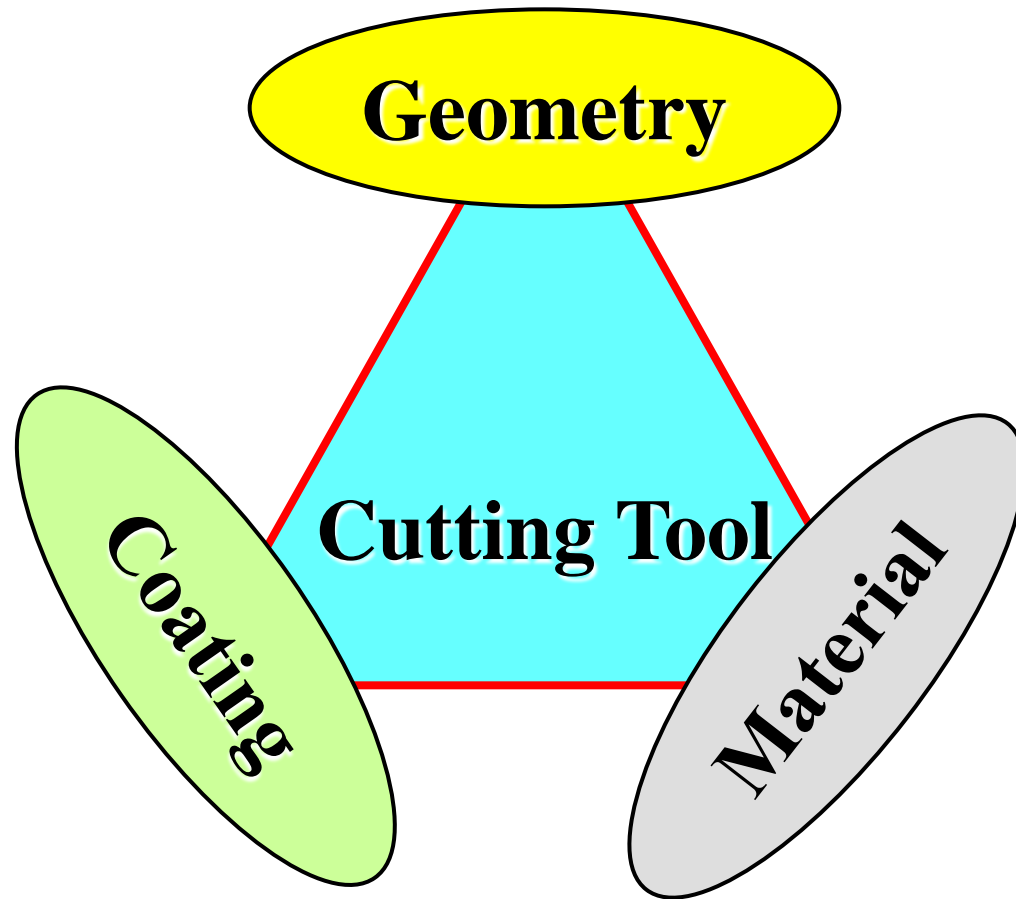


End Mill Training

Three Key Elements of a Cutting Tool



- 3 Elements Needed in a Good Cutting Tool
- Well Balanced For Best Performance
- Only Good as the Weakest Link

