	92.4						○										○	○				
		VM40	AV207	3.0	90.9						◎										◎	◎				
		VM50	AV210	3.2	89.8						◎										○	○	○			
		VM60	AV212	3.3	89.0						◎							○			◎	◎	◎			
		VM60	AV215	3.3	87.8						◎										○	○	◎			
		VC70	AV320	3.0	84.5						○												○			
		VC70	AV325	2.9	83.0						○												○			
	Impact resistance	VC40	AG408	2.8	89.0							◎											○			
		VC50	AG410	2.8	87.7							◎							○				○			
		VC60	AG411	2.8	87.0							◎							◎				○			
		VC70	AG416	2.7	85.5							◎							○				◎			
For Specific Purpose	Micro fine grain	Micro grain	AF505	2.0*	93.6	○					○						○	○								
			AF5085	2.6	92.7	○					○						○	○								
			AF513	3.3*	91.4						○						◎	○		○						
		Ultra micro grain	AF308	3.8	93.6						○						○	○								
			AF312	4.4	92.5						○						○	○		◎						
			AF209	4.0	93.5															○						
	Circular saw	P grade carbide	AP209H	2.1	91.7										○	○										
			AP211	2.5	90.8										◎	◎										
			AP211S	2.5	91.0										○	○										
			AP112	2.6	90.0										○	○										
			AP112S	2.4	90.4										○	○										
		Cermet	AT6010	2.3	92.4										◎	◎										
			AT616	1.8	92.1										○	○										
			AT6013	2.2	91.6										◎	◎										
			AT5016	2.5	91.1										◎	◎										
		K grade carbide	AK308	3.1	90.5								◎													
		High wear resistance	AK102	2.9	93.4									◎												
			AK202	2.9	92.8									○												
			AK203	2.5	92.0									○												
	High wear resistance		AF2005	1.0	—						○														◎	
			AF3005	1.3	—						○													◎	◎	
			AF303	2.9	94.2	○					○						○									
	Anti-corrosiveness		AE809C	2.5	92.2						○															◎
			AE2008	3.1	90.3						○															◎

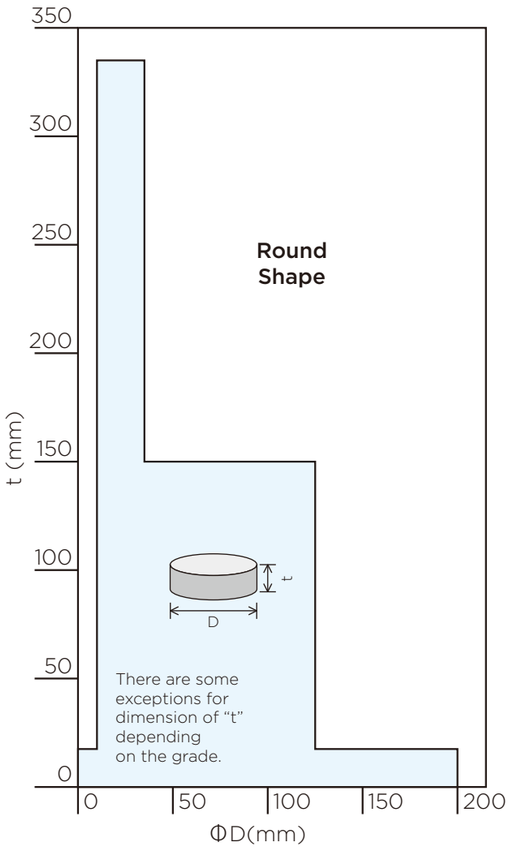
∗These TRS values are different from the values described on page13.
If higher TRS value is required, please contact us.

