Advanced Engineering

New Product News No.1102E-1
2016-4

Epoch® CBN End Mill series

Epoch®
CBN Super Ball End Mill CBN-EPSB
CBN Super Radius End Mill CBN-EPSR

Epoch® CBN Super Radius

Size expanded to a total of 46 items!

Additional corner R size for machining of fine corners, Full lineup of short under neck lengths with high rigidity

Flute shape with low cutting force provides high-quality machined surface roughness!

Employs low-resistance, high-rigidity geometry

Actual measured mill diameter value shown.

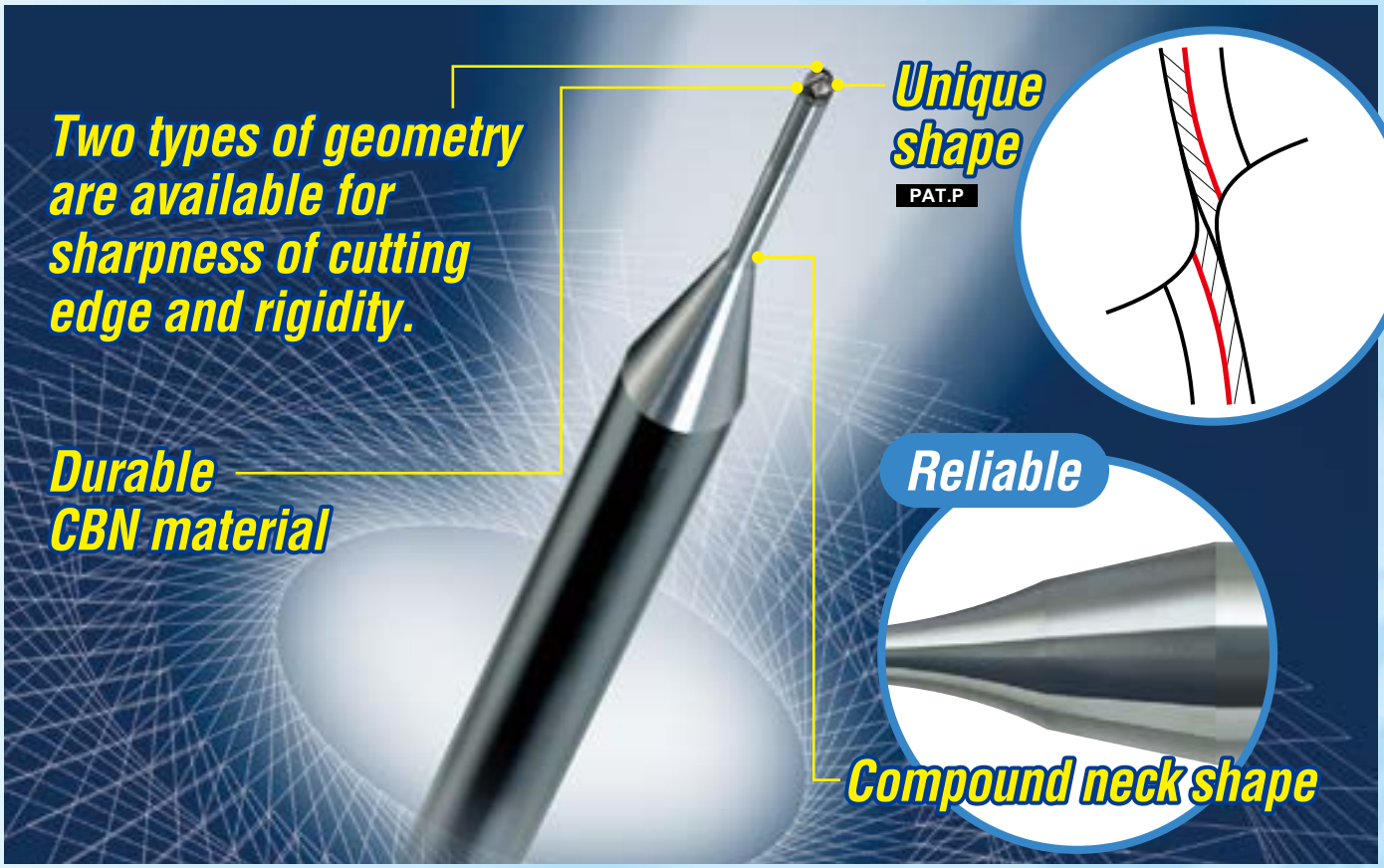
初校
2016.3.16
校正担当：川畑・青木・羽山

EPOCH

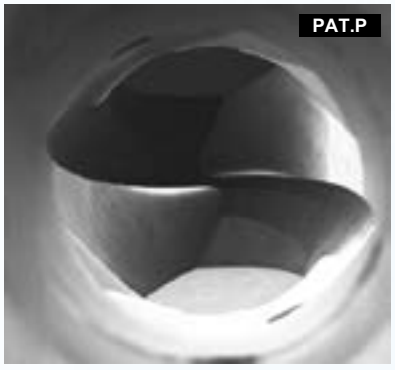
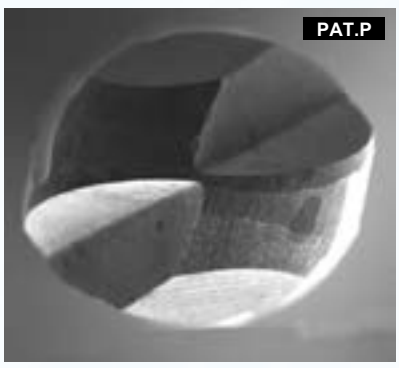
Mitsubishi Hitachi Tool Engineering, Ltd.

Achieves both strength and

Features of
Epoch® CBN Super Ball End Mill



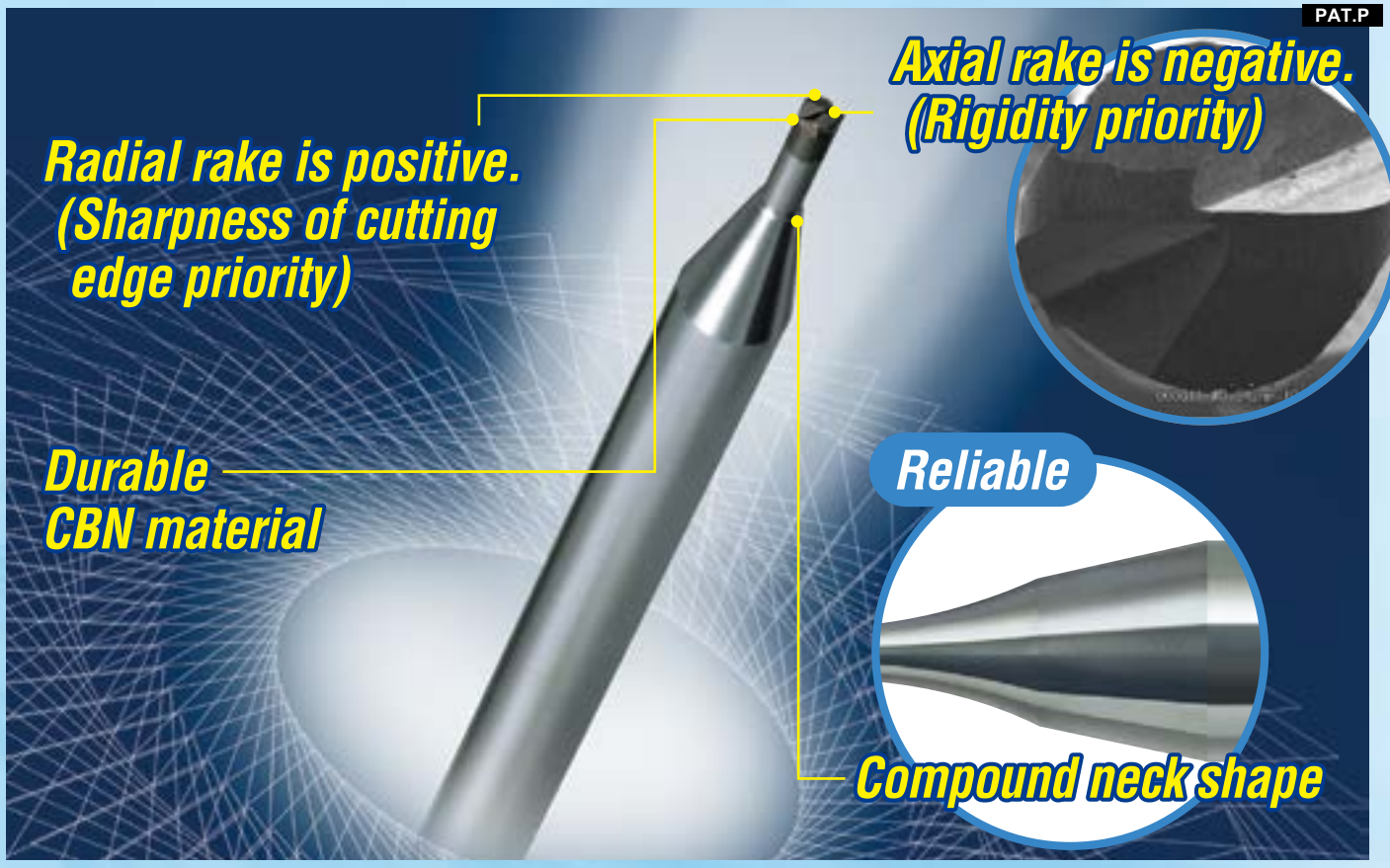
Cutting resistance is low, so the finishing surface is excellent and finish accuracy is higher.