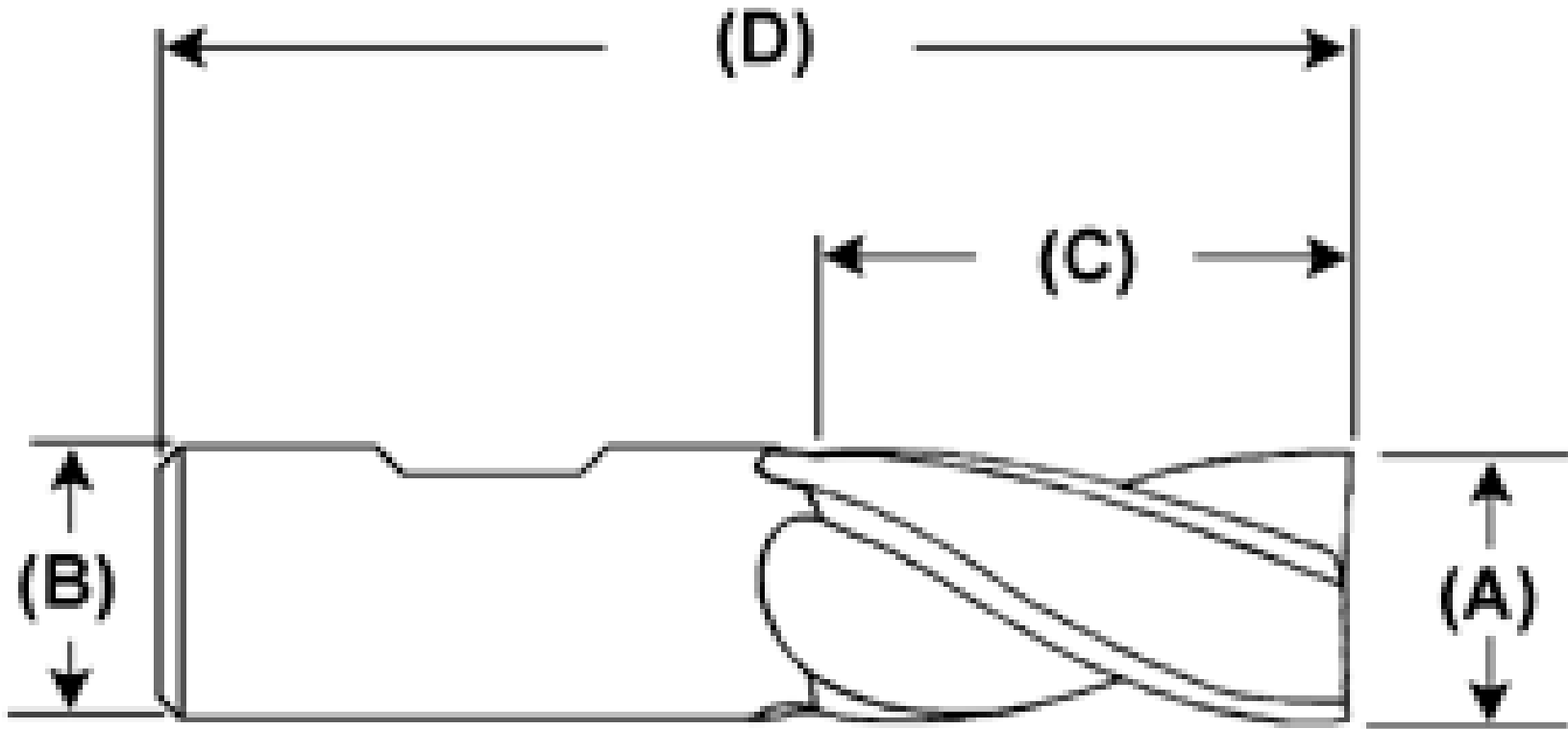
End Mill Terms

A - Mill Size or Cutting Diameter

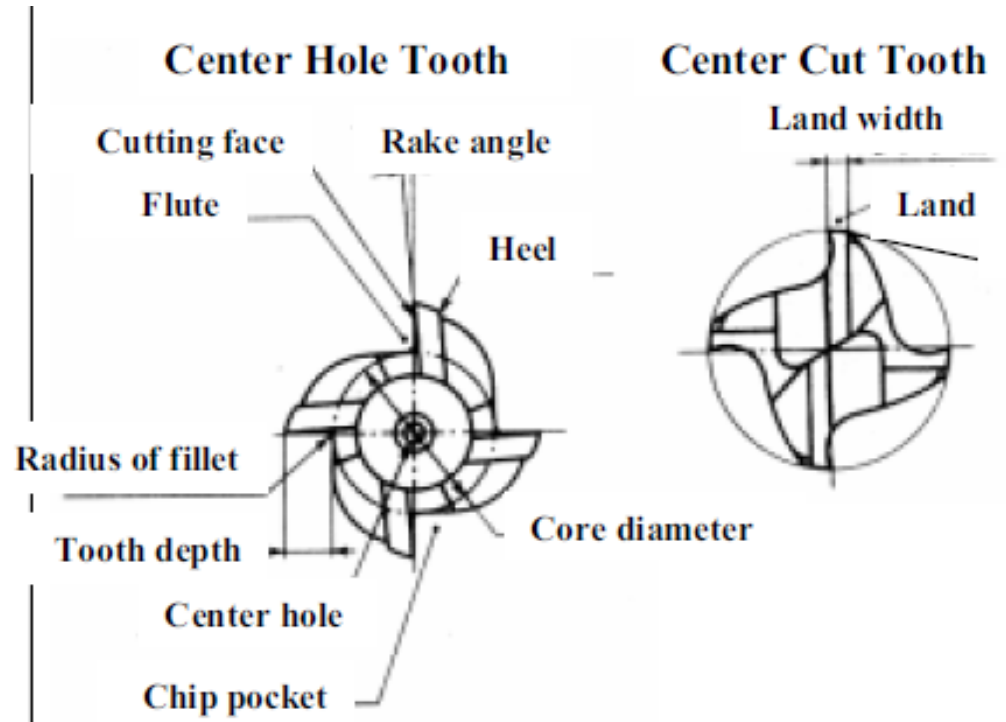
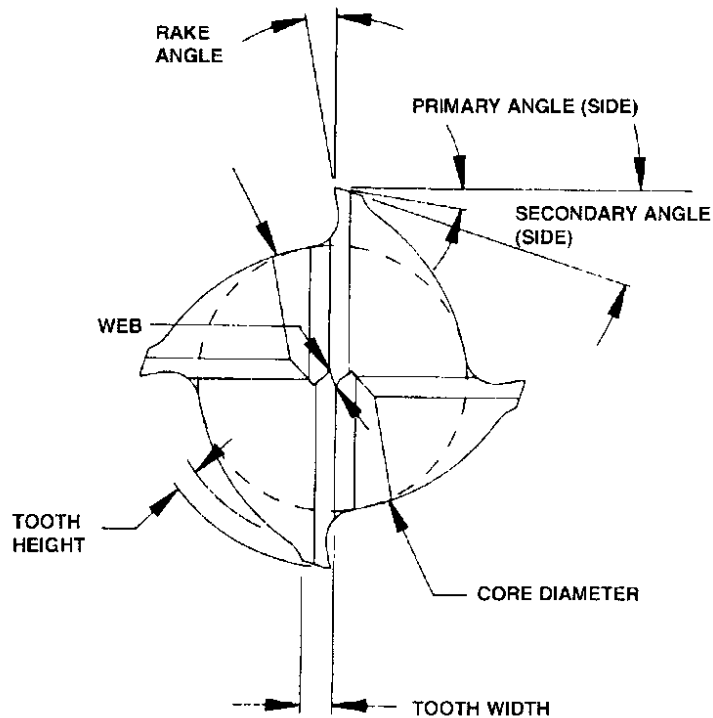
B - Shank Diameter