(—) Please refer to page 25
for the hardness of AF2005 & AF2005

◎:Most recommended
○:Recommended

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%

PRODUCT

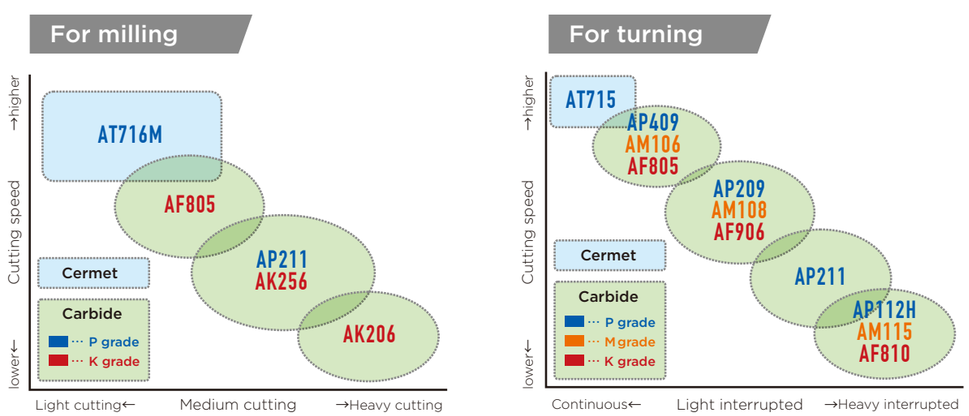
Blanks for various cutting tools, wear resistant tools, dies & molds

Blanks For General Cutting Tools

Application Example

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

Applicable Grades

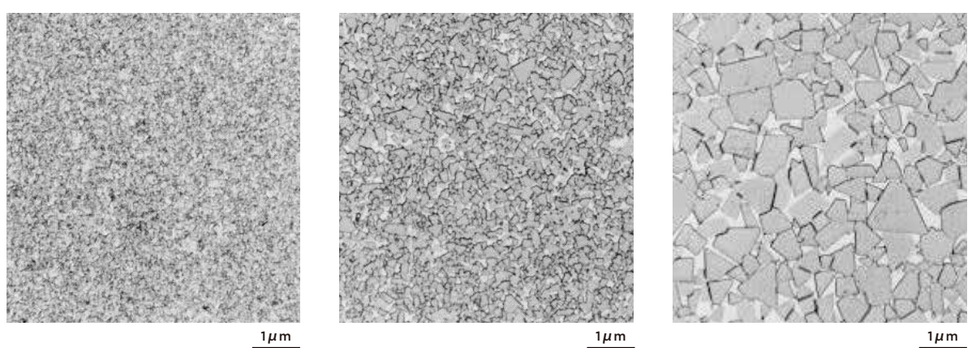


Blanks For Wear & Impact Resistant tools

Application Example

- Punches
- Die molds
- Sleeves
- Crushing tools
- Sliding parts

Microstructure of Typical Grades



Ultra micro grain
AF312

Medium grain
AV212

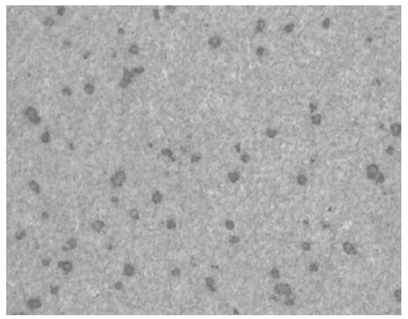
coarse grain
AG411

Blanks for Slitters & Blades

Application Example

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

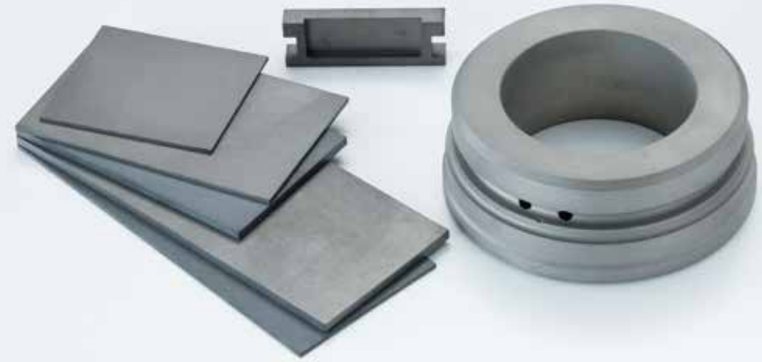
Microstructure of Typical Grades



AF513

Blanks for Die & Mold

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 AF312 which shows stable high efficiency



Ultra micro grain grade
AF312

This is the ultra micro grain grade with 0.3 grain which enables us to get sharp cutting edges.
AF312 has the extreme high TRS and hardness which bring a long tool life for precision die & molds.