Fine (F) type: Prioritizes high-accuracy machining	Strong (S) type: Prioritizes stable machining
	

Two types of geometry are available for sharpness of cutting edge and rigidity, enabling the geometry type to be selected according to the machining application.

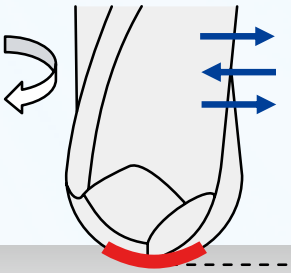
sharpness of cutting edge.

Features of
Epoch® CBN Super Radius End Mill

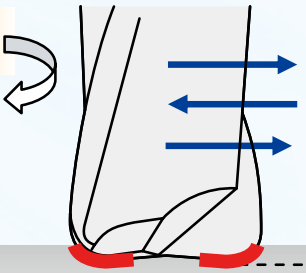


Differences in cutting characteristics for ball end mill and radius end mill

When bottom cutting



Cutting is performed near tool axis, so there are few outside vibrations.



Vibrations are more likely to occur with radius end mills.

When cutting, vibrations tend to become stronger at the outside.

Because of this, with a radius end mill, even if priority is just placed on sharpness of cutting edge, chipping is likely to occur due to vibrations. On the other hand, if sharpness of cutting edge is sacrificed and priority is placed on rigidity, vibrations become remarkable, resulting in unstable cutting.

Epoch CBN Super Radius End Mill uses a geometry that provides benefits of both.

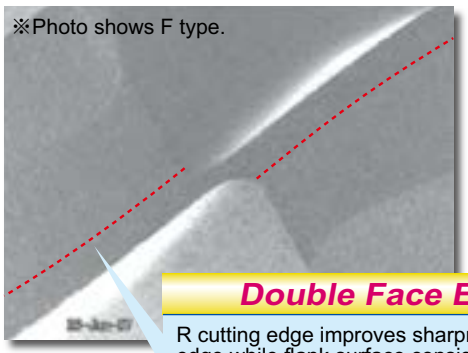
Adopts Double Face shape in the cutter geometry.

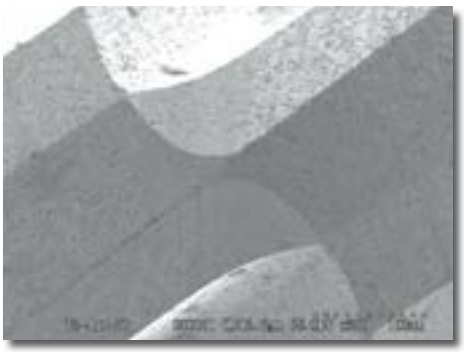
Epoch® CBN Super Ball End Mill

Adopts Double Face shape in the cutter geometry.

Adopts both F type and S type.

Double Face Shape	General CBN tool



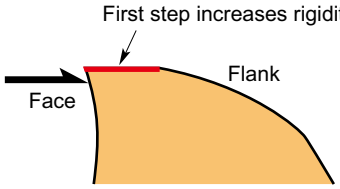


Double Face Effect

R cutting edge improves sharpness of cutting edge while flank surface consists of 2 surfaces to ensure rigidity.

Excellent sharpness of cutting edge

F type and S type both ensure sharpness of cutting edge while rigidity of flank surface is improved.

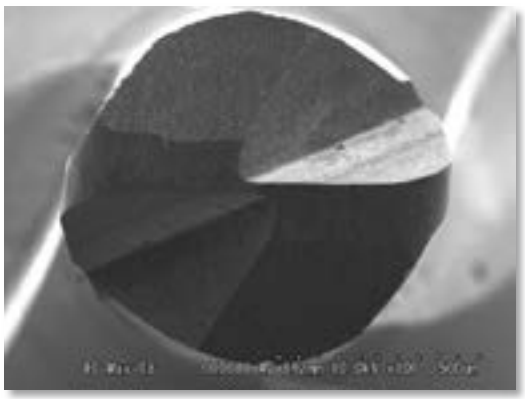


Cutting resistance easily occurs at cutting edge and sharpness of cutting edge is poor.

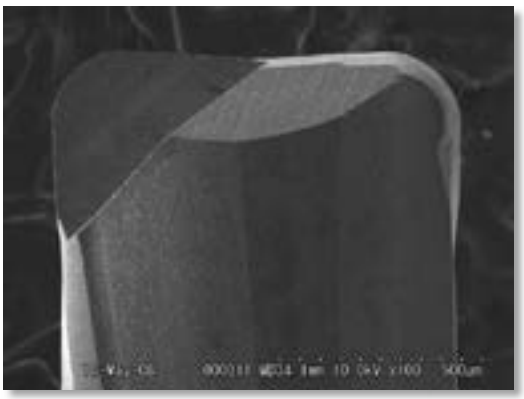
When cutting resistance rises up easily, it affects the finish accuracy of the workpiece.

Epoch® CBN Super Radius End Mill

Adopts special geometry to provide both sharpness of cutting edge and rigidity.



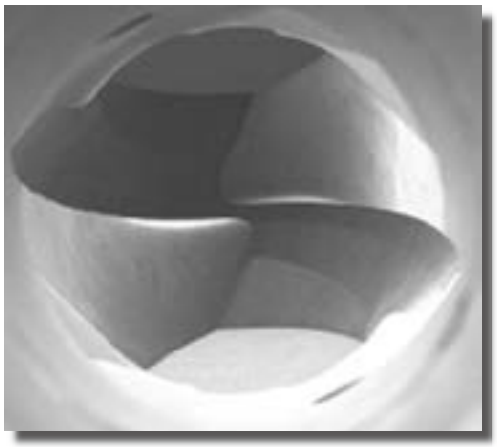
Flute shape with negative face angle in axial direction increases rigidity and improves cutting performance in the radial direction!

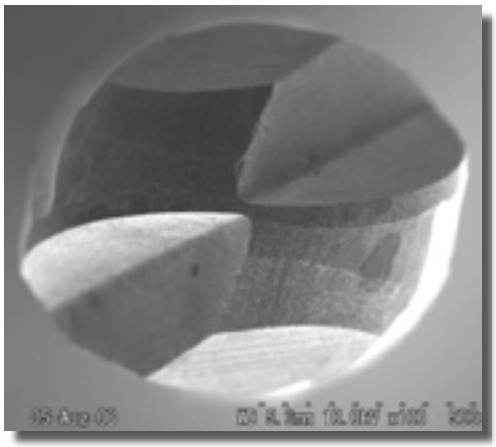


Flute geometry achieves both cutting performance and rigidity!

Selecting geometry type for CBN Super Ball End Mills

Employs 2 types of flute shapes.
(Selectable according to the application.)





Fine type		Strong type
Priority on high-accuracy machining geometry	Applications	**Priority on deep machining**
Geometry with priority on cutting performance enables higher machining accuracy.	Features	Enables stable machining even in environments where vibrations are likely.
L/D≦5	Basic Recomendation	**L/D>5**

Cutting Data (for *R*0.5, L/D=10)

Tool : **CBN-EPSB2010-10-F　CBN-EPSB2010-10-S**

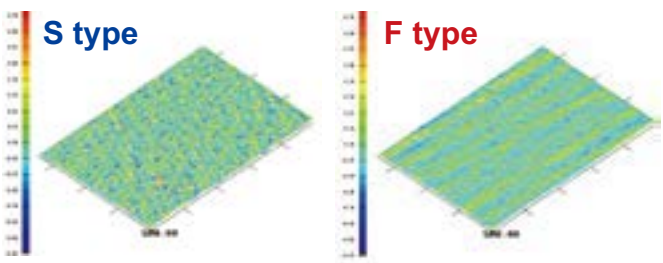
Machining accuracy

● Comparison of surface roughness

Cutting Condition

Work material : HPM38H(52HRC)
Incline angle : 15°
n=16,000min^{-1} (v_c=50m/min)
v_f=960mm/min (f_z=0.03mm/t)
a_p=0.01mm　a_e=0.02mm　Mist Blow

S type		F type	
Ra (μm)	Rz (μm) Max. hight	Ra (μm)	Rz (μm) Max. hight
0.24	1.51	0.10	0.68



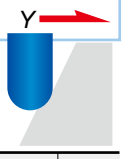
F type provides smaller machined surface roughness.

Stability

● Comparison of cutting depth limit

Cutting Condition

Work material : HPM38H(52HRC)
Incline angle : 15°
n=16,000min^{-1} (v_c=50m/min)
v_f=960mm/min (f_z=0.03mm/t)
a_p=0.05mm　Mist Blow



Depth of cut a_e(mm)	0.01	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05
S type	○	○	○	○	○	○	○	○	×
F type	○	○	○	○	○	○	×		

S type has a high cutting depth limit, enabling stable machining.

