fives

CITCO high-performance diamond & PcBN cutting tools



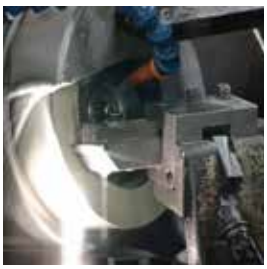
Custom engineered solutions for high productivity operations



With a strong foundation based upon the renowned CITCO name, Fives specializes in the design and supply of custom engineered PCD and PcBN tooling for boring, turning, grooving/parting and milling coupled with expert application engineering, product design capabilities and service support (on-site support, training and retooling).



Fives is a pioneer in proprietary superhard cutting technology, supplying CITCO tooling solutions for the world's toughest metal cutting and abrasive machining applications since 1939. As the largest manufacturer of custom engineered cutting tools in North America, highly skilled and experienced engineering team and worldwide customer base, Fives offers the most valuable technologies in the industry exceeding its customers' objectives in terms of precision, high-performance, reliability and return on investment.



From design to operation and throughout the product's lifecycle, Fives proposes ultimate cutting solutions and executes projects as an enterprising partner. It is a value-added resource, a culture of active listening, and decades of expertise and experience of understanding and adapting to customers' needs. Fives provides the foundation required for the next century of progress, and is committed to offering CITCO tools designed with the broadest range of the most advanced PCD and PcBN materials to precisely match the applications of the future.



UAMA UNIFIED ABRASIVES MANUFACTURERS' ASSOCIATION

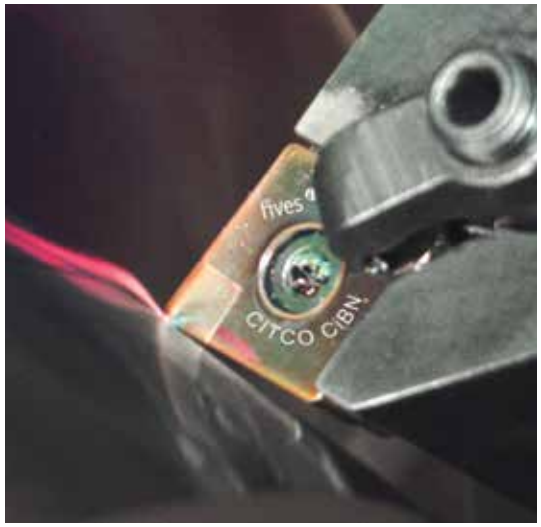
MEMBER INDUSTRIAL DIAMOND ASSOCIATION OF AMERICA, INC.

bsi. ISO 9001 Quality Management | ISO 14001 Environmental Management | OHSAS 18001 Occupational Health and Safety Management

Index

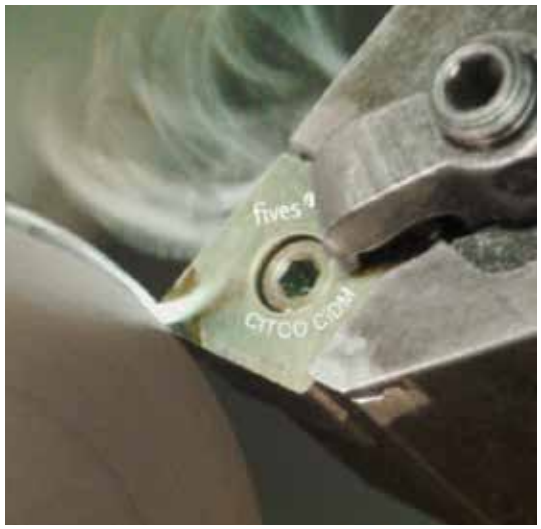
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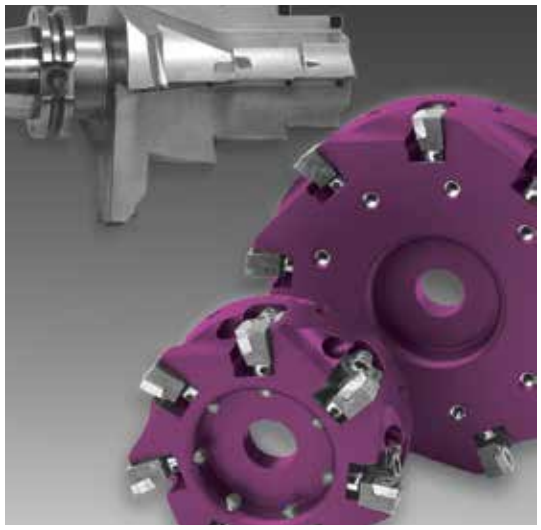
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CiBN™ PcBN cutting tools

Coated PcBN grades for hard turning applications

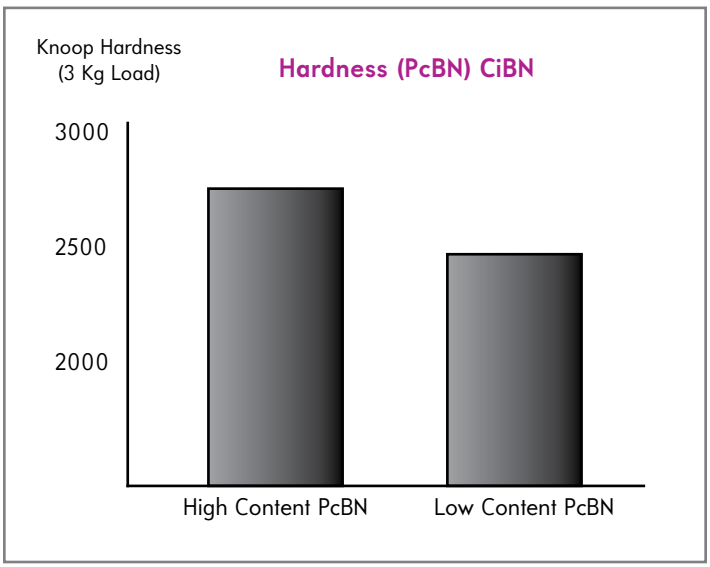
Polycrystalline Cubic Boron Nitride (PcBN)

Polycrystalline PcBN blanks are manufactured from cubic Boron Nitride crystals utilizing an advanced high temperature, high pressure process. The cubic Boron Nitride crystals are sintered together with a binder phase and integrally bonded to a tungsten carbide substrate. The binder phase, usually either a metallic or ceramic matrix, provides chemical stability enabling the PcBN qualities to be utilized in high speed machining environments.