Micro Grain Grade
AF810 / AF813

They are well balanced grades of both hardness and TRS, recommended for punches and dies.

General grades for wear resistant tools
AV106 / AV207 / AV210 / AV212 / AV215 / AV320 / AV325

The above shows general carbide grades for wear resistant tools.
It is a turn of AV106, AV207, AV210, AV212, and AV215 from abrasion resistant high one
Please choose the suitable grade depending on the requirement.

Grade for impact resistant tools
AG408 / AG410 / AG411 / AG416

They are grades to resist high impact force such as cold forging.
Please refer to the bellow chart to choose the suitable grade.

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	AF810		◎		◎	○	◎		◎		◎					
		AF813		○		○		○		○		○					
	Micro grain	AF505	○		○												
		AF5085	○		○												
		AF513	○		○												
	Ultra micro grain	AF308	○		○												
		AF312	◎		◎		◎										
		AF209	○		○												
Wear resistant grade	VM20	AV106								○		○				○	
	VM40	AV207								○		○			○	○	
	VM50	AV210														○	
	VM60	AV212							○		○		○	○			○
	VM60	AV215							○		○		○	○			○
	VC70	AV320															○
		AV325															○
Impact resistant grade	VC40	AG408															○
	VC50	AG410															○
	VC60	AG411															○
	VC70	AG416															○

◎:Most recommended
○:Recommended

PRODUCT

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

Binder-less Carbide Blanks for Lens Forming Mold

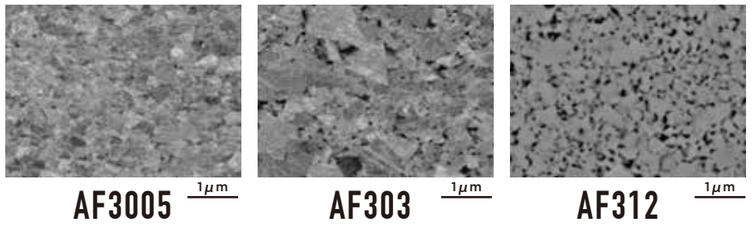
High hardness and high surface quality are realized adopting ultra micro gain WC and minimal Co content.

Grade Property

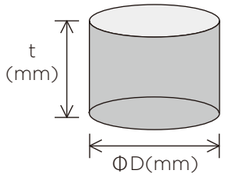
Grade		Grain size (μm)	Co content (wt%)	Specific gravity	Hardness HRA	Hardness Hv (GPa)	T.R.S. (GPa)	KIC (MPa m^1/2)	Thermal expansion coefficient(×10⁻⁶/°C) 400°C	600°C	800°C	Characteristics Hardness	Low thermal expansion	Surface quality	Grind ability
Minimal Co content	AF3005	0.3	0.5	15.4	—	25.3	1.3	4.5	4.2	4.5	4.8	◎	◎	◎	△
Low Co content	AF303	0.3	3	15.2	94.2	21.0	2.9	5.4	4.5	4.8	5.2	○	○	○	○
Ultra micro grain WC	AF312	0.3	12	14.1	92.5	17.3	4.4	8.3	5.5	5.8	6.3	△	△	◎	◎

Microstructure

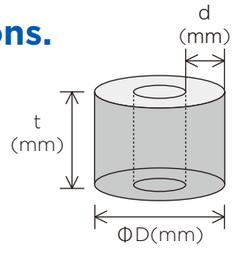
WC grain is grey and Co is black in the following photo.



Producible Blank Dimensions.