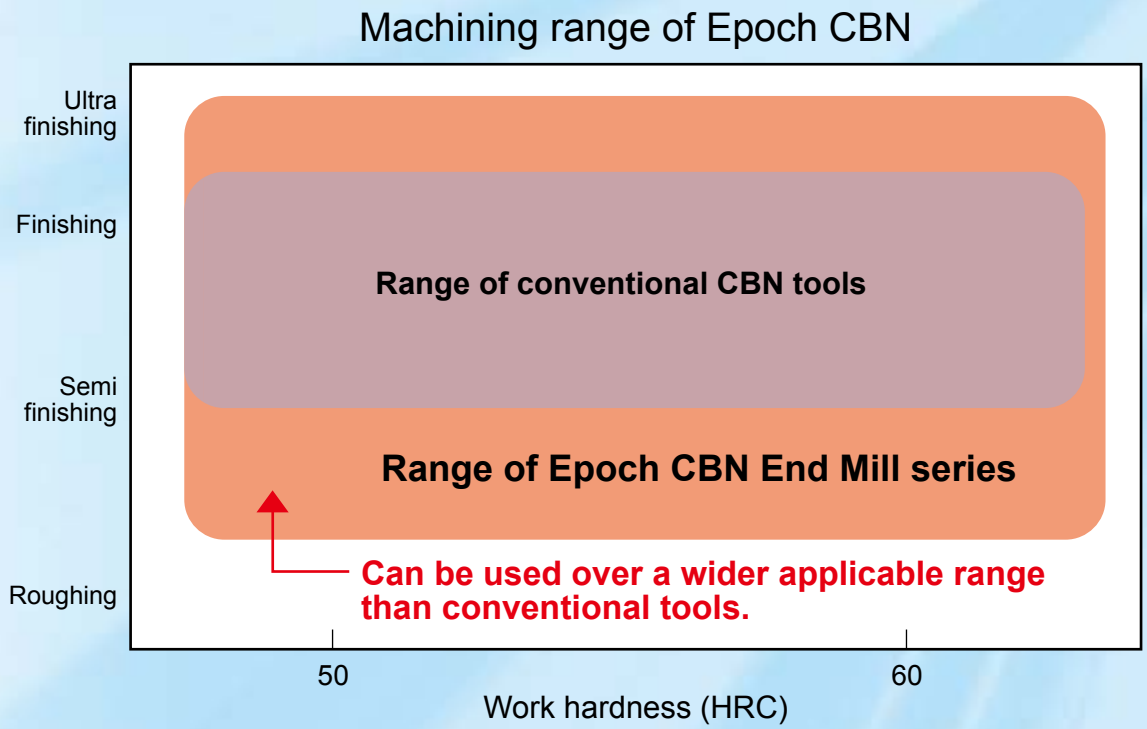
Epoch® CBN End Mill series

Recently, the trend in mold has been toward harder and harder materials, and cutting such materials has become very difficult. In addition, in order to respond to demands for ultra-high precision, tool wear resistance has become very important, and recently tool materials other than carbide, such as CBN, etc., are receiving a lot of attention. The geometry of this newly developed Epoch CBN End Mill series, unlike the conventional geometry commonly seen on most CBN tools which focuses on rigidity, achieves both rigidity and good sharpness of cutting edge.
In this way, it enables high-precision finishing machining over a long period of time on high-hardness materials.

Features and Applications

1. Can be used as easily as carbide end mills while amazingly reducing wear.
2. Cutting edge shape takes care of chipping, which is a problem with CBN materials, enabling stable finishing for a long time.
3. Biting characteristics are the same as those of carbide end mill but cutting resistance is reduced, so finish accuracy is greatly improved.
4. Long life even when direct cutting high hardness materials of 60HRC or higher.
5. Ideal for small-work machining, with a lineup of ball end mills in sizes from *R*0.1 to *R*1mm and radius end mills in sizes from ϕ0.5 to ϕ3mm. (Under neck length: up to 10D)

Machining range of Epoch CBN series



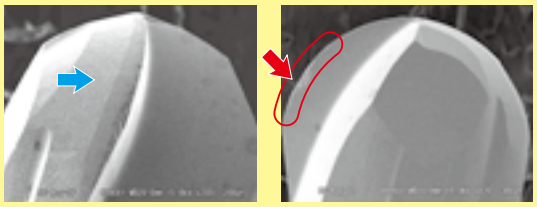
Machining examples

Example: Z-constant finishing of SKD11Ⓗ

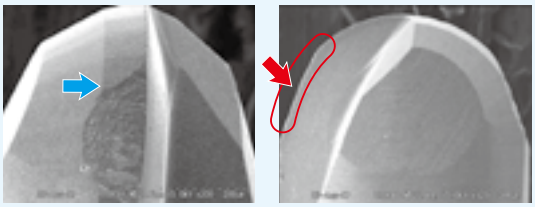
Tool wear ?

When L=100m

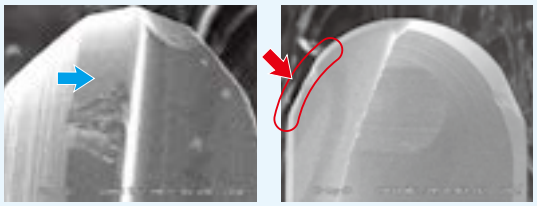
Epoch® CBN Super Ball End Mill F type
CBN-EPSB2010-2.5-F F type



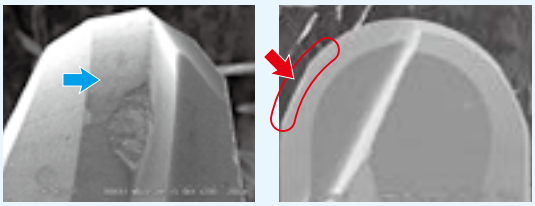
Conventional A : CBN ball

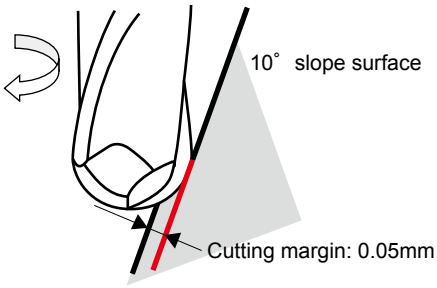


Conventional B : CBN ball



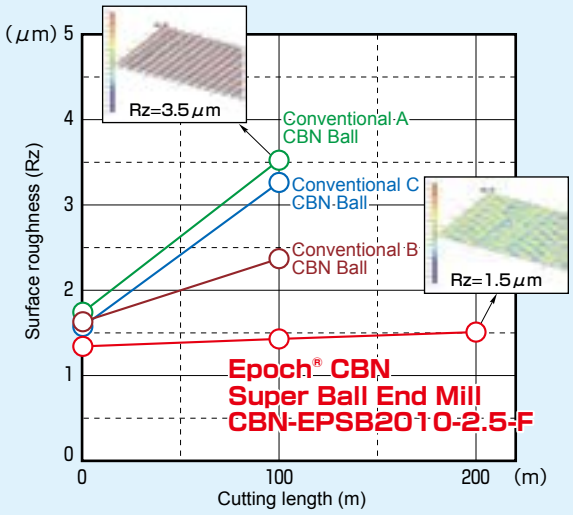
Conventional C : CBN ball



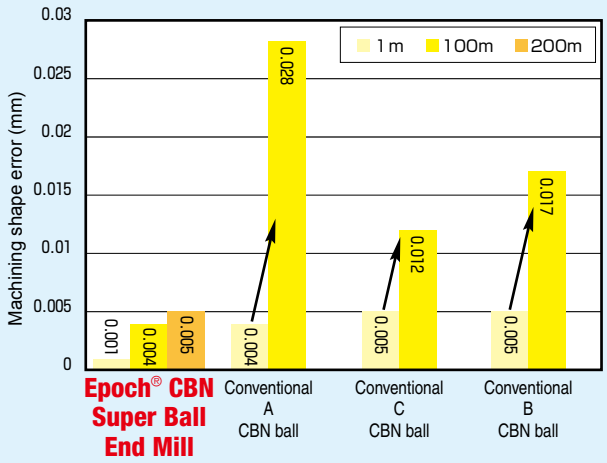


Tool size : *R*0.5×2.5mm (Under neck length)
Work material : SKD11H (60HRC)
n=40,000min^{-1} (v_c=125m/min)
v_f=2,400mm/min (f_z=0.03mm/t)
Z=0.05mm Mist Blow

Surface roughness ?



Finish accuracy ?



For Epoch CBN Super Ball End Mill, there is almost no error in machining shape.