C - Length of Cut or Flute Length

D - Overall Length

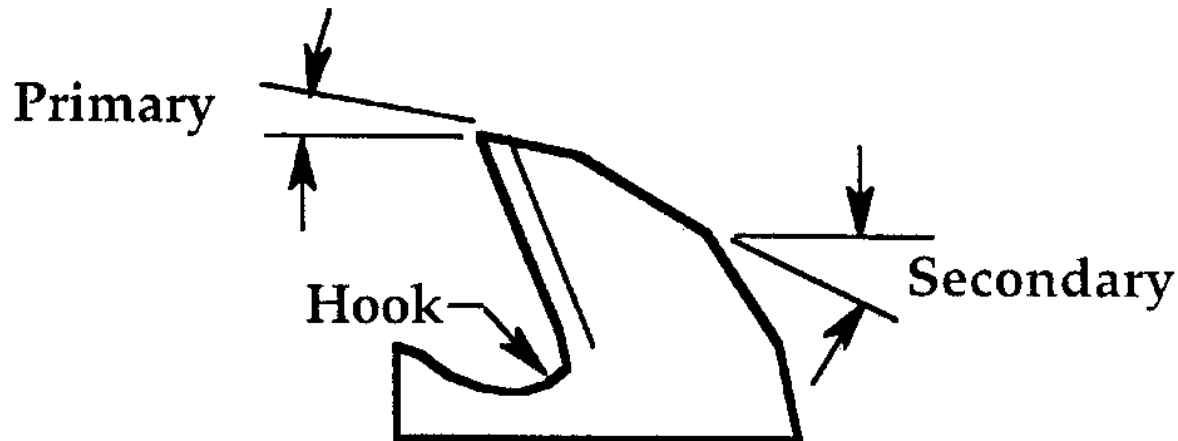


End Mill Terms Continued



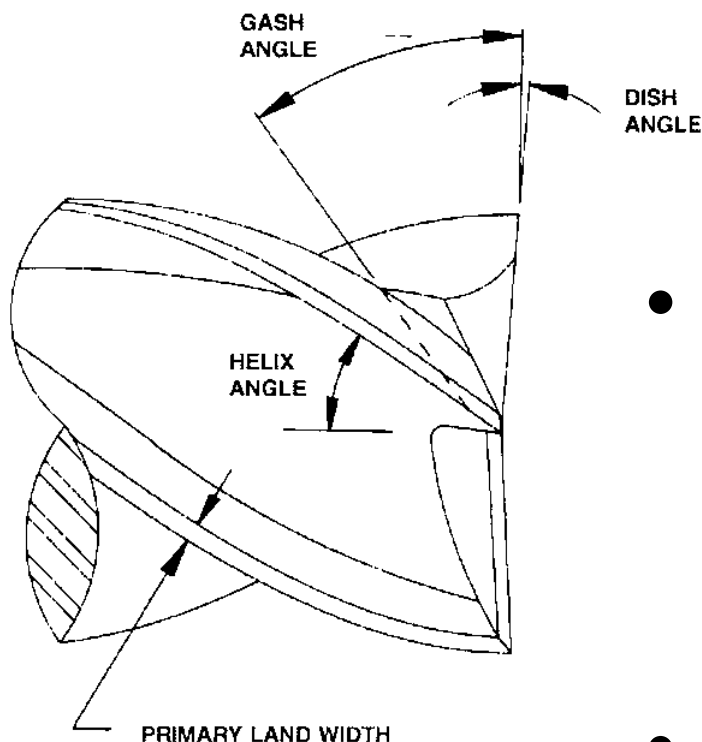
End Mill Side Clearance

- Primary (1st angle, 5° - 9°)
 - Relief Adjacent to Cutting Edge
- Secondary (2nd angle, 14° - 17°)
 - Relief Adjacent to Primary Angle
- Tertiary (3rd)
 - Additional Relief Provided Adjacent to the Secondary
 - High Performance End Mills



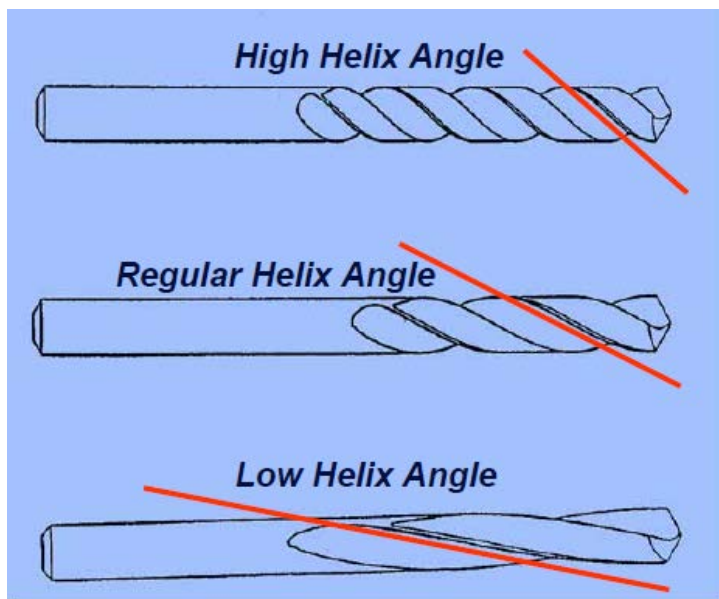
End Mill End Clearance

- Dish Angle
 - Angle Between End of Cutting Edge and Perpendicular to the Cutter Axis
 - Dish Ensures a flat Surface is Produced
- Gash (Notch)
 - Secondary Cuts to Provide Chip Space at Corners and Ends
 - Forming the End Cutting Edge when Feeding Axially
- Gash Angle
 - Relief Angle of the Gash Feature



End Mill Flutes

- Evacuate Chips
 - Outward
 - Not Upward like a Drill
- Two or More Flutes
- Usually Spiral Helix Shape



- Low Helix 10-20°
 - Harder Material 35 HRC +



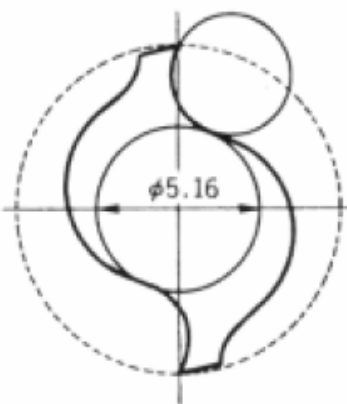
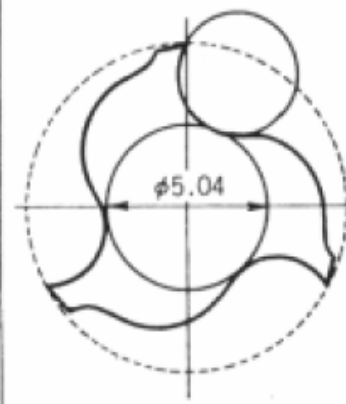
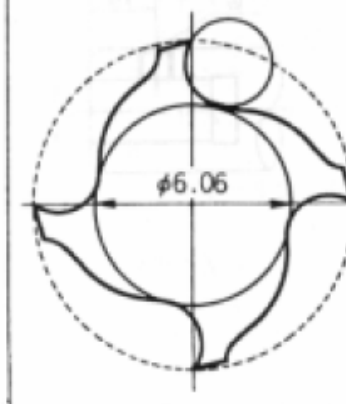
- Normal (GP) Helix 28-30°



- High Helix 40° +
 - Stringy Chips



Chip Pocket and # Teeth

	$\phi 10$ Two flutes	$\phi 10$ Three flutes	$\phi 10$ Four flutes
Core diameter and size of chip pocket			
Cross section of tooth	41 mm ²	44 mm ²	48 mm ²
Section rate	52%	56%	61%

Less No. of tooth=better chip ejection,less rigidity



More No. of tooth=worse chip ejection,high rigidity



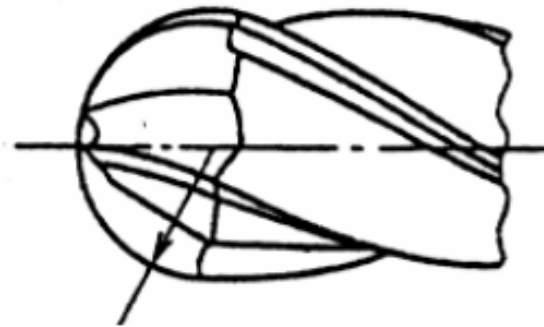
Four flutes end mill
is not suitable for
spot facing