By varying the binder phase and the percentage of cBN crystals, different grades are available. The various grades allow CITCO PcBN Cutting Tools to maximize your machining operations. Each grade of PcBN has distinct characteristics suitable for specific applications.

The Tungsten Carbide substrate in the PcBN blanks provides the high impact resistance necessary for the depths of cuts and high speeds associated with machining of hardened ferrous materials. PcBN cutting tools offer excellent heat dissipation and wear resistance. Cutting tool geometries can be prepared to withstand interrupted cuts with a T-land and/or hone to stabilize the cutting edge and prolong tool life.

Fives not only uses the highest quality PcBN materials available, but our cutting tools are fabricated with the most current, state-of the-art equipment and technology. Its professional applications and engineering staff can assist in developing cutting tools to meet your requirements. CITCO CiBN products can be fabricated for a broad range of applications, including turning, boring, facing, forming, milling, grooving, reaming, parting and fly cutting.



Polycrystalline Cubic Boron Nitride (PcBN)

- Can machine hardened steel parts vs. costly grinding processes.
- Obtains consistent fine surface finishes. Because of this, reduced polishing time may be realized.
- Productivity rates involving hard turning can easily be four (4) times higher than that of grinding the same parts.
- Resistance to abrasion is two (2) to five (5) times higher than ceramics and five (5) to ten (10) times that of coated carbide.
- In some cases coolants are eliminated altogether, which is environmentally friendly, and chip recycling can be recognized.
- Less capital equipment will be required due to productivity improvements.

Recommended Applications

HARD CAST IRONS
- Pumps
- Impellers
- Shafts
- Rolls

SOFT CAST IRONS
- Engine Blocks
- Brake Rotors
- Brake Drums
- Clutch Plates
- Transfer Housings

SINTERED IRONS
- Valve Seats
- Cam Shafts
- Gears

HARDEN STEELS
- Pinion Gears
- Side Gears
- Transmissions
- Shafts
- Bearings

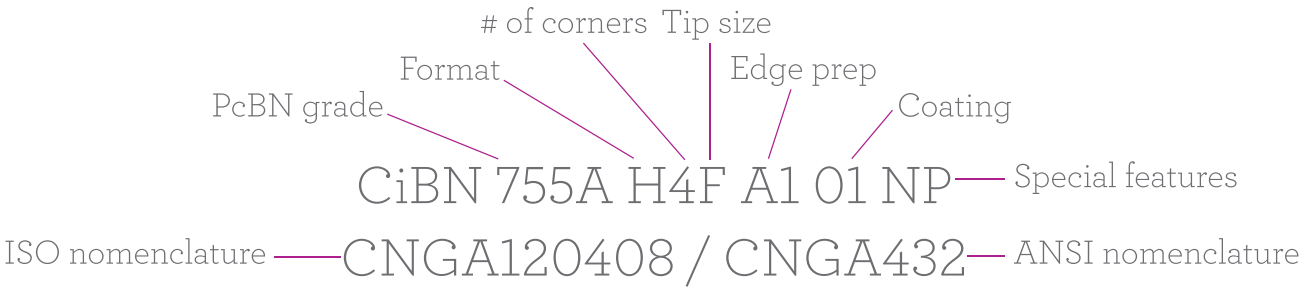
SUPER ALLOYS
- Turbine Disk
- Turbine Blade
- Turbine
- Shrouds
- Engines Shafts
- Turbine Vanes



Courtesy of Element 6

CITCO CiBN™ Series Chart

CiBN grade	Application	Application Class	Available Formats
CiBN 932	— Continuous turning of harden steel — Achieves super finishes	H05	Solid, tipped, hybrid, full top
CiBN 922	— Continuous to lightly interrupted turning of hardened steel	H10	Solid, tipped, hybrid, full top
CiBN 755	— General purpose hard turning grade — Continuous to moderate and slightly heavier interrupted turning of hardened steel	H15	Solid, tipped, full top
CiBN 654	— Moderate to heavy interrupted turning of hardened steels	H20	Tipped, full top
CiBN 566	— Moderate to heavy interrupted turning of hardened steels	H25	Solid, tipped, hybrid, full top
CiBN 467	— Heavily interrupted hard turning and hard miling of steel — For materials with higher abrasivity	H30	Solid, tipped, hybrid, full top
CiBN 379	— Interrupted machining of hardened steels, grey and hard cast irons, and high-alloy sintered irons and powder metals	H35	Tipped, full top
CiBN 287	— Turning and miling grey and hard cast iron, heavy turning of hardened steels	K900	Solid, tipped, hybrid, full top
CiBN 278	— Heavily interrupted turning of grey and hard cast iron	K901	Solid, tipped, hybrid, full top
CiBN 296	— Continuous turning of highly abrasive ferrous materials	K902	Solid, tipped, hybrid, full top
CiBN 193	— Continuous to lightly interrupted turning of highly abrasive ferrous materials	KP950	Solid, tipped, hybrid, full top