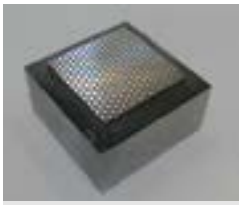
Machining examples

Prism-shape machining examples

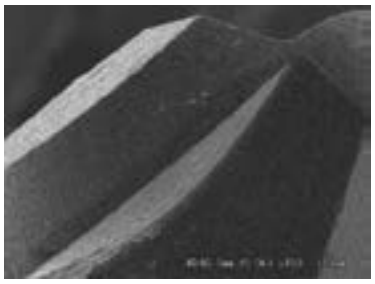
Work material：Equivalent to SUS420J2 (52HRC)
Tool：CBN-EPSB2004-1-F (*R*0.2×Under neck length 1mm)
n=40,000min^{-1} (v_c=50m/min)
v_f=320mm/min (f_z=0.004mm/t)
Pitch＝0.005mm (Scan line machining)　Mist
※Epoch Super Hard Ball Evolution was used for roughing.

Work shape

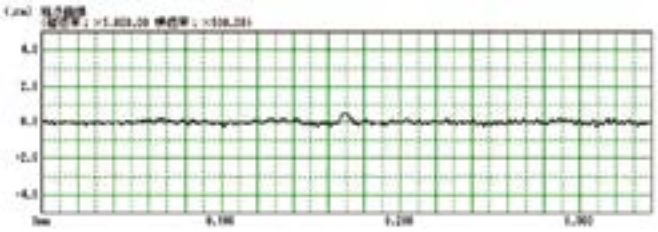
Protrusion height : 0.5mm
Incline angle : 63°



Work size :
28mm square



Extremely low wear enables continuous machining!
Tool wear after using (Machining time: 13h 45min.)

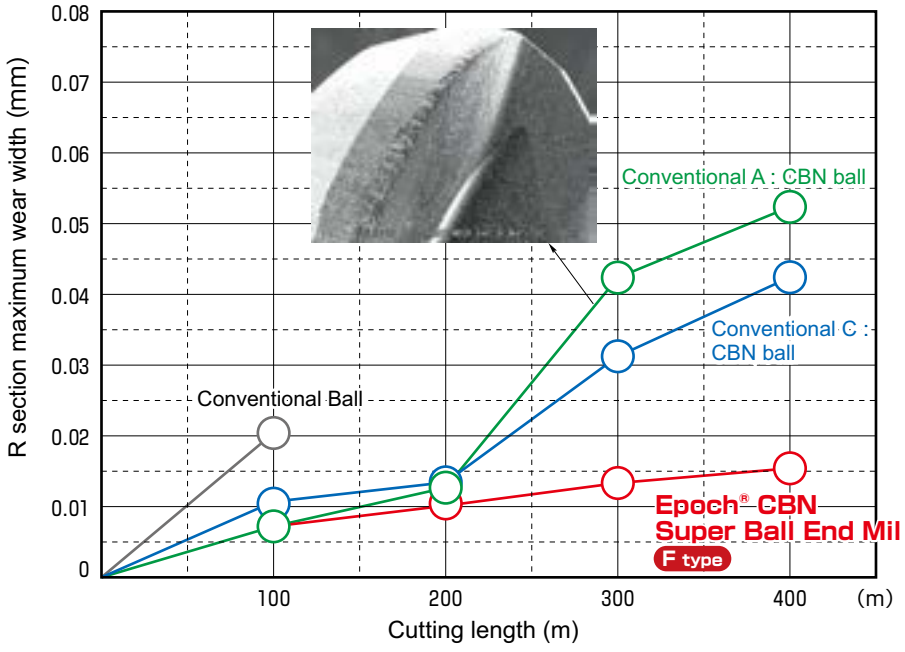


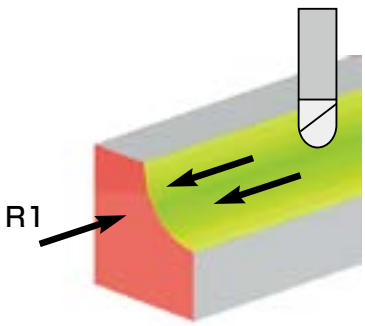
Machined surface roughness Ra: 0.07μm; Rz: 0.54μm
Achieves good surface roughness.

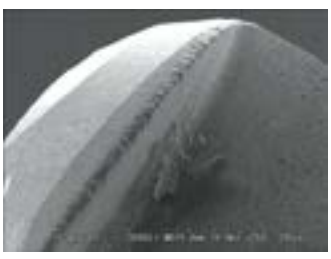
Provides good surface roughness and enables stable machining over a long time.

Z-constant milling for R shape, Work material: Powder HSS HAP40, 65HRC

Work material：HAP40 (65HRC)　Tool：*R*0.5×Under neck length 2.5mm
n=40,000min^{-1} (v_c=125m/min)　v_f=2,400mm/min (f_z=0.03mm/t)
a_p=0.03mm　a_e=0.03mm　(Mist Blow)

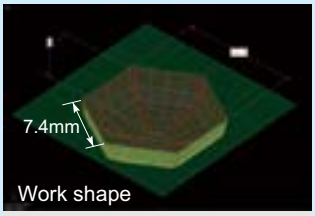




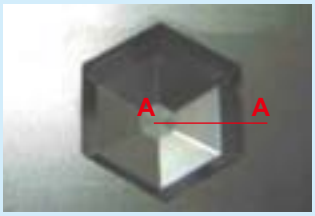


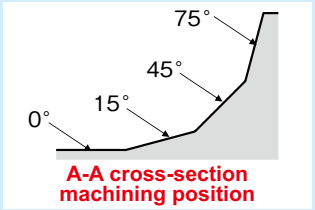
CBN-EPSB2010-2.5-F

Comparison of machined surface roughness

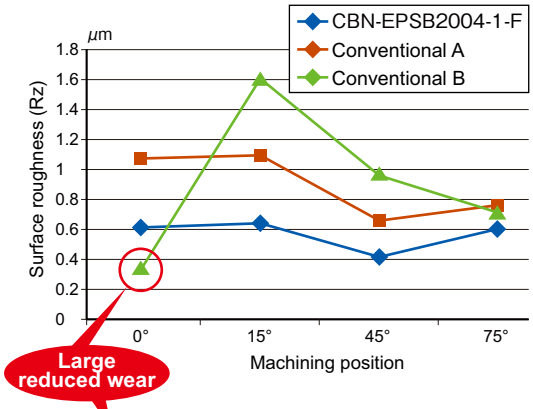


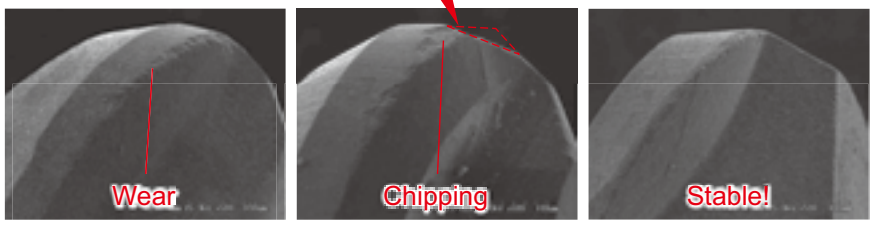
Work size
Length of one side: 7.4mm;
Depth: 4mm





Work material：SKD11 (60HRC)
Tool：*R*0.2×Under neck length 1mm
n=40,000min^{-1} (*v*c=50m/min)
*v*f=800mm/min (*f*z=0.01mm/t)
*a*p=0.005mm *a*e=0.015mm
(Contouring)
Mist
Cutting time = 1hour





Conventional A　Conventional B　CBN-EPSB2004-1-F

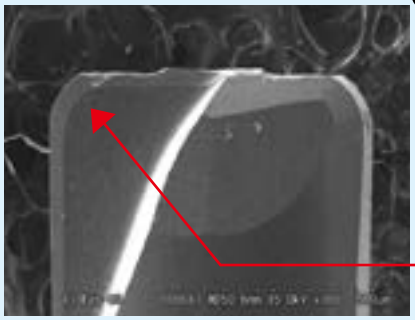
Good machined surface roughness was obtained for each inclined surface.

Bottom cutting of high-hardness material using CBN Super Radius End Mill

CBN-EPSR2010-2.5-02

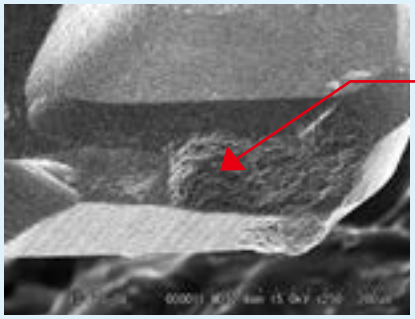
Conventional A : CBN Radius

L=100m
Cutting length



Form breakage is extremely large.

Cutting resistance is likely to increase.