End Cutting Edge Types

Square type



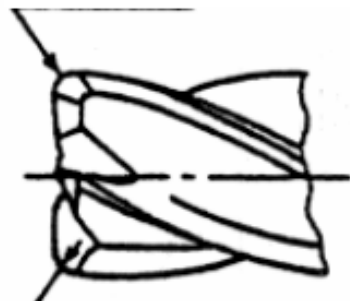
Ball nosed type



Radius of ball nose

Radius type

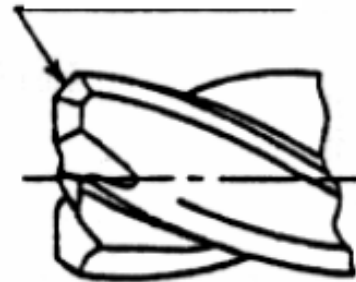
Rounded corner



Corner radius

Chamfer type

Chamfer

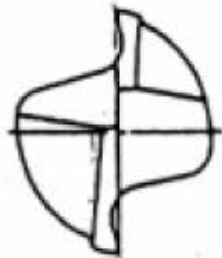


Cutting Edge Type

Center cut tooth



Two Flutes



Two Flutes(Long & Short Teeth)



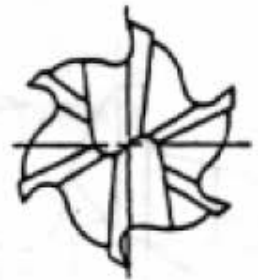
Three Flutes



Four Flutes

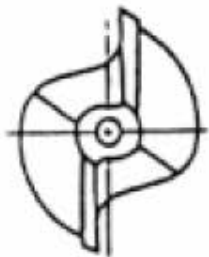


Four Flutes(Long & Short Teeth)



Six Flutes

Center hole tooth



Two Flutes



Three Flutes



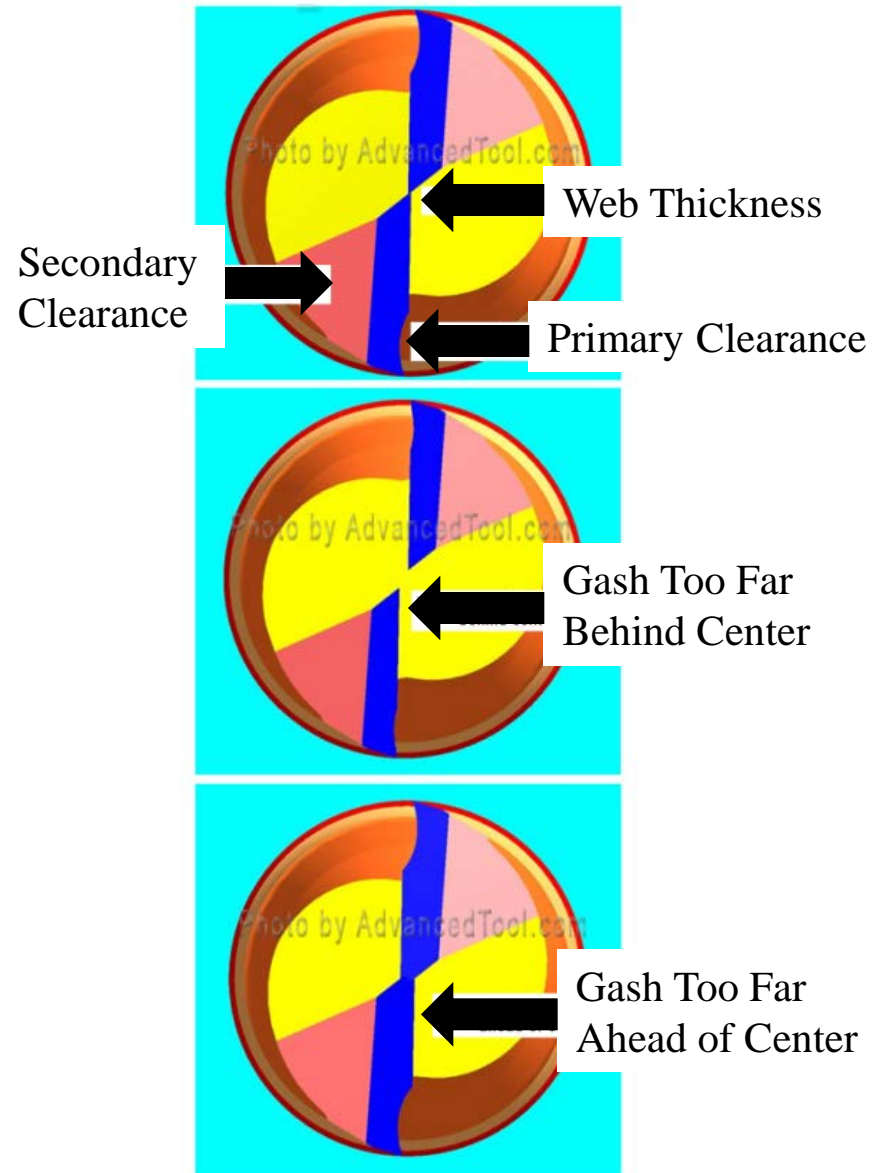
Four Flutes



Six Flutes

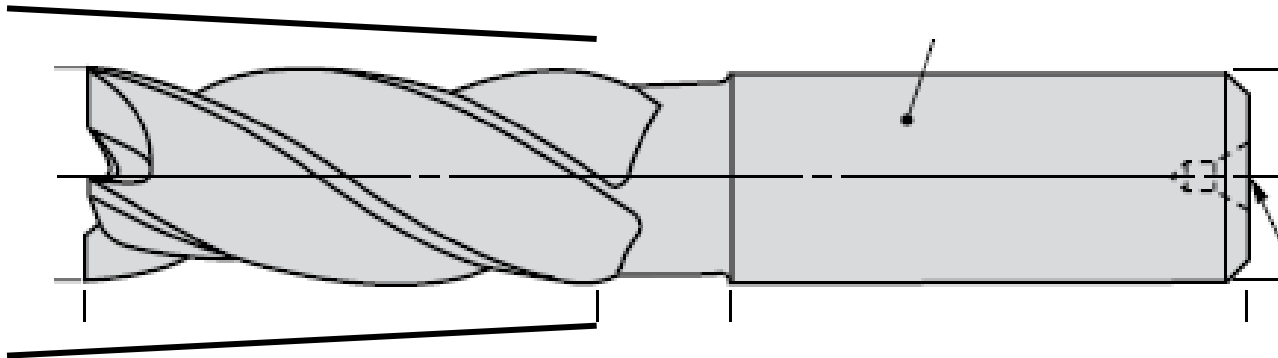
End Mill Web Thinning

- The Web is Non-Cutting
- Consume Power and Torque to Push Through the Work
- Thinning Reduces These
- Thinned Using Gash