New CITCO CiBN™ HT Series

CiBN grade	Application	Application Class	Available Formats
CiBN 932	— Continuous turning of harden steel — Achieves super finishes	**H01 - H05**	Solid, tipped, hybrid, full top
CiBN 755	— Continuous to moderate and slightly heavier interrupted turning of hardened steel	**H10 - H15**	Solid, tipped, hybrid, full top
CiBN 566	— Moderate to heavy interrupted turning of hardened steels	**H20 - H25**	Solid, tipped, hybrid, full top
CiBN 467	— Heavily interrupted hard turning of hardened steels — For more abrasive materials	**H25 - H30**	Solid, tipped, hybrid, full top
CiBN 379	— Interrupted machining of hardened steels, grey and hard cast irons, and high-alloy sintered irons and powdered metals	**H30 - H35**	Tipped, full top

CITCO CiBN™ advantages

— Newest generation of PcBN grade formulations incorporating the latest advances in synthesis research
— Each grade is individually matched with high-performance coatings based on the latest HiPIMS PVD technology
— Both high density nano-structured mono-layers and multi-layer coatings are offered
— Best in industry manufacturing techniques are customized for each individual PcBN grade based on their properties and target applications
— The combinations of PcBN grade, coating, and manufacturing technique provides an excellent balance between chemical resistance and toughness, thus increasing the utility range of the insert
— The complete CiBN portfolio covers the entire range of application demands for hard turning

Available formats

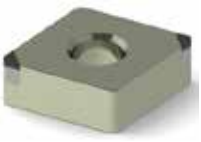
HYBRID



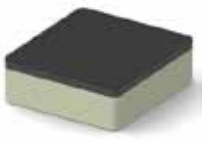
SOLID



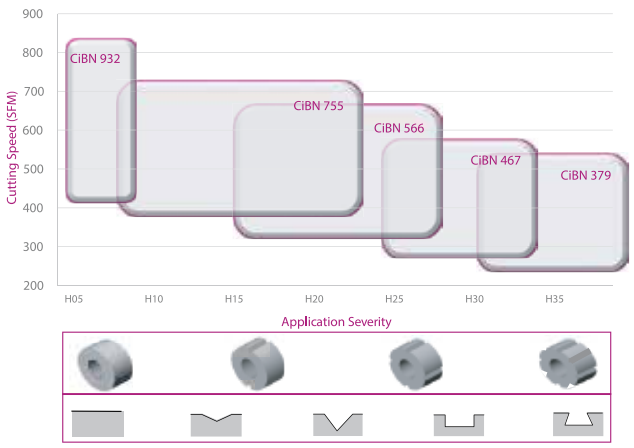
TIPPED



FULL TOP



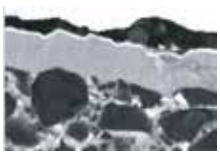
Application range



High density nano-structured coatings



— Multi-layer
— Tougher coating better suited for interrupted cutting



— Mono-layer
— Harder coating better suited for continuous cutting

CiBN™ PcBN Cutting Tools

Insert & Edge Geometry

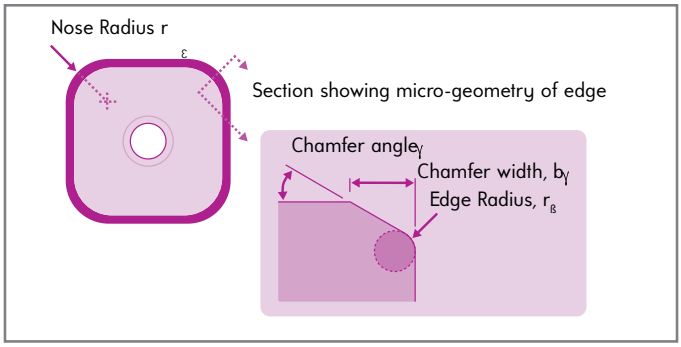
Insert geometry is often dictated by existing process specifications (e.g. turning, grooving, shoulder machining, profile-turning) or by the existing tool holders in the machine. For ISO insert styles, it is generally accepted that, for a given inscribed circle, insert strength increases as a function of shape — in the order: V, D, C, S, R. The insert style CNMA1204 is the single most popular style for PcBN inserts.

For finish turning operations, cutting takes place principally on the nose radius of the tool and the insert shape is generally not too critical in terms of the tool's resistance to fracture. Where the insert nose radius is not already dictated, it should be selected with two considerations in mind: workpiece surface roughness and in-process cutting forces. For finish turning operations, the tool nose radius, along with the depth of cut and feed, determine the cross-sectional shape of the chip to be removed, and both the shape of the chip and the workpiece material properties dictate the forces that are generated.

While a more negative chamfer provides for a stronger edge, it also increases the cutting forces, and, in particular, the thrust force, so greater deflection of the workpiece may be expected. For more heavily interrupted cutting operations, more negative chamfers are sometimes used.

While chamfer widths tend to be standardized, a meaningful method of determining the required chamfer width for a given tool nose radius, feed and depth of cut is to use a dimension equal to twice the maximum un-deformed chip thickness.

The use of edge hones provides a similar strengthening effect as a chamfer, however, when selecting the size of the edge hone, one should be mindful of the un-deformed chip cross-sectional shape. Where the chip being formed is very thin, the presence of a large edge hone provides for a highly negative cutting geometry and this can promote "chatter" (regenerative cutting vibrations).



Insert Coatings

Fives' engineers to recommend the correct coating whenever the benefits are warranted. Following are descriptions of the most common coating materials and applications.

TiN coating is used as a cosmetic feature to show wear patterns on multi-tipped PcBN inserts or solid inserts. This is an easy visual reference to indicate which tip, tips or corners on an insert have been used, so indexing to a new or unused corner is easy to recognize.

TiAlN coating is applied to add lubricity. The coating directly above the cutting point vaporizes almost immediately upon cutting. This leaves the PcBN edge exposed to do its desired function on hardened steel. The coating does not do any of the cutting, but it protects the PcBN material from flank wear and cratering. Thus, it extends the parameters at which the PcBN will work, and protects against speed related issues.