Round shape without hole:
D=Φ10～70mm
t≦20mm



Round shape with hole：
D=Φ10～70mm
Maximum thickness(t or d)≦20mm

■**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
AE2008

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

Anti-Corrosive Carbide
AE809C

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 AF2008 & AF809C

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

Type	Grade	Property S.G.	Property Hardness (HRA)	Property T.R.S. (GPa)	Corrosive resistance(Weight reduction by corrosion g/m2•Hr) 5%HCl 25℃24Hr	36%HCl 50℃8Hr	10%HNO3 25℃24Hr
Anti-corrosive nonmagnetic carbide	AE2008	14.8	90.3	3.1	0.15	0.49	0.07
Anti-corrosive carbide	AE809C	14.3	92.2	2.5	0.30	1.97	16.5
Ordinal Carbide for Comparison	AV212	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

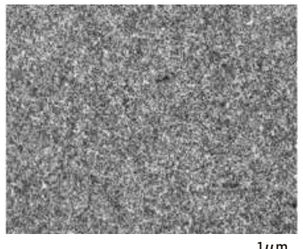
■ Water jet nozzle ■ Mold for glass lens ■ Sliding parts

Applicable Grade

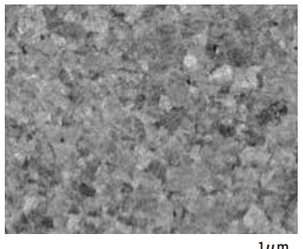
AF2005 / AF3005

	Co content (wt%)	Hardness HV(GPa)
AF2005	0.5	27.0
AF3005	0.5	25.3

Microstructure



AF2005

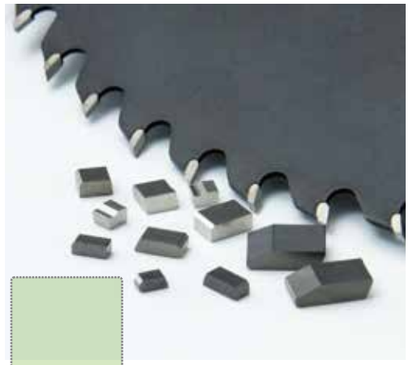


AF3005

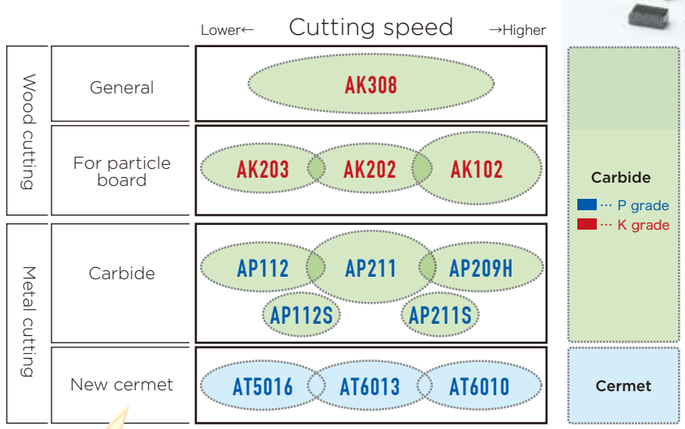
Carbide Saw Tip Blanks

Application

■ Metal cutting ■ Wood cutting
■ Particle board cutting



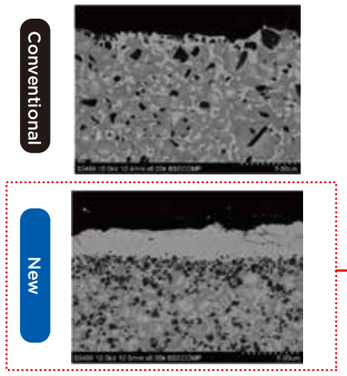
Applicable Grade



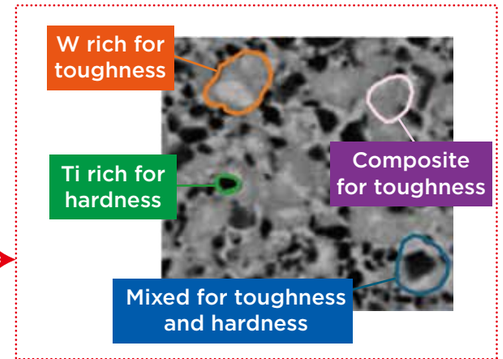
New cermet

Microstructure and physical properties are remarkably improved

□Microstructure



□Hybrid structure



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

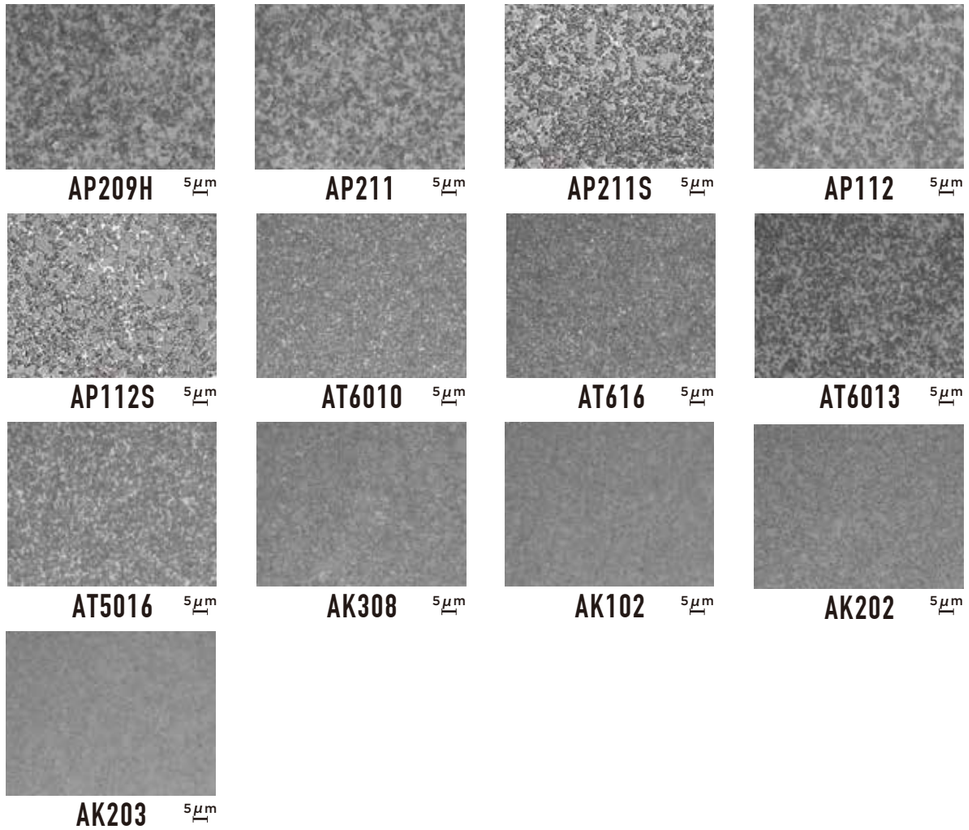
PRODUCT

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

Property of Tip Saw Carbide

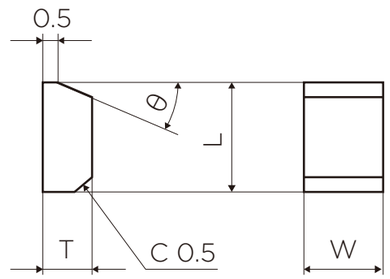
By indentation method