Back Taper

- \emptyset is Tapered Towards the Shank
- Aids in Plunging/Drilling
- Compensate for Deflection



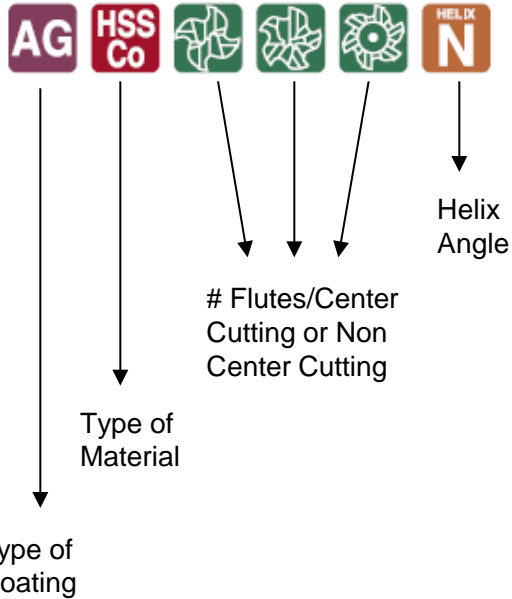
	Mark	Explanation	Mark	Explanation
Coating	G	G (TiN) Coating	Flutes of Drills	N Normal Helix Flutes ~ 30°
	UG	UG (TiCN multi layer) Coating		H High Helix Flutes 40° - 45°
	SG	SG (TiCN multi layer) Coating		L Low Helix Flutes 15° - 20°
	AG	AG (TiAlN multi layer) Coating	Drill Dimension	Point Angle of Drills
	AQ	AQ (TiAlN multi layer) Coating		Drill Length is from Center Point
	X's	X's (TiAlN multi layer) Coating		Drill Length is from Corner Point
	GS	GS (TiAlN multi layer) Coating		Oil-hole Drills
	DLC	DLC Coating		Three Flutes Drills
	DIA	Diamond Coating	Lip Relief of Drills	Shape of Lip Relief is Conical
Tool Materials	HSS	High Speed Steels		Shape of Lip Relief is Two Rake
	HSS Co	Cobalt High Speed Steels		Shape of Lip Relief is Three Rake
	FMX	Fine Melting HSS	Thinning of Drills	S-type Thinning
	FAX	High Grade Powder HSS		Notch Thinning
	Vanadium HSS	Vanadium HSS		X-type Thinning
	HSS-M	Vanadium HSS		XH-type Thinning
	HSS-E	Cobalt/Vanadium HSS		2 Rake Relief & X-type Thinning
	Tungsten Carbide	Tungsten Carbide		2 Rake Relief & XR-type Thinning
				3 Flutes Drills & 3F-type Thinning

	Mark	Explanation	Mark	Explanation
Tolerance of Drills Dia.	js6	Tolerance of Drills Diameter is js6	Flutes of End Mills	4 Flutes Radius End mills (Center Cut)
	h7	Tolerance of Drills Diameter is h7		2 Flutes Ball Nose End mills (Center Cut)
	h8	Tolerance of Drills Diameter is h8		4 Flutes Ball Nose End mills (Center Cut)
Flutes of End Mills	Sharp corner Type End mills			6 Flutes Ball Nose End mills (Center Cut)
	2 Flutes Square End mills (Center Cut)		Type of Taps	Cutting Taps
	3 Flutes Square End mills (Center Cut)			Forming Taps
	4 Flutes Square End mills (Center Cut)			Straight Flutes Taps
	4 Flutes Square for X's-mill Hard (Center Cut)		Flutes of Taps	Spiral Pointed Taps
	5 Flutes Square End mills (Center Cut)			Normal Helix Flutes Taps
	6 Flutes Square End mills (Center Cut)			High Helix Flutes Taps
	6 Flutes Square for X's-mill Hard & X's-mill Multi Flutes (Center Cut)			Low Helix Flutes Taps
	8 Flutes Square for X's-mill Hard & X's-mill Multi Flutes (Center Cut)		Chamfer of Taps	Chamfer Length is 2.5P to 3P
	4 Flutes Square End mills (with Center Hole)			Chamfer Length is 4P to 5P (for through hole)
	5 Flutes Square End mills (with Center Hole)			Chamfer Length is 1.5P (for blind hole)
	6 Flutes Square End mills (with Center Hole)			Chamfer Length is 2.5P
	Multiple Flutes (over 8) Square End mills (with Center Hole)			Chamfer Length is 3.5P
	2 Flutes Radius End mills (Center Cut)			Cutting Taps for Taper Pipe

Endmills / Visual Index

List 6488

AG-MILL ROUGHING LONG



H=High Helix (40°)

N= Normal Helix (30°)

L= Low Helix (15°)



Specs/Sizes
Speeds/Feeds

P160
P192

Specs
/Sizes

Speeds &
Feeds

NACHI CNC TOLERANCE (Cutting Diameter)

+.0010 0				0 -.0010	
List No.	Tool No.	List No.	Tool No.	List No.	Tool No.
6201	PF	6233	PGE	6230	MPG
6203	PFL	6367	PK	6290	MPR
6207	PFX	6367P	PKP	±.0040	
6210	HPF	6367X	PKX		
6211M	PFC	7221P	PHP	6303	PQ
6211X	PFCX	0 -0.0015		6303P	PQP
6213	PFLC			6303X	PQX
6231	PG	6261	PC	6304	MPQ
6231X	PGX	6295	PRR	6305	PQA
				6307	PQF

*Some items, present stock until depleted.