Tips for Machining with CiBN™ Polycrystalline Cubic Boron Nitride (PcBN)

- It is essential for machines using PcBN products to be rigid and solid
- Overhang of the tool holder to be kept to a miniumum
- Tool height to be on center line
- Make certain tool holder is clean and free of debris before seating PcBN inserts. Don't stop machine while tool is in cut - this will result in tool breakage
- Don't use coolant on interrupted cuts when using PcBN cutting tools
- Handle PcBN cutting tools with care. Micro chipping can occur if contacted with a hard surface prior to machine operation

Workpiece Material	Operating Conditions	
	Speed (ft./min.)	Feed (in./rev.)
Hardened Steels	400 - 500	.004 - .008
Grey Cast Irons <240 HBN >240 HBN	 1500 - 3500 1000 - 2000	 .010 - .020 .010 - .020
White Alloy Cast Iron	300 - 600	.010 - .030
Super Alloys	500 - 1000	.004 - .010
Powder Metal	300 - 1000	.003 - .008
Thermal Spray	500 - 1000	.003 - .008
Bearing Steels	375 - 500	.002 - .008

Designations & Composition of Common Steels

	Typical Chemical Composition Wt%												
	AISI/SAE	C	SI	Mn	P	S	Cr	Cu	Mo	NI	V	Co	W
Case Hardened Steels	1016 5115 5120 8620 E 9315	0.16 0.16 0.2 0.2 0.16	 0.25 0.25 0.25 0.28	0.75 0.8 0.8 0.8 0.55	0.3 0.3 0.3 0.3 0.025	0.05 0.04 0.04 0.04 0.025	 0.8 0.8 0.5 1.2	 0.35 0.35 0.35	 0.06 0.06 0.2 0.12	 0.25 0.25 0.55 3.25			
Bearing	5130 5140 5160 50100 52100	0.31 0.41 0.6 1.04 1.03	0.25 0.25 0.25 0.25 0.5	0.8 0.8 0.85 0.35 0.4	0.03 0.03 0.03 0.025 0.025	0.04 0.04 0.04 0.025 0.025	0.95 0.8 0.8 0.5 1.45	0.35 0.35 0.35	0.6 0.6 0.6	0.25 0.25 0.25			
Cold Work Tool Steel Steels	L3 D2 D3 A2 01	1.03 1.5 2.18 1 0.9	0.3 0.4 0.35 0.3 0.3	0.4 0.4 0.35 0.6 1.15			1.5 12 12 5.13 0.5		0.95 0.8 1.15 2.5		0.2 0.8 0.8 0.4 0.2	0.6	 0.75 0.5
Hot Work Tool Steel	H10 H11 H12 H13	0.4 0.35 0.35 0.35	1 1 1 1	0.48 0.3 0.3 0.3	0.03 0.03 0.03 0.03		3.38 5.13 5.13 5.13		1.5 1.5 1.5 0.2		0.5 0.4 0.3 1		 1.35
Alloy Steels	4130 4140 4320 4340	0.31 0.41 0.2 0.41	0.25 0.25 0.25 0.25	0.5 0.88 0.55 0.7	0.03 0.03 0.03 0.03	0.04 0.04 0.04 0.04	0.95 0.95 0.5 0.8	0.35 0.35 0.35 0.35	0.2 0.25 0.25	0.25 0.25 1.8 1.8			
Plain Carbon Steels	1020 1040 1045 1050	0.21 0.41 0.47 0.52		0.45 0.75 0.75 0.75		0.05 0.05 0.05 0.05							

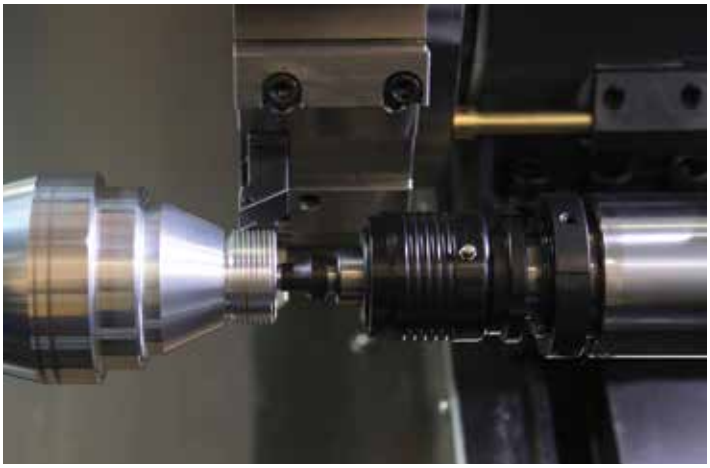
CiBN™ PcBN Tools

	AISI/SAE	DIN	W-NR	JIS
Case Hardened Steels	1016 5115 5120 8620 E 9315	15Mn3 16Mn3 20Cr4 20NiCrMo2-2 14NiCr14	1.0419 1.7131 1.7027 1.6523 1.5752	SWRCH16A SMnC21H SMnC21 SNC815H
Bearing	5130 5140 5160 50100 52100	28Cr4 38Cr2 60MnCrB3 100Cr2 100Cr6	1.703 1.7003 1.7137 1.3501 1.3505	SCR440M
Cold Work Tool Steel Steels	L3 D2 D3 A2 01	102Cr6 X153CrMoV12 Z210Cr12 X10CrMoV5 100MnCrW4	1.2067 1.2379 1.2080 1.2363 1.251	SUJ2 SKD10 SKD1 SKD12 SKS21
Hot Work Tool Steel	H10 H11 H12 H13	32CrMoV12-28 X38CrMoV5-1 X37CrMoW5-1 X40CrMoV5-1	1.2365 1.2343 1.2606 1.2344	SKD7 SKD6 SKD61
Alloy Steels	4130 4140 4320 4340	25CrMo4 42CrMo4 15CrNi6 40NiCrMo6	1.7218 1.7225 1.5919 1.6565	SCM420;SCM430 SCM440 SNCM420 SNCM4239
Plain Carbon Steels	1020 1040 1045 1050	C22 C40 C45 C50	1.0402 1.0511 1.0503 1.054	S20C S40C S45C S50CM

CiDM PCD Cutting Tools

Polycrystalline Diamond (PCD)

CiDM Polycrystalline Diamond (PCD) is the product of sophisticated high-pressure, high-temperature technology in which carefully selected synthetic diamond particles are sintered together in a cobalt matrix. The random orientation of the diamond particles produces a highly uniform hardness and resistance to abrasion in every direction. This polycrystalline diamond layer is integrally bonded by an advanced process to a super tough tungsten carbide substrate which provides strength and permits joining with other metals.