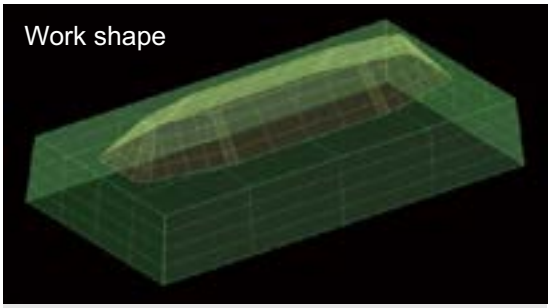


Breakage of flank side and large amount of wear

Work material：SKD11Ⓗ(60HRC)　Tool：*ϕ*1×*r*0.2×Under neck length 2.5mm
n=40,000min^{-1} (*v*c=125m/min)　*v*f=2400mm/min (*f*z=0.03mm/t)　*a*p=0.02mm *a*e=0.3mm　(Mist Blow)

Machining examples

High-performance slope machining

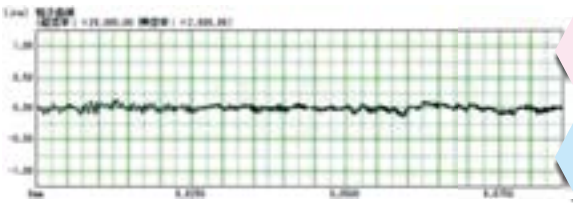


Work size　Width:Bottom width 0.78mm, Hight:0.3mm
Length:2.7mm, Incline angle:15°, 40°

Tool：CBN-EPSR2004-1-005

Tool size：ϕ0.4×r0.05×Under neck length 1mm
n=40,000min^{-1} (v_c=50m/min)
v_f=520mm/min (f_z=0.0065mm/t)
Zpic＝0.002mm
XY＝0.005mm (Finishing allowance：0.005mm) Mist
Cutting time：2.5min/piece

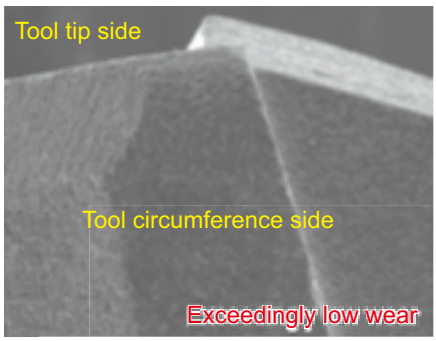
※Epoch Deep Radius used for roughing.



Surface roughness

Average surface roughness 0.03μm

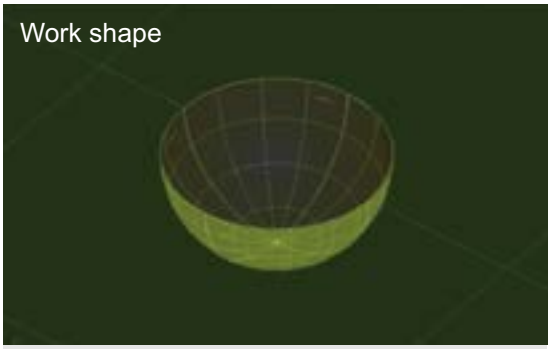
Maximum surface roughness 0.22μm



Flute tip condition after machining 6 pieces

Good machined surface roughness can be obtained even under high-performance machining conditions.

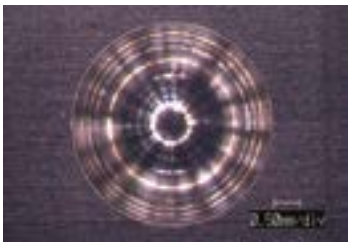
Spherical machined surface roughness evaluation



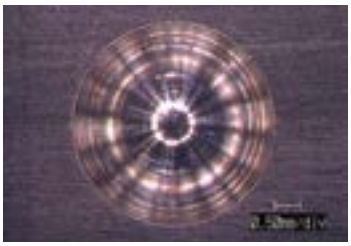
Work size　ϕ4mm at upper surface × 2mm depth

Tool：CBN-EPSB2020-5-F

Tool size：R1×Under neck length 5mm



Work after machining under condition 1



Work after machining under condition 2

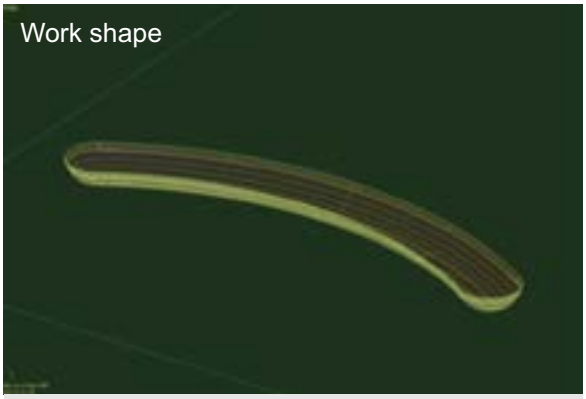
※Images taken from top surface using CCD camera

	Condition 1	Condition 2
Cutting conditions (Scan line machining)	n=40000min^{-1} (v_c=251m/min) v_f=800mm/min (f_z=0.01mm/t) Pitch：0.003 (At surface), Mist	n=40000min^{-1} (v_c=251m/min) v_f=800mm/min (f_z=0.01mm/t) Pitch：0.008 (At surface), Mist
Surface roughness	Ra:0.09μm　Rz:0.51μm	Ra:0.10μm　Rz:0.63μm

※Epoch Super Hard Ball Evolution used for roughing.

Low-resistance flute shape design enables good machined surface roughness even if machining pitch is changed! (Shortens machining time.)

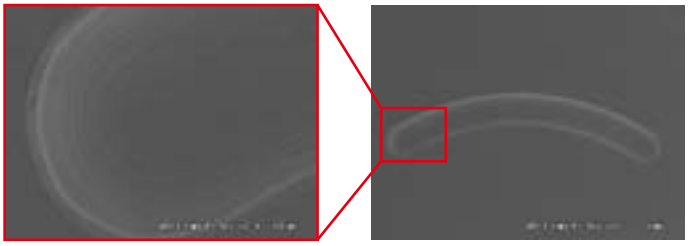
Stopped groove finish machining using *R*0.1



Work size
Groove width: 0.25mm at surface; Groove depth: 0.1mm;
Slope angle: 18°

Tool：CBN-EPSB2002-0.5-F

Tool size：*R*0.1×Under neck length 0.5mm
n=40,000min^{-1} (v_c=25m/min)
v_f=560mm/min (f_z=0.007mm/t)
a_p×a_e=0.004mm×0.004mm　Mist
Cutting time：4min/piece
※Epoch Super Hard Ball Evolution used for roughing.



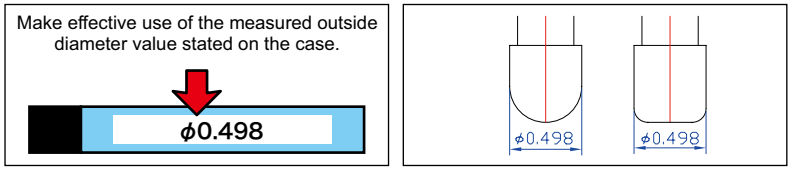
Enables stable micro slotting!
Provides good surface without vibration in corner areas.

Cautions regarding use

＜About semi-finishing＞

For stable machining, perform medium finishing to remove waste in the corners. (This will make the machining amount for finishing uniform.) At this time, it is recommended that the program be set so that the cusp height will be a fixed amount. In addition, it is recommended that medium finishing be performed using a CBN end mill.

＜Input of diameter correction value＞



【Input example】
Ball end mill: Tool diameter ϕ0.498 → *R*0.249
Radius end mill: Tool diameter ϕ0.498
(Corner R value is catalog value.)

For Epoch CBN end mill series products, the measured outside diameter value is stated on the case.
Inputting the actual measured value for the tool diameter in CAM from roughing to finishing will enable improved final machining accuracy.

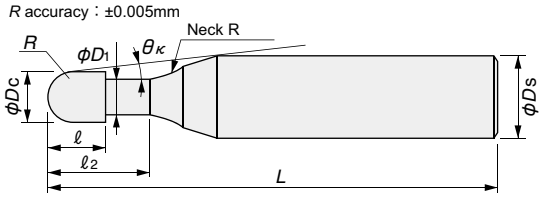
＜Regarding corner speed reduction＞

If the actual feed rate of the machine does not reach the set value (such as when workpiece is small and speed cannot be increased, etc.), sudden increases/decreases in feed rate may occur, which can cause chipping, etc.
In such cases, input the feed rate that the machine can provide.

Epoch® CBN Super Ball End Mill

Dimensions

Includes actual measured mill diameter value.



Tolerance on shank：h4

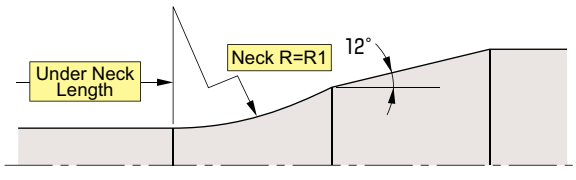
CBN-EPSB2○○○-○○.○-○○○-S/F

※Actual measured mill diameter value is shown on case.