Specs/Sizes EX 9263X & 9267X

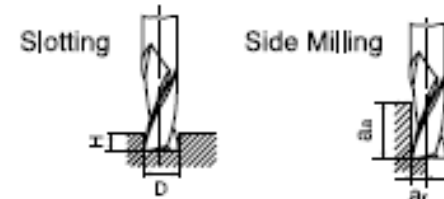
L9263X	L9273X	Diameter of Mill	Shank Diameter	Length of Cut	Number of Flutes	Overall Length
CFX4	CRFX4	1/8	1/8	1/2	4	1 1/2
CFX6	CRFX6	3/16	3/16	5/8	4	2
CFX8	CRFX8	1/4	1/4	3/4	4	2 1/2
CFX10	CRFX10	5/16	5/16	13/16	4	2 1/2
CFX12	CRFX12	3/8	3/8	1	4	2 1/2
CFX14	CRFX14	7/16	7/16	1	4	2 3/4
CFX16	CRFX16	1/2	1/2	1	4	3
CFX20	CRFX20	5/8	5/8	1 1/4	4	3 1/2
CFX24	CRFX24	3/4	3/4	1 1/2	4	4
CFX32	CRFX32	1	1	1 1/2	4	4

Speeds/Feeds EX 9263X & 9267X

Work Material		Carbon Steels (up to 30HRc)		Alloy Steels 30~45HRc		Tool Steels 45~55HRC		Cast Iron (up to 200HB)		Cast Iron (200HB~)		Stainless Steels		Titanium Alloys		Aluminum, Nonferrous Metals	
Milling Conditions		200 SFM		150 SFM		100 SFM		220 SFM		160 SFM		140 SFM		140 SFM		590 SFM	
Dia. of Mill (inch)		RPM	Feed (IPM)	RPM	Feed (IPM)	RPM	Feed (IPM)	RPM	Feed (IPM)	RPM	Feed (IPM)	RPM	Feed (IPM)	RPM	Feed (IPM)	RPM	Feed (IPM)
1/8		6,110	19.6	4,580	9.2	3,060	6.1	6,720	32.3	4,890	9.8	4,280	10.3	4,280	8.6	18,300	51.2
3/16		4,070	16.3	3,060	7.3	2,040	4.9	4,480	26.9	3,260	7.8	2,850	8.0	2,850	6.8	12,200	39.0
1/4		3,060	14.7	2,290	6.4	1,530	4.3	3,360	24.2	2,450	6.9	2,140	6.8	2,140	6.0	9,100	32.8
5/16		2,440	12.7	1,820	5.8	1,220	3.9	2,690	23.7	1,960	6.3	1,700	6.1	1,700	5.4	7,300	29.2
3/8		2,030	12.2	1,540	5.5	1,020	3.7	2,240	22.4	1,620	5.8	1,420	5.7	1,420	5.1	6,100	26.8
7/16		1,740	12.5	1,300	5.2	870	3.5	1,920	21.5	1,400	5.6	1,220	5.4	1,220	4.9	5,200	25.0
1/2		1,530	12.2	1,150	4.6	760	3.0	1,680	20.2	1,220	5.4	1,070	5.1	1,070	4.7	4,500	23.4
5/8		1,220	11.7	910	4.0	610	2.7	1,350	18.9	980	4.7	850	4.8	850	4.1	3,600	21.6
3/4		1,010	10.5	770	3.7	510	2.4	1,120	17.9	810	4.2	710	4.3	710	4.0	3,000	19.2
1		760	9.1	650	3.9	380	2.3	840	15.1	610	3.7	530	3.2	530	3.2	2,200	17.6
Depth of Cut	a _s	1.5D (Long 2.0D)												1.0D (Long 2.0D)		1.5D (Long 2.0D)	
	a _r	0.1D (Long 0.05D)				0.05D (Long 0.02D)		0.1D (Long 0.05D)				0.1D (Long 0.05D)		0.05D (Long 0.2D)		0.2D (Long 0.1D)	
	H	0.25D				0.15D		0.25D				0.15D		0.05D		0.25D	

- 1) Mill using coolants,
- 2) Adjust milling condition when unusual vibration or sound occurs.

D: Dia. of Mill



Nachi Materials

- HSS = High Speed Steel

- General Purpose

- Symbol= 



EX's – L231, L261,
L211, L215, & L271

- HSSCo = Cobalt High Speed Steel

- HSS With Added Cobalt for Wear Resistance

- Symbol= 



EX's – L6231HD, L6450, L6485, L6406, L6484, L6486, L6488,
L6403, L6402, L6404, L6231X, L6211X, L6367X, L6303X, L6231,
L6233, L6230, L6213, L6210, L6211M, 6367, L6303, & L6307

Nachi Materials

- Carbide = Tungsten Carbide
- Compacted & Sintered 3 X Stiffer than Steel
- Symbol= 