Consistent quality and repeatability is a major advantage of CiDM. Its uniform hardness, combined with the toughness and shock resistance of the carbide substrate permit exceptionally high cutting speeds on nonmetallic materials and nonferrous metals.

Like its counterpart PcBN, PCD also has different grades for specific applications. The different grades are recognized by the sized diamond particles. Larger particles give the cutting tool superior abrasion resistance while the smaller particles allow better finishes to be obtained. By utilizing the correct grade, you can control the surface finish necessary throughout the machining process and receive optimum tool life. PCD is used for nonferrous materials and abrasive nonmetallics. In wear part applications, PCD may be used with all materials.

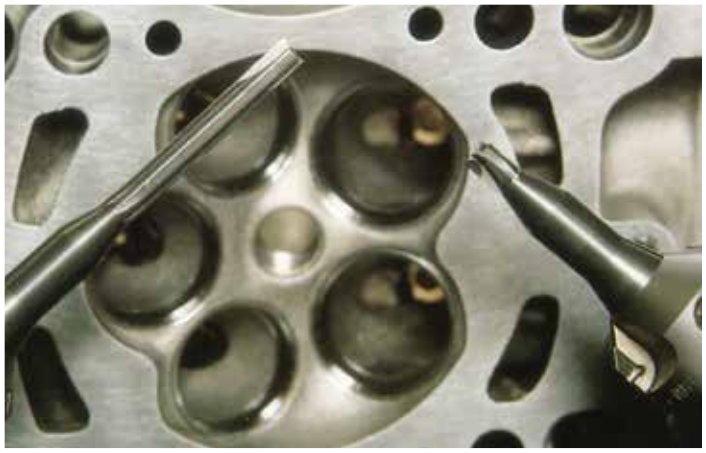
Recommended Applications

Abrasive Nonmetallics

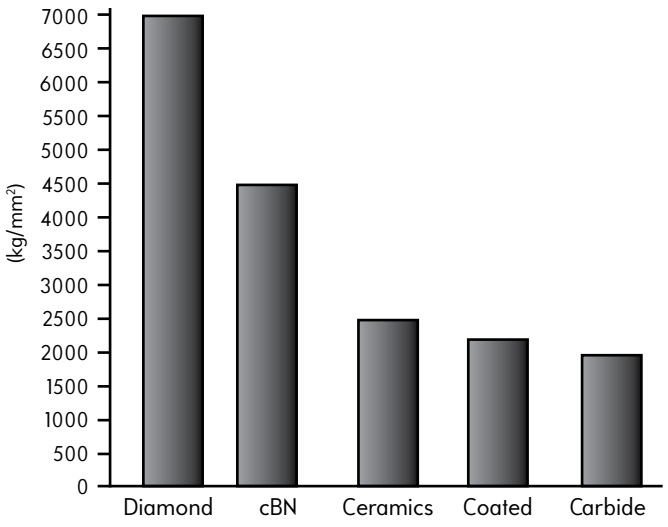
- Carbon
- Ceramics
- Fiberglass
- Composites
- Graphite
- Plastics
- Rubber
- Wood

Nonferrous Metals

- Aluminum
- Aluminum Alloys
- Brass Alloys
- Bronze Alloys
- Copper
- Copper Alloys
- Precious Metals
- Magnesium Alloys
- Presintered Tungsten Carbide



Physical Properties of Cutting Tool Materials



CiDM PCD Cutting Tools

Tips for Machining with CiDM

— Rigid setups and tool holders are recommended. Vibration or chatter will reduce tool life.
— Use of coolant will reduce heat and improve surface finish.
— Higher speeds minimize material build up and reduce heat.
— Use correct tool geometry to eliminate rubbing.
— Perform milling operations in a climb mode when using PCD inserts to optimize tool life.
— Depth of cut should not exceed 70% of PCD segment length.
— Handle PCD cutting tools with care. Micro chipping can occur if contacted with a hard surface prior to machine operation.

Workpiece Material	Speed (ft./min.)	Feed (in./rev.)
Aluminum Alloys		
– 4% - 8% Si	4200 - 10,000	.004 - .015
– 9% - 14% Si	3300 - 5200	.004 - .015
– 16% - 18% Si	1000 - 2300	.004 - .015
Copper Alloys	2000 - 3300	.002 - .008
Plastics/Composites	1000 - 3300	.004 - .012
Sintered Tungsen Carbide	65 - 130	.006 - .010
Manufactured Wood	3300 - 9800	.004 - .015

Problem	Possible Cause	Suggested Action
Rapid Wear	Improper grade	Change to coarser grade PCD
Edge buildup	Slow speed	Increase cutting speed
Poor surface finish	Improper grade	Change to finer grade PCD
Edge chipping	Poor rigidity	Minimize vibration, check set-up
	Operating conditions	Review from proper speeds and feeds

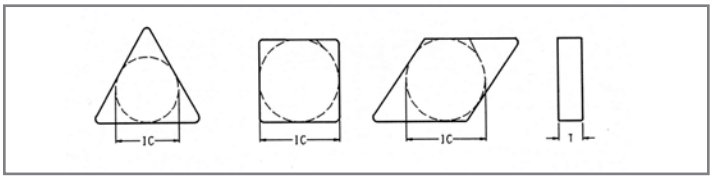
Abrasive grain types

Many custom or special CiDM (diamond based) and CiBN (PcBN) products can be manufactured by Fives' highly skilled workforce to your specifications. By providing a detailed blueprint or sample tool, Fives' engineering staff can provide the correct superhard cutting tool for you, including products like drills, reamers, gun drills, piston and standard groove tools, wear parts and intricate form tools.