Classification	ISO code	Grade	S.G.	Grain size	Binder Content	Hardness		T.R.S.	Fracture toughness K1c	Young's modulus	Thermal conductivity (RT)
				(μm)	(wt%)	HRA	Hv(GPa)	(GPa)	(MPam$^{1/2}$)	(GPa)	(W/(m·K))
P grade carbide	P20	AP209H	12.1	3.4	9.0	91.7	16.1	2.1			
	P30	AP211	11.7	3.4	11.0	90.8	14.9	2.5	9.1	520	30
	P30	AP211S	11.8	3.4	11.0	91.0	14.8	2.5	8.8		
	P40	AP112	12.4	3.6	12.0	90.0	13.9	2.6	10.5		
	P40	AP112S	12.7	3.9	11.5	90.4	14.4	2.4	9.5		
Cermet	P20	AT6010	7.4		15.0	92.4	15.8	2.3	6.5		
	P30	AT616	7.2		15.5	92.1	14.5	1.8	8.0		
	P30	AT6013	7.5		19.0	91.6	14.5	2.2	7.5		
	P40	AT5016	7.3		21.5	91.1	14.5	2.5	8.0		
K grade carbide		AK308	14.6	2.4	8.0	90.5	14.3	3.1	9.7		
High wear resistance		AK102	15.3	1.4	2.0	93.4	19.4	2.9	5.2		92
		AK202	15.4	2.0	2.0	92.8	18.1	2.9	5.4		99
		AK203	15.3	2.0	3.0	92.0	16.8	2.5	6.0		122



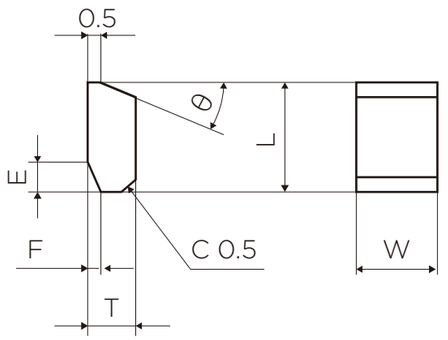
Description of Tip Saw Blanks

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°

W : 1.5 ~ 5.5

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

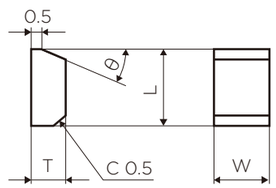
$4.9 < W \leqq 5.5\ ^{+0.2}_{-0}$

Available Dimensions for Tip Saw Blanks

SW Type (θ =0°)

No.	Description	Carbide grade L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade 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		2.00		5.00		2.00	
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	±0.1	5.00	±0.1	8.78	±0.1	4.88	±0.1
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°

W : 1.5 ~ 5.5

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

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

SWA Type (θ =10°)