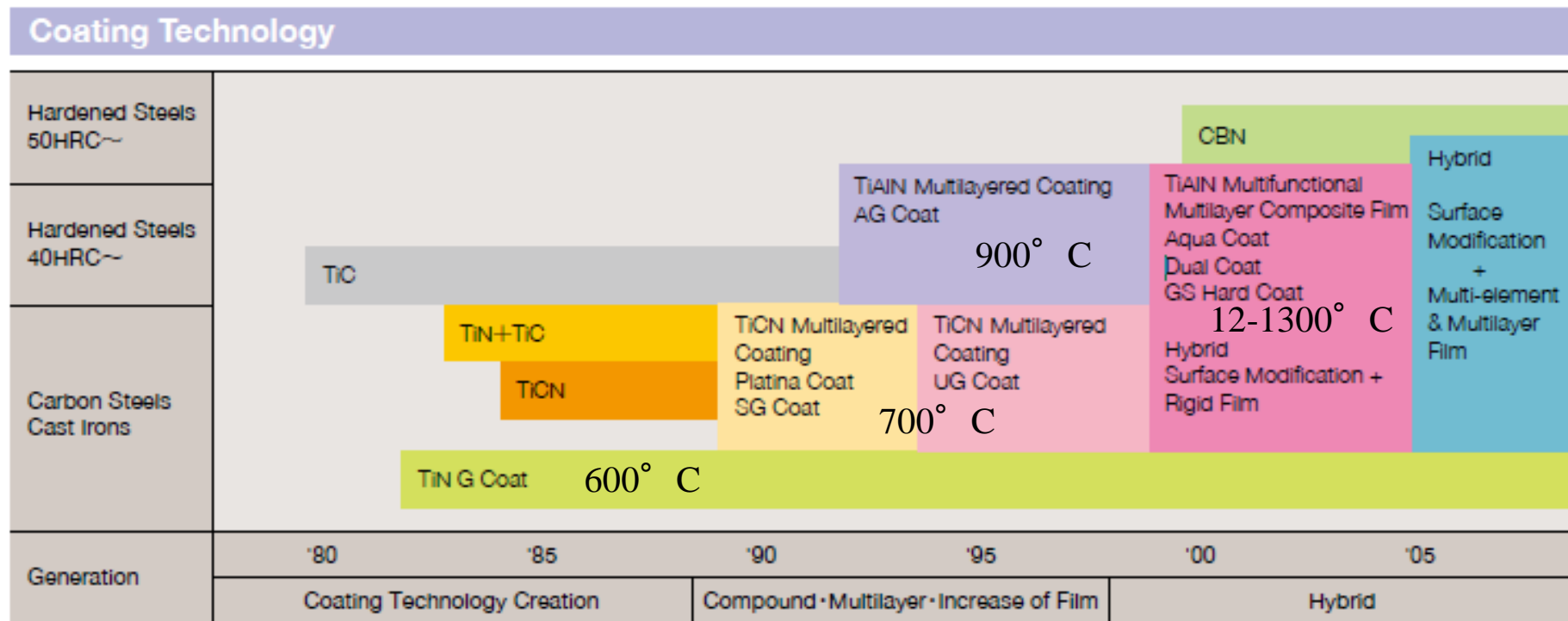


EX's – L9382, L9384, L9386, L9398,
 L9422, L9399, L9423, L9408, L9321, L9322,
 L9324, L9338, L9366, L9368, L9340, L9332, L9330,
 L9378, L9302, L9390, L9360, L9261X, L9265X, L9271X,
 L9275X, L9263X, L9267X, L9273X, L9277X, L9251X, & L9221X


Coatings Advantages

- Better Wear Resistance
- Better Toughness
- Better Heat Resistance
- Better Lubrication

Coatings Development and Approx. Temperature Max



Nachi Coatings

- SG-Coating = TiN + TiCN (Multi Layer Coating)
- Service Temperature= 700° C
- Color= Gold Yellow
- Symbol= 



EX – L9261X, L9265X, L9271X, L9275X, L9263X, L9267X,
L9273X, L9277X, L9251X, L9221X, L6231X, L6211X, L6367X, & L6303X

- AG-Coating = TiALN (Multi Layer Coating)
- Service Temperature= 900° C
- Color= Violet-Gray
- Symbol= 




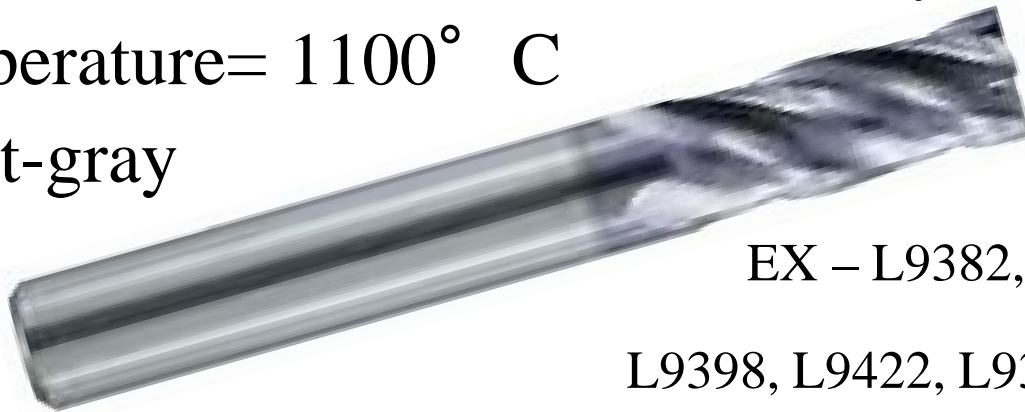
EX – L6485, L6406, L6484,
L6486, L6488, L6403, L6402, & L6404

Nachi Coatings


- X's-Coating = TiALN (Multi Layer Coating) for End Mills
- Service Temperature= 900° C
- Color= Violet-Gray
- Symbol=  EX – L9408, L9321, L9322, L9324, L9338, L9366, L9368, L9340, & L9332

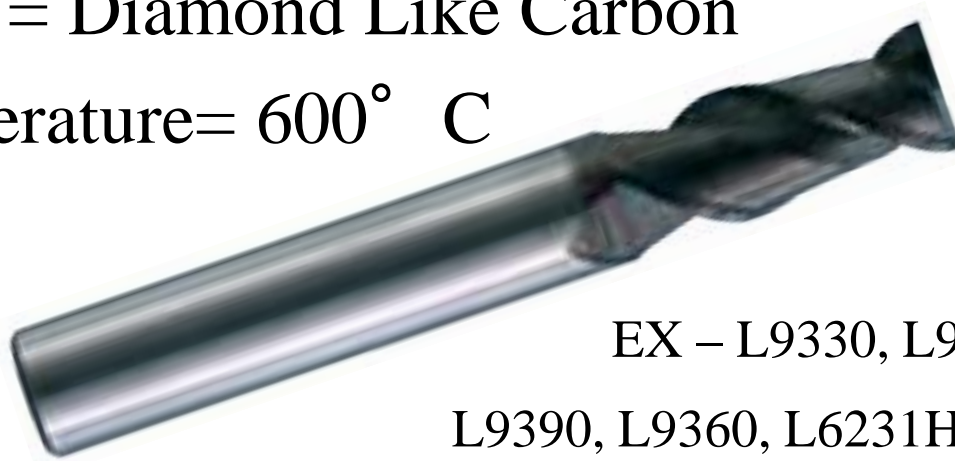


- GS-Coating = TiALN + Al-Ti-Cr (Multi Layer Coating)
- Service Temperature= 1100° C
- Color= Violet-gray
- Symbol=  EX – L9382, L9384, L9386, L9398, L9422, L9399, & L9423



Nachi Coatings

- DLC-Coating = Diamond Like Carbon
- Service Temperature= 600° C
- Color= Black
- Symbol= 



EX – L9330, L9378, L9302,
L9390, L9360, L6231HD, & L6450

Metric Conversion Table

- Last Page of the Nachi Catalog
- Can use formula
 - $\text{mm}/25.4 =$ English
 - $\text{English} \times 25.4 =$ mm