— Reamers
— Drills
— Gundrills
— Special Groovers
— Wear Pads, etc.



Standard Inserts



ANSI	C	N	M	A	4	3	2	–	–
ISO	C	N	M	A	12	04	08	–	–
Position	1	2	3	4	5	6	7	8	9

Position 1:
Insert Shape

Insert Shape	Symbol	Shape	Nose Angle
	S	Square	90°
	T	Trianlge	60°
	C D V	Rhombic (Diamond)	80° 55° 35°
	H	Hexagonal	120°
	R	Round	–

Position 2:
Relief Angle

Symbol	Angle
N	0°
C	7°
P	11°
D	15°
E	20°
F	25°

Position 3:
Tolerances

Tol Class	Tol on IC IN	Tol on B IN	Tol on T IN
C	±.0010	±.0005	±.001
H	±.0005	±.0005	±.001
E	±.0010	±.0010	±.001
G	±.0010	±.0010	±.005
M	±.002/ ±.005	±.003/ ±.006	±.005

Position 4:
Insert Type

Symbol
N
A
G
W
T
H
X

Position 5:
Insert Size

Inch	IN	MM
1.2(5)	5/32	3.97
1.5(6)	3/16	4.76
1.8(7)	7/32	5.56
2	1/4	6.35
2.5	5/16	7.94
–	.315	8.00
3	3/8	9.52
–	.394	10.00
3.5	7/16	11.11
4	1/2	12.70
4.5	9/16	14.29
5	5/8	15.88
6	3/4	19.05

Position 6:
Thickness

Size	ANSI	ISO
.062	1	01
.093	1.5	02
.125	2	03
.156	2.5	T3
.187	3	04
.218	3.5	05
.250	4	06
.312	5	07
.375	6	09

Position 7:
Corner Radius

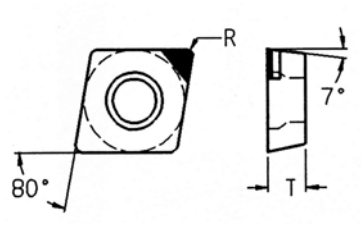
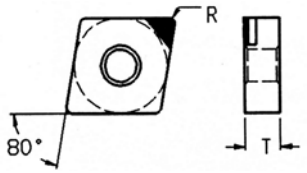
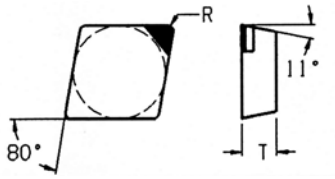
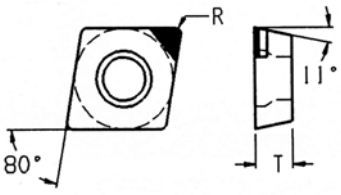
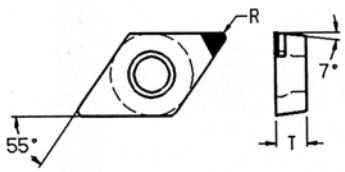
Corner Radius	Symbol	
IN	ANSI	ISO
.004	0	01
.008	0.5	02
1/64	1	04
1/32	2	08
3/64	3	12
1/16	4	16
5/64	4	20
3/32	6	24
7/64	7	28
1/8	8	32

Position 8: Material PCD (D) or PcBN (B)

Position 9: Grade of PCD or PCDN Material Applied to insert

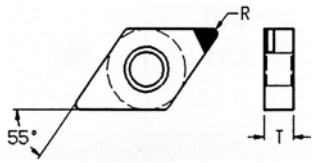
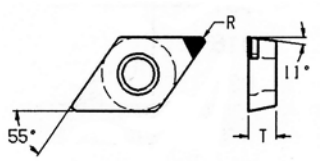
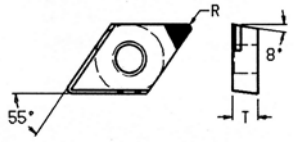
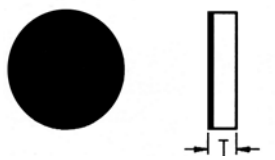
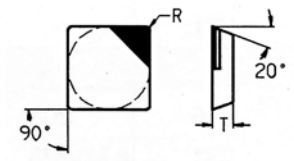
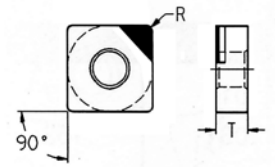
Example: CMNA432D

Standard Inserts

Insert Style	Catalog Number	IC	T	R	H
CCGW 	CCGW2150	.250	.094	.004	.110
	CCGW2151	.250	.094	.016	.110
	CCGW2152	.250	.094	.031	.110
	CCGW3250	.375	.156	.004	.173
	CCGW3251	.375	.156	.016	.173
	CCGW3252	.375	.156	.031	.173
CNGA 	CNGA431	.500	.1875	.016	.203
	CNGA432	.500	.1875	.031	.203
	CNGA433	.500	.1875	.047	.203
CPG 	CPG421	.500	.125	.004	–
	CPG422	.500	.125	.016	–
	CPG423	.500	.125	.031	–
CPGW 	CPGW2150	.250	.094	.004	.110
	CPGW2151	.250	.094	.016	.110
	CPGW2152	.250	.094	.031	.110
	CPGW3250	.375	.156	.004	.173
	CPGW3251	.375	.156	.016	.173
	CPGW3252	.375	.156	.031	.173
DCGW 	DCGW2150	.250	.094	.004	.110
	DCGW2151	.250	.094	.016	.110
	DCGW2152	.250	.094	.031	.110
	DCGW3250	.375	.156	.004	.173
	DCGW3251	.375	.156	.016	.173
	DCGW3252	.375	.156	.031	.173