Fine (F) type		Strong (S) type		Size (mm) Display of actual measured mill dia. for all tools									Actual Effective Length in incline angles				
Item Code	Stock	Item Code	Stock	Tool dia. Dc	Ball radius R	Under neck length ℓ2	Flute length ℓ	Neck dia. D1	Overall length L	Shank dia. Ds	Neck R	Interference angle θκ	0.5°	1°	1.5°	2°	3°
CBN-EPSB2002-0.5-F	●	CBN-EPSB2002-0.5-S	●	0.2	0.1	0.5	0.12	0.18	50	4	1	11.45	0.67	0.7	0.72	0.75	0.8
CBN-EPSB2002-1-F	●	CBN-EPSB2002-1-S	●	0.2	0.1	1	0.12	0.18	50	4	1	10.88	1.19	1.24	1.28	1.32	1.38
CBN-EPSB2003-0.75-F	●	CBN-EPSB2003-0.75-S	●	0.3	0.15	0.75	0.18	0.27	50	4	1	11.17	0.95	0.99	1.02	1.05	1.1
CBN-EPSB2003-1.5-F	●	CBN-EPSB2003-1.5-S	●	0.3	0.15	1.5	0.18	0.27	50	4	1	10.36	1.73	1.79	1.83	1.88	2.03
CBN-EPSB2004-1-F	●	CBN-EPSB2004-1-S	●	0.4	0.2	1	0.24	0.37	50	4	1	10.91	1.21	1.25	1.29	1.32	1.38
CBN-EPSB2004-2-F	●	CBN-EPSB2004-2-S	●	0.4	0.2	2	0.24	0.37	50	4	1	9.88	2.25	2.31	2.37	2.43	2.68
CBN-EPSB2005-1.5-F	●	CBN-EPSB2005-1.5-S	●	0.5	0.25	1.5	0.3	0.47	50	4	1	10.39	1.73	1.78	1.83	1.87	2
CBN-EPSB2005-3-F	●	CBN-EPSB2005-3-S	●	0.5	0.25	3	0.3	0.47	50	4	1	9	3.28	3.36	3.46	3.62	3.99
CBN-EPSB2006-1.5-F	●	CBN-EPSB2006-1.5-S	●	0.6	0.3	1.5	0.36	0.57	50	4	1	10.4	1.73	1.78	1.82	1.86	1.98
CBN-EPSB2006-3-F	●	CBN-EPSB2006-3-S	●	0.6	0.3	3	0.36	0.57	50	4	1	8.98	3.28	3.36	3.46	3.61	3.97
CBN-EPSB2008-2.5-F	●	CBN-EPSB2008-2.5-S	●	0.8	0.4	2.5	0.48	0.77	50	4	1	9.37	2.76	2.83	2.89	2.99	3.28
CBN-EPSB2008-5-F	●	CBN-EPSB2008-5-S	●	0.8	0.4	5	0.48	0.77	50	4	1	7.48	5.33	5.48	5.72	5.99	6.6
CBN-EPSB2010-2.5-F	●	CBN-EPSB2010-2.5-S	●	1	0.5	2.5	0.6	0.96	50	4	1	9.31	2.77	2.84	2.89	3	3.28
CBN-EPSB2010-5-F	●	CBN-EPSB2010-5-S	●	1	0.5	5	0.6	0.96	50	4	1	7.34	5.34	5.5	5.74	5.99	6.6
CBN-EPSB2010-10-F	●	CBN-EPSB2010-10-S	●	1	0.5	10	0.6	0.96	50	4	1	5.15	10.5	10.95	11.44	11.98	13.23
CBN-EPSB2015-5-F	●	CBN-EPSB2015-5-S	●	1.5	0.75	5	0.9	1.44	50	4	1	6.94	5.36	5.53	5.75	6	6.58
CBN-EPSB2015-10-F	●	CBN-EPSB2015-10-S	●	1.5	0.75	10	0.9	1.44	50	4	1	4.68	10.54	10.98	11.46	11.98	13.22
CBN-EPSB2020-5-F	●	CBN-EPSB2020-5-S	●	2	1	5	1.2	1.92	50	4	1	6.42	5.38	5.56	5.77	6.01	6.56
CBN-EPSB2020-10-F	●	CBN-EPSB2020-10-S	●	2	1	10	1.2	1.92	50	4	1	4.12	10.58	11.01	11.48	11.99	13.2
CBN-EPSB2020-20-F	●	CBN-EPSB2020-20-S	●	2	1	20	1.2	1.92	55	4	1	2.4	21	21.9	22.88	23.96	No interference

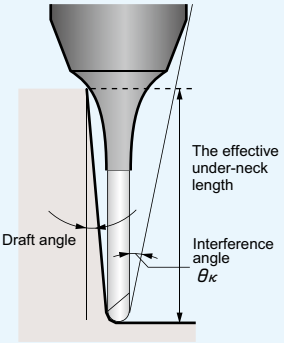
●：Stocked Items.

Detailed shape below neck



【Note】

If the workpiece has draft angle, the interference length will be longer than the under-neck length. Please refer to the effective under-neck length for the various draft angles.
In addition, the angle at which the tool will interfere with the workpiece is shown as the "interference angle θκ", and should also be referred to.



Recommended Cutting Conditions

＜Semi-finishing condition＞

Work material					1 Hardened Steels (～55HRC) HPM1,SKD61,SKT4		2 Hardened Steels (55～65HRC) SKD11,SKH51		3 Hardened Steels (65～68HRC) SKH,Melted HSS		4 Hardened Steels (68～72HRC) HAP,Powdered HSS	
Ratio to standard depth of cut					100%		90%		80%		70%	
Tool dia. D_c (mm)	Ball radius R (mm)	Under neck length ℓ_2 (mm)	Depth of cut (mm) a_p	Depth of cut (mm) a_e	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min
0.2	0.1	0.5	0.005	0.015	50,000	600	48,000	500	45,000	410	43,000	320
		1	0.005	0.015	46,000	460	44,000	390	42,000	320	39,000	240
0.3	0.15	0.75	0.006	0.018	50,000	900	47,000	740	45,000	610	42,000	470
		1.5	0.006	0.018	45,000	680	42,000	550	40,000	450	38,000	360
0.4	0.2	1	0.008	0.024	46,000	1,100	44,000	920	42,000	760	39,000	590
		2	0.008	0.024	41,000	820	39,000	680	37,000	560	35,000	440
0.5	0.25	1.5	0.013	0.039	46,000	1,380	44,000	1,160	41,000	920	39,000	730
		3	0.01	0.03	41,000	1,030	39,000	850	37,000	690	35,000	550
0.6	0.3	1.5	0.015	0.045	42,000	1,760	40,000	1,470	38,000	1,200	36,000	950
		3	0.012	0.036	38,000	1,370	36,000	1,130	34,000	920	32,000	720
0.8	0.4	2.5	0.02	0.06	42,000	2,350	40,000	1,960	38,000	1,600	36,000	1,260
		5	0.016	0.048	38,000	2,130	36,000	1,760	34,000	1,430	32,000	1,120
1	0.5	2.5	0.035	0.105	38,000	2,660	36,000	2,210	34,000	1,790	32,000	1,400
		5	0.02	0.06	34,000	2,380	33,000	2,020	31,000	1,630	29,000	1,270
		10	0.015	0.045	27,000	1,620	25,000	1,310	24,000	1,080	23,000	860
1.5	0.75	5	0.03	0.09	32,000	2,400	30,000	1,970	29,000	1,630	27,000	1,270
		10	0.02	0.06	22,000	1,320	21,000	1,100	20,000	900	19,000	710
2	1	5	0.05	0.15	28,000	2,800	27,000	2,360	25,000	1,880	24,000	1,500
		10	0.03	0.09	25,000	2,500	24,000	2,100	23,000	1,730	21,000	1,310
		20	0.02	0.06	20,000	1,600	19,000	1,330	18,000	1,080	17,000	850

＜Finishing condition＞

Work material					1 Hardened Steels (～55HRC) HPM1,SKD61,SKT4		2 Hardened Steels (55～65HRC) SKD11,SKH51		3 Hardened Steels (65～68HRC) SKH,Melted HSS		4 Hardened Steels (68～72HRC) HAP,Powdered HSS	
Ratio to standard depth of cut					100%		90%		80%		70%	
Tool dia. D_c (mm)	Ball radius R (mm)	Under neck length ℓ_2 (mm)	Depth of cut (mm) a_p	Depth of cut (mm) a_e	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min
0.2	0.1	0.5	0.005	0.015	50,000	480	48,000	410	45,000	350	43,000	290
		1	0.005	0.015	46,000	370	44,000	320	42,000	270	39,000	220
0.3	0.15	0.75	0.005	0.015	50,000	720	47,000	610	45,000	520	42,000	420
		1.5	0.005	0.015	45,000	540	42,000	450	40,000	380	38,000	320
0.4	0.2	1	0.006	0.018	46,000	880	44,000	760	42,000	650	39,000	520
		2	0.006	0.018	41,000	660	39,000	560	37,000	470	35,000	390
0.5	0.25	1.5	0.008	0.024	46,000	1,100	44,000	950	41,000	790	39,000	660
		3	0.008	0.024	41,000	820	39,000	700	37,000	590	35,000	490
0.6	0.3	1.5	0.01	0.03	42,000	1,410	40,000	1,210	38,000	1,020	36,000	850
		3	0.008	0.024	38,000	1,090	36,000	930	34,000	780	32,000	650
0.8	0.4	2.5	0.015	0.045	42,000	1,880	40,000	1,610	38,000	1,360	36,000	1,130
		5	0.012	0.036	38,000	1,700	36,000	1,450	34,000	1,220	32,000	1,000
1	0.5	2.5	0.02	0.06	38,000	2,130	36,000	1,810	34,000	1,520	32,000	1,250
		5	0.018	0.054	34,000	1,900	33,000	1,660	31,000	1,390	29,000	1,140
		10	0.01	0.03	27,000	1,300	25,000	1,080	24,000	920	23,000	770
1.5	0.75	5	0.023	0.069	32,000	1,920	30,000	1,620	29,000	1,390	27,000	1,130
		10	0.018	0.054	22,000	1,060	21,000	910	20,000	770	19,000	640
2	1	5	0.025	0.075	28,000	2,240	27,000	1,940	25,000	1,600	24,000	1,340
		10	0.02	0.06	25,000	2,000	24,000	1,730	23,000	1,470	21,000	1,180
		20	0.012	0.036	20,000	1,280	19,000	1,090	18,000	920	17,000	760