Decimal	Fraction	Wire, Letter	mm	Tap Sizes To be used with drills as indicated
.0029	97/15			
.0063	96/16			
.0067	95/17			
.0071	94/18			
.0075	93/19			
.0079	92/20			
.0083	91/21			
.0087	90/22			
.0091	89/23			
.0095	88/24			
.0098				
.0100	87/25			
.0105	86/26			
.0110	85/28			
.0115	84/29			
.0118				
.0120	83/30			
.0125	82/32			
.0126				
.0130	81/33			
.0135	80/35			
.0138				
.0145	79/38			
.0150				
.0156				
.0157				
.0160	78/40			
.0177				
.0180	77/42			
.0197				
.0200	76/43			
.0217				
.0225	74/45			
.0229				
.0240	73/47			
.0250	72/48			
.0610				
.0614				
.0630				
.0635				
.0650				
.0669				
.0670				
.0689				
.0700				
.0709				
.0728				
.0730				
.0748				
.0760				
.0768				
.0781				
.0785				
.0787				
.0807				
.0810				
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.6094				
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.5807				
.5906				
.5938				
.6004				
.6094				
.6102				
.5781				
.5807				
.5906				
.5938				
.6004				
.6094				
.6102				

Variable Helix-Variable Index End Mills

- Genac VGX End Mill
 - High Performance
 - Carbide
 - AG Coated
- Variable Helix-Variable Index Reduce Vibration
 - Faster Feed Rates
 - Improved Surface Finish



Drill/End Mill Selection Tool

Item Search —END MILLS—

BACK

Item Search [Top](#) > Endmill Size Specification

Endmills Size Specification

* Sections marked * must be filled in.

EDP number

EDP Search

Clear

Size *



mm



Inch

1/32



Search

Clear

Length Style

All Length Style

Number of
Flutes

All No of Flutes

Workpiece
Material

All Workpiece Material



Search

Clear

BACK

Hi-Performance End Mills

Hi-Performance End Mills

Product Review

- X's-Mill Geo
- X's-Mill Slot
- GS-Mill Hard & GS-Mill Hard Ball
- Mold Meister Ball
- AG-Mill Roughing/AG-Mill Heavy
- DLC -Mill
- Standard High Speed End Mills

Geo X-Mill



Features:

- **Unique Flute Geometry Resulting in Fast Groove Milling and Excellent Chip Evacuation**
- **Tough Micro Grain Carbide and TiAlN Coating Equals Longer Tool Life**
- **Multifunctional End Mill for High Speed Roughing and Precise Side Milling**

Work Materials:

- **Carbon Steels, Alloy Steels, Pre-Hardened Steels, Stainless Steels, Nickel Alloys, Titanium Alloys, Cast Irons**

Feature of Geo X Mill

Geometry of Geo X Mill



Geo X Mill Design

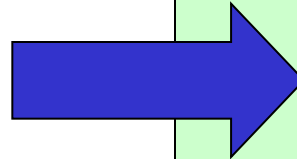


Conventional End Mill Design

Background of X' s-Mill Geo's Development

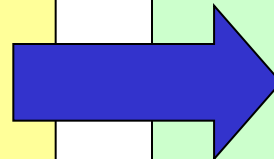
Futures Required for End Mills

HSC・HFC Requires High RPM Machining Center



High Efficient
Machining by
Conventional
Machines

- Cost down
- Short Life Cycle of Products (PC, Mobile Phone)
- Flexible Manufacturing due to Various User Needs
- Short Delivery Time of Mold & Die

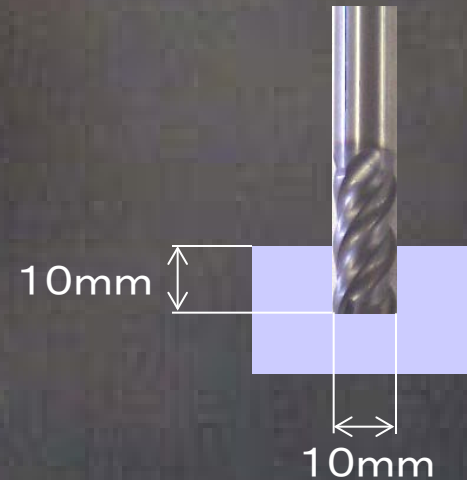


Flexibility
Multipurpose

Example

Critical Feed Test

End Mill: $\phi 10$ 4Flutes
Rotation: $2,550 \text{ min}^{-1}$ Feed: $1,500 \text{ mm/min}$
Cut Depth: $a_a 10 \text{ mm}$ $a_r 10 \text{ mm}$ Slotting
Material: SKD11 (220HB) DRY (No Air B Low)



Chip Shape



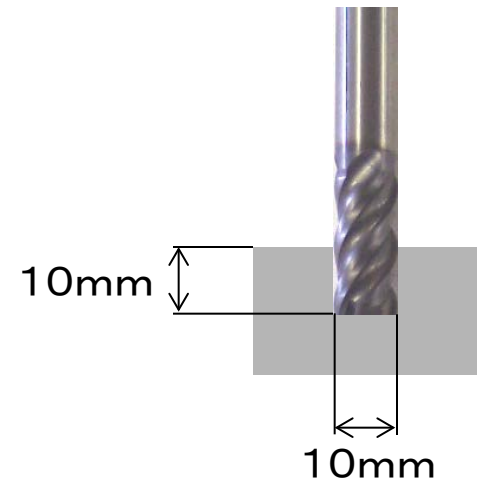
10mm

End Mill: $\phi 10$ 4Flutes

Rotation: 2, 550min⁻¹ Feed: 1, 500mm/min

Cut Depth: aa10mm ar10mm Slotting

Material: SKD11 (220HB) DRY (No Air BLow)



Difference of Flute Geometry

X 's-Mill *Geo*



Brand C



X's Mill Geo Series

- X's-Mill Geo, Geo Radius
- X's-Mill Geo Ball
- X's-Mill Geo Micro Ball
- X's-Mill Geo Long Shank
- X's-Mill Geo Slot



X's-Mill Geo

High Speed Machining Wide Range Materials

Wide Range of High Speed Milling from Carbon Steel to Hardened Steel - Thanks for the Best Combination with Multilayered TiAlN Coating Film and Tough Carbide Substrate

Easy Chip Control

High Speed Grooving, and Drilling with the 4 Flutes Mill Thanks to NACHI's Unique Flute Geometry

Ridged and Tough

Unique Flute Geometry and Wide Land on the Cutting Edge

Tough Cutting Edge Extremely High Milling Speed and Excellent Finishing Surface



⊙: Stable Milling ○: Milling △: Chipping ×: Broken

Conditions	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
X's Mill Geo	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	○	○	○	△	△
Competitor