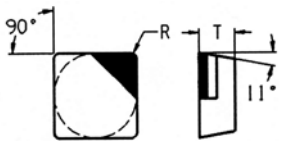
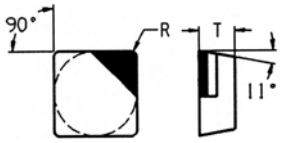
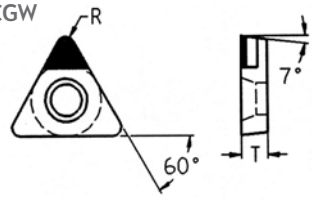
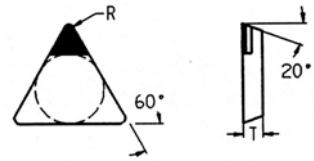
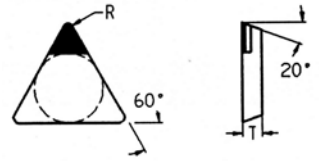
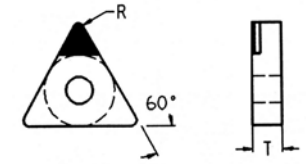
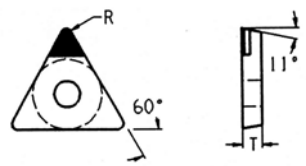
PCD/PcBN TIP LENGTH = APPROX .150

Standard Inserts

Insert Style	Catalog Number	IC	T	R	H
DNGA 	DNGA431	.500	.1875	.016	.203
	DNGA432	.500	.1875	.031	.203
	DNGA433	.500	.1875	.047	.203
DPGW 	DPGW2150	.250	.094	.004	.110
	DPGW2151	.250	.094	.016	.110
	DPGW2152	.250	.094	.031	.110
	DPGW3250	.375	.156	.004	.173
	DPGW3251	.375	.156	.016	.173
	DPGW3252	.375	.156	.031	.173
DTGA 	DTGA432	.500	.1875	.031	.203
	DTGA433	.500	.1875	.047	.203
RNG 	RNG32	.375	.125	–	–
	RNG42	.500	.125	–	–
	RNG43	.500	.1875	–	–
SEC 	SEC421	.500	.125	0.16	–
	SEC422	.500	.125	.031	–
SNGA 	SNGA431	.500	.1875	.016	.203
	SNGA432	.500	.1875	.031	.203
	SNGA433	.500	.1875	.047	.203

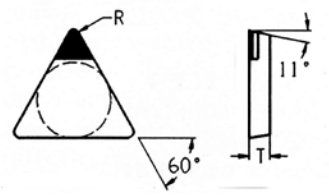
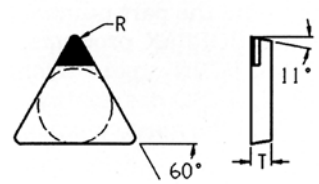
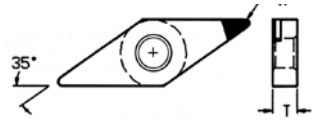
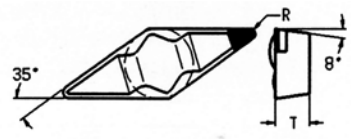
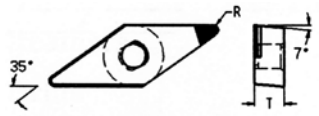
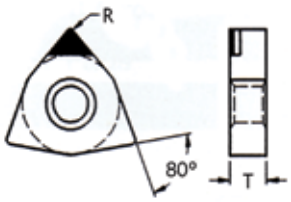
PCD/PcBN TIP LENGTH = APPROX .150

Standard Inserts

Insert Style	Catalog Number	IC	T	R	H
SPCE 	SPCE731	.2187	.094	.016	–
	SPCE732	.2187	.094	.031	–
SPG 	SPG321	.375	.125	.016	–
	SPG322	.375	.125	.031	–
	SPG421	.500	.125	.016	–
	SPG422	.500	.125	.031	–
TCGW 	TCGW2150	.250	.094	.004	.110
	TCGW2151	.250	.094	.016	.110
	TCGW2152	.250	.094	.031	.110
	TCGW3250	.375	.156	.004	.173
	TCGW3251	.375	.156	.016	.173
	TCGW3252	.375	.156	.031	.173
TD 	TD6P	.375	.125	.031	.125
	TD7P	.4375	.125	.031	.125
TEC 	TEC2521	.3125	.125	.016	–
	TEC2522	.3125	.125	.031	–
	TEC321	.375	.125	.016	–
	TEC322	.375	.125	.031	–
TNGA 	TNGA431	.500	.016	.016	.203
	TNGA432	.500	.031	.031	.203
	TNGA433	.500	.047	.047	.203
TP 	TP41	.250	.094	.016	.137
	TP61	.375	.125	.031	.163