No.	Description	Carbide grade L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade 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 L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade 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 L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade 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	

PRODUCT

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

Available Dimensions for Tip Saw Blanks

SWP Type (θ =0°)

No.	Description	Carbide grade L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade T		E		F	
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		0.5	
3	SWP 130 - 35 - W	13.49	±0.2	3.63		13.00	±0.2	3.50		2		0.5	

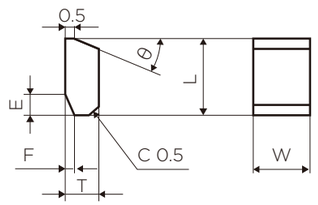
SWPA Type (θ =10°)

No.	Description	Carbide grade L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade T		E		F	
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 L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade T		E		F	
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°

W : 1.5 ~ 5.5

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

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

SWPC Type (θ =20°)

No.	Description	Carbide grade L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade T		E		F	
1	SWPC 40 - 18 - W	4.00	+0.3 -0.0	1.80	+0.2 -0.0	4.00	+0.3 -0.0	1.80	+0.2 -0.0	0.70	±0.15	0.30	±0.15
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		2.00		6.74		1.92		2.00		1.00	
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 L		Carbide grade T		Cermet & Fine grain grade L		Cermet & Fine grain grade T		E		F	
1	SWPD 45 - 15 - W	4.50	+0.3 -0.0	1.50	+0.2 -0.0	4.34	+0.3 -0.0	1.46	+0.2 -0.0	1.00	±0.15	0.50	±0.15
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		2.00		5.78		1.92		1.00		0.50	
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	

PRODUCT

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