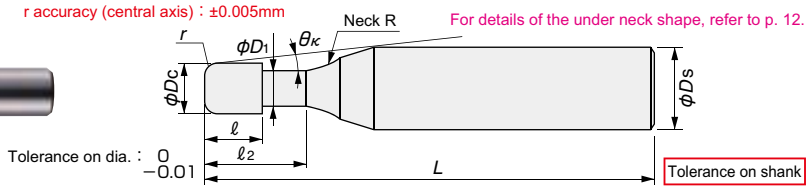
(※) The indicated standard cutting depth is a reference value for Group 1 work materials.
For materials in other groups, the cutting depth should be adjusted using the reference ratio shown in the above table.

【Note】 1) Use the appropriate coolant for the work material and machining shape.
2) This standard cutting condition table is intended as reference cutting conditions. The conditions should be adjusted as necessary according to the actual conditions of machined shape, purpose, machine used, etc.
3) If the machine rotation speed is insufficient, reduce the rotation speed and feed rate by the same ratio.

Epoch® CBN Super Radius End Mill

Dimensions

Includes actual measured mill diameter value.



CBN-EPSR2○○○-○○.○-○○○

※Actual measured mill diameter value is shown on case.

Item Code	Stock	Size (mm) Display of actual measured mill dia. for all tools									Actual Effective Length in incline angles				
		Tool dia. Dc	Corner radius r	Under neck length ℓ2	Flute length ℓ	Neck dia. D1	Overall length L	Shank dia. Ds	Neck R	Interference angle θκ	0.5°	1°	1.5°	2°	3°
CBN-EPSR2002-0.5-005	●	0.2	0.05	0.5	0.07	0.18	50	4	1	11.39	0.67	0.7	0.73	0.76	0.81
CBN-EPSR2002-1-005	●	0.2	0.05	1	0.07	0.18	50	4	1	10.83	1.19	1.24	1.28	1.32	1.39
CBN-EPSR2003-0.5-005	●	0.3	0.05	0.5	0.11	0.27	50	4	1	11.35	0.7	0.73	0.75	0.78	0.82
CBN-EPSR2003-0.75-005	●	0.3	0.05	0.75	0.11	0.27	50	4	1	11.05	0.96	0.99	1.03	1.06	1.12
CBN-EPSR2003-1.5-005	●	0.3	0.05	1.5	0.11	0.27	50	4	1	10.26	1.74	1.79	1.84	1.89	2.06
CBN-EPSR2003-2-005	●	0.3	0.05	2	0.11	0.27	50	4	1	9.79	2.25	2.32	2.38	2.46	2.73
CBN-EPSR2004-0.5-005	●	0.4	0.05	0.5	0.14	0.37	50	4	1	11.33	0.7	0.73	0.75	0.78	0.82
CBN-EPSR2004-1-005	●	0.4	0.05	1	0.14	0.37	50	4	1	10.75	1.22	1.26	1.3	1.34	1.4
CBN-EPSR2004-2-005	●	0.4	0.05	2	0.14	0.37	50	4	1	9.74	2.25	2.32	2.38	2.46	2.73
CBN-EPSR2005-0.5-005	●	0.5	0.05	0.5	0.18	0.47	50	4	1	11.31	0.7	0.73	0.75	0.78	0.82
CBN-EPSR2005-1.5-005	●	0.5	0.05	1.5	0.18	0.47	50	4	1	10.18	1.74	1.79	1.84	1.89	2.06
CBN-EPSR2005-3-005	●	0.5	0.05	3	0.18	0.47	50	4	1	8.84	3.29	3.37	3.49	3.66	4.05
CBN-EPSR2005-0.5-01	●	0.5	0.1	0.5	0.18	0.47	50	4	1	11.37	0.7	0.72	0.75	0.77	0.82
CBN-EPSR2005-1.5-01	●	0.5	0.1	1.5	0.18	0.47	50	4	1	10.23	1.74	1.79	1.84	1.88	2.05
CBN-EPSR2005-3-01	●	0.5	0.1	3	0.18	0.47	50	4	1	8.88	3.28	3.37	3.48	3.65	4.04
CBN-EPSR2006-1.5-01	●	0.6	0.1	1.5	0.21	0.57	50	4	1	10.18	1.74	1.79	1.84	1.88	2.05
CBN-EPSR2006-3-01	●	0.6	0.1	3	0.21	0.57	50	4	1	8.82	3.28	3.37	3.48	3.65	4.04
CBN-EPSR2008-2.5-01	●	0.8	0.1	2.5	0.28	0.77	50	4	1	9.1	2.77	2.84	2.91	3.05	3.37
CBN-EPSR2008-5-01	●	0.8	0.1	5	0.28	0.77	50	4	1	7.3	5.34	5.51	5.76	6.04	6.69
CBN-EPSR2010-1-005	●	1	0.05	1	0.35	0.96	50	4	1	10.5	1.24	1.28	1.32	1.35	1.43
CBN-EPSR2010-2.5-005	●	1	0.05	2.5	0.35	0.96	50	4	1	8.88	2.79	2.86	2.95	3.09	3.42
CBN-EPSR2010-5-005	●	1	0.05	5	0.35	0.96	50	4	1	7.07	5.35	5.54	5.8	6.08	6.74
CBN-EPSR2010-1-01	●	1	0.1	1	0.35	0.96	50	4	1	10.56	1.24	1.28	1.31	1.35	1.42
CBN-EPSR2010-2.5-01	●	1	0.1	2.5	0.35	0.96	50	4	1	8.93	2.79	2.86	2.94	3.08	3.41
CBN-EPSR2010-5-01	●	1	0.1	5	0.35	0.96	50	4	1	7.1	5.35	5.54	5.79	6.07	6.72
CBN-EPSR2010-2.5-02	●	1	0.2	2.5	0.35	0.96	50	4	1	9.02	2.78	2.85	2.93	3.06	3.37
CBN-EPSR2010-5-02	●	1	0.2	5	0.35	0.96	50	4	1	7.16	5.35	5.53	5.78	6.05	6.69
CBN-EPSR2010-10-02	●	1	0.2	10	0.35	0.96	50	4	1	5.06	10.51	10.97	11.48	12.03	13.33
CBN-EPSR2015-2-005	●	1.5	0.05	2	0.53	1.44	50	4	1	8.92	2.31	2.36	2.43	2.55	2.82
CBN-EPSR2015-5-005	●	1.5	0.05	5	0.53	1.44	50	4	1	6.5	5.38	5.59	5.85	6.14	6.8
CBN-EPSR2015-2-01	●	1.5	0.1	2	0.53	1.44	50	4	1	8.97	2.31	2.36	2.42	2.54	2.8
CBN-EPSR2015-5-01	●	1.5	0.1	5	0.53	1.44	50	4	1	6.53	5.38	5.59	5.84	6.13	6.79
CBN-EPSR2015-5-02	●	1.5	0.2	5	0.53	1.44	50	4	1	6.59	5.38	5.58	5.83	6.11	6.75
CBN-EPSR2015-10-02	●	1.5	0.2	10	0.53	1.44	50	4	1	4.52	10.56	11.03	11.53	12.09	13.39
CBN-EPSR2020-3-005	●	2	0.05	3	0.7	1.92	50	4	1	7.27	3.36	3.46	3.62	3.8	4.21
CBN-EPSR2020-5-005	●	2	0.05	5	0.7	1.92	50	4	1	5.81	5.4	5.64	5.91	6.19	6.87
CBN-EPSR2020-10-005	●	2	0.05	10	0.7	1.92	50	4	1	3.86	10.62	11.09	11.61	12.18	13.5
CBN-EPSR2020-3-01	●	2	0.1	3	0.7	1.92	50	4	1	7.32	3.36	3.46	3.62	3.79	4.19
CBN-EPSR2020-5-01	●	2	0.1	5	0.7	1.92	50	4	1	5.84	5.4	5.64	5.9	6.18	6.85
CBN-EPSR2020-10-01	●	2	0.1	10	0.7	1.92	50	4	1	3.87	10.62	11.09	11.6	12.17	13.49
CBN-EPSR2020-5-02	●	2	0.2	5	0.7	1.92	50	4	1	5.9	5.4	5.63	5.88	6.16	6.82
CBN-EPSR2020-10-02	●	2	0.2	10	0.7	1.92	50	4	1	3.9	10.61	11.08	11.59	12.15	13.45
CBN-EPSR2020-20-02	●	2	0.2	20	0.7	1.92	55	4	1	2.32	21.04	21.97	22.99	24.11	No interference
CBN-EPSR2030-6-005	●	3	0.05	6	1.05	2.86	50	4	1	3.32	6.59	6.89	7.21	7.56	8.38
CBN-EPSR2030-6-01	●	3	0.1	6	1.05	2.86	50	4	1	3.34	6.59	6.88	7.2	7.55	8.36
CBN-EPSR2030-6-05	●	3	0.5	6	1.05	2.86	50	4	1	3.5	6.57	6.85	7.14	7.47	8.24

● : Stocked Items.