PCD/PcBN TIP LENGTH = APPROX .150

Standard Inserts

Insert Style	Catalog Number	IC	T	R	H
TPEE 	TPEE731	.2187	.094	.016	–
	TPEE732	.2187	.094	.031	–
	TPEE631	.1875	.094	.016	–
	TPEE521	.1562	.0625	.016	–
TPG 	TPG221	.250	.125	.016	–
	TPG222	.250	.125	.031	–
	TPG2521	.3125	.125	.016	–
	TPG2522	.3125	.125	.031	–
	TPG321	.375	.125	.016	–
	TPG322	.375	.125	.031	–
	TPG333	.375	.125	.047	–
VNGA 	VNGA331	.375	.1875	.016	.150
	VNGA332	.375	.1875	.031	.150
	VNGA333	.375	.1875	.047	.150
VPGR 	VPGR332	.375	.1875	.031	–
	VPGR333	.375	.1875	.047	–
VTGA 	VTGA332	.375	.1875	.031	.150
WNMA 	WNMA431	.500	.1875	.016	.203
	WNMA432	.500	.1875	.031	.203
	WNMA433	.500	.1875	.047	.203

PCD/PcBN TIP LENGTH = APPROX .150

Custom Round Tools

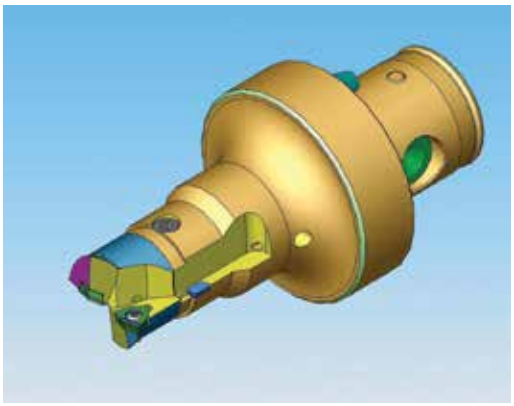
PCD- & PcBN-Tipped Custom Round Tools

Fives offers a comprehensive line of CITCO high-precision, PCD and PcBN-tipped custom round tools for milling, drilling and reaming with the industry's fastest available delivery. Powerful, highly efficient design-and-manufacture software enables Fives' engineers to rapidly create precision tool designs and models using information from the customer's part print, and then write NC-CAM programs for fabricating the tools. Tool designs are optimized for PCD and PcBN cutting applications using Fives' vast experience in designing CITCO tools.

Fives' highly accurate round tools with fixed, brazed tips of polycrystalline diamond (PCD) or polycrystalline cubic boron nitride (PcBN) are ideal for small-diameter machining applications (approximately 0.25" diameter and larger) where space is a restriction for insert-type cutting tools. CITCO round tools are also suitable for applications that have 3 – 5 micron tolerances on diameter, for example. Achieving such tolerances with inserted-type cutting tools is difficult because of the possibility of cutting edge movement. Presetting of multiple-tipped inserted cutter-bodies is also time-consuming and requires a high skill level.

Fives can design and fabricate CITCO PCD- and PcBN-tipped round tools in sizes from approximately 0.25" diameter and larger, with all popular spindle shank styles.









PCD Drills

CITCO PCD drills

The exclusive high-performance CITCO PCD drills are developed specifically to meet the requirements of today's precision production drilling applications. CITCO solid PCD tipped drills are multi-application, high performance drills that provided high-capacity utilization, flexibility and versatility, ideal for machining composites as well as stacked materials.

Tooling advantages

- Tungsten carbide drill body with a PCD drill point
- Diameter range from 1.5mm up to 19mm is available with no limitations in length
- Engineered point geometry for reducing cutting force, avoiding delaminations
- Boost stability and reduce deflection
- Maintain precision tolerances while increasing productivity
- Reconditioning service offered

Application

- Optimized for composite material and non-ferrous metals
- Capable of drilling CFRP and GFRP materials
- Use for high demanding hole quality
- Tool specifications
- Fractional, Number, Metric, Letter Types
- Standard and non-standard lengths
- Custom tip geometries for stacked and composite materials

Tool specifications

- Fractional, Number, Metric, Letter sizes
- Standard and non-standard lengths
- Custom tip geometries for stacked and composite materials

Reconditioning service offered

- Fast turnaround
- No drop in tool life



Milling Cutters

High Speed Milling Cutters Designed to Meet and Exceed Your Needs

Fives designs and supplies compelling technologies that are designed to exact customer specifications without comprising quality and productivity through a one-size-fits all design approach.

Its capabilities to customize designs allow it to propose the most valuable solutions that deliver ultimate productivity in specific customer applications.

The CITCO custom milling cutter program includes:

- Lightweight aluminum or super-tough steel bodies
- PcBN or PCD inserts for steel, aluminum, or composite workpieces
- Endmill, facemill, shell mill, in any geometry you need
- Large, small, or sizes in between

Key features include:

- All clamps and adjusting screws are captivated for safety
- Drive-key locking screws designed for no backlash on acceleration and braking

Adjustable balance screws:

- Radial and Axial adjustment for zero tracking and longer tool life
- High-tensile aluminum alloy cutters with hardened steel insert for shell mill adaptor location

Available in (3) sizes:

- 4" — LVC04-07
- 6" — LVC06-09
- 8" — LVC08-15



Machining Formulæ & References

RPM X DIAM X .26218 = SFPM

SFM= RPM X DIAM DIV 3.82

RPM = 3.82 x SFPM DIV. BY DIAM.

In x 25.4 = mm

Ft x .305 = m

mm x .039 = in

m x 3.28 = ft

IPM = IPT x #Teeth x RPM

IPT = IPM/(#Teeth x RPM)

Micron = 0.000039

2 = 0.000078

3 = 0.000118

4 = 0.000157

5 = 0.000196

6 = 0.000236

7 = 0.000275

8 = 0.000314

9 = 0.000354

10 = 0.00039

100 = 0.0039

.5mm = 0.0197

MM = .03947

Divide SFPM by 196.85 = meter per second

Contact Us

Fives Landis Corp. (CITCO tool products)
7605 Discovery Lane - Concord Twp., OH 44077 - USA
T: +1 440 709 0700 - F: +1 440 709 0710
Email: citcoinfo@fivesgroup.com

fives ultimate machines ultimate factory

www.fivesgroup.com

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