Recommended Cutting Conditions

＜Finishing condition＞

Work material					1 Hardened Steels (～55HRC) HPM1,SKD61,SKT4		2 Hardened Steels (55～65HRC) SKD11,SKH51		3 Hardened Steels (65～68HRC) SKH,Melted HSS		4 Hardened Steels (68～72HRC) HAP,Powdered HSS	
Ratio to standard depth of cut					100%		90%		80%		70%	
Tool dia. Dc (mm)	Corner radius r (mm)	Under neck length ℓ_2 (mm)	Depth of cut (mm) a_p	Depth of cut (mm) a_e	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min
0.2	0.05	0.5	0.004	0.05	50,000	400	48,000	350	45,000	290	43,000	240
		1	0.003	0.05	45,000	340	43,000	290	41,000	250	38,000	200
0.3	0.05	0.5	0.006	0.1	50,000	600	48,000	520	45,000	430	43,000	360
		0.75	0.006	0.1	50,000	600	48,000	520	45,000	430	43,000	360
		1.5	0.005	0.1	45,000	510	43,000	440	41,000	370	38,000	300
		2	0.003	0.1	40,000	430	38,000	370	36,000	310	34,000	260
0.4	0.05	0.5	0.008	0.15	46,000	740	44,000	630	41,000	520	39,000	440
		1	0.008	0.15	46,000	740	44,000	630	41,000	520	39,000	440
		2	0.006	0.15	41,000	620	39,000	530	37,000	450	35,000	370
0.5	0.05	0.5	0.01	0.2	46,000	920	44,000	790	41,000	660	39,000	550
		1.5	0.01	0.2	46,000	920	44,000	790	41,000	660	39,000	550
		3	0.005	0.2	37,000	670	35,000	570	33,000	480	31,000	390
	0.1	0.5	0.01	0.15	46,000	920	44,000	790	41,000	660	39,000	550
		1.5	0.01	0.15	46,000	920	44,000	790	41,000	660	39,000	550
		3	0.005	0.15	37,000	670	35,000	570	33,000	480	31,000	390
0.6	0.1	1.5	0.012	0.2	42,000	1,010	40,000	860	38,000	730	36,000	600
		3	0.009	0.2	38,000	870	36,000	740	34,000	620	32,000	510
0.8	0.1	2.5	0.012	0.3	42,000	1,280	40,000	1,090	38,000	920	36,000	770
		5	0.008	0.3	38,000	1,090	36,000	930	34,000	780	32,000	650
1	0.05	1	0.02	0.45	38,000	1,520	36,000	1,300	34,000	1,090	32,000	900
		2.5	0.02	0.45	38,000	1,520	36,000	1,300	34,000	1,090	32,000	900
		5	0.015	0.45	34,000	1,290	32,000	1,090	31,000	940	29,000	770
	0.1	1	0.02	0.4	38,000	1,520	36,000	1,300	34,000	1,090	32,000	900
		2.5	0.02	0.4	38,000	1,520	36,000	1,300	34,000	1,090	32,000	900
		5	0.015	0.4	34,000	1,290	32,000	1,090	31,000	940	29,000	770
	0.2	2.5	0.02	0.3	38,000	1,520	36,000	1,300	34,000	1,090	32,000	900
		5	0.015	0.3	34,000	1,290	32,000	1,090	31,000	940	29,000	770
		10	0.005	0.3	27,000	920	26,000	800	24,000	650	23,000	550
1.5	0.05	2	0.02	0.7	32,000	1,920	30,000	1,620	29,000	1,390	27,000	1,130
		5	0.02	0.7	29,000	1,650	28,000	1,440	26,000	1,190	25,000	1,000
	0.1	2	0.02	0.65	32,000	1,920	30,000	1,620	29,000	1,390	27,000	1,130
		5	0.02	0.65	29,000	1,650	28,000	1,440	26,000	1,190	25,000	1,000
	0.2	5	0.02	0.55	29,000	1,650	28,000	1,440	26,000	1,190	25,000	1,000
		10	0.015	0.55	26,000	1,400	25,000	1,220	23,000	990	22,000	830
2	0.05	3	0.02	0.95	28,000	2,240	27,000	1,940	25,000	1,600	24,000	1,340
		5	0.02	0.95	28,000	2,240	27,000	1,940	25,000	1,600	24,000	1,340
		10	0.02	0.95	25,000	1,900	24,000	1,640	23,000	1,400	21,000	1,120
	0.1	3	0.02	0.9	28,000	2,240	27,000	1,940	25,000	1,600	24,000	1,340
		5	0.02	0.9	28,000	2,240	27,000	1,940	25,000	1,600	24,000	1,340
		10	0.02	0.9	25,000	1,900	24,000	1,640	23,000	1,400	21,000	1,120
	0.2	5	0.02	0.8	28,000	2,240	27,000	1,940	25,000	1,600	24,000	1,340
		10	0.02	0.8	25,000	1,900	24,000	1,640	23,000	1,400	21,000	1,120
		20	0.01	0.8	20,000	1,360	19,000	1,160	18,000	980	17,000	810
3	0.05	6	0.02	1.45	24,000	2,450	23,000	2,110	22,000	1,800	20,000	1,430
	0.1	6	0.02	1.4	24,000	2,450	23,000	2,110	22,000	1,800	20,000	1,430
	0.5	6	0.02	1	24,000	2,450	23,000	2,110	22,000	1,800	20,000	1,430

(※) The indicated standard cutting depth is a reference value for Group 1 work materials. For materials in other groups, the cutting depth should be adjusted using the reference ratio shown in the above table.
The depth of cut stated in these cutting conditions are calculated assuming bottom surface machining. For finishing machining such as slope machining, it should be set according to the theoretical surface roughness (cusp height).

【Note】 1) Use the appropriate coolant for the work material and machining shape.
2) This standard cutting condition table is intended as reference cutting conditions. The conditions should be adjusted as necessary according to the actual conditions of machined shape, purpose, machine used, etc.
3) If the machine rotation speed is insufficient, reduce the rotation speed and feed rate by the same ratio.

CBN Technology

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The diagrams and table data are examples of test results, and are not guaranteed values.
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⚠ Attentions on Safety

1. Cautions regarding handling

(1) When removing the tool from its case (packaging), be careful that the tool does not pop out or is dropped. Be particularly careful regarding contact with the tool flutes.
(2) When handling tools with sharp cutting flutes, be careful not to touch the cutting flutes directly with your bare hands.

2. Cautions regarding mounting

(1) Before use, check the outside appearance of the tool for scratches, cracks, etc. and that it is firmly mounted in the collet chuck, etc.
(2) If abnormal chattering, etc. occurs during use, stop the machine immediately and remove the cause of the chattering.

3. Cautions during use

(1) Before use, confirm the dimensions and direction of rotation of the tool and milling work material.
(2) The numerical values in the standard cutting conditions table should be used as criteria when starting new work. The cutting conditions should be adjusted as appropriate when the cutting depth is large, the rigidity of the machine being used is low, or according to the conditions of the work material.
(3) Cutting tools are made of a hard material. During use, they may break and fly off. In addition, cutting chips may also fly off. Since there is a danger of injury to workers, fire, or eye damage from such flying pieces, a safety cover should be attached when work is performed and safety equipment such as safety goggles should be worn to create a safe environment for work.
(4) There is a risk of fire or inflammation due to sparks, heat due to breakage, and cutting chips. Do not use where there is a risk of fire or explosion. **Please caution of fire while using oil base coolant, fire prevention is necessary.**
(5) Do not use the tool for any purpose other than that for which it is intended.

4. Cautions regarding regrinding

(1) If regrinding is not performed at the proper time, there is a risk of the tool breaking. Replace the tool with one in good condition, or perform regrinding.
(2) Grinding dust will be created when regrinding a tool. When regrinding, be sure to attach a safety cover over the work area and wear safety clothes such as safety goggles, etc.
(3) This product contains the specified chemical substance cobalt and its inorganic compounds. When performing regrinding or similar processing, be sure to handle the processing in accordance with thelocal laws and regulations regarding prevention of hazards due to specified chemical substances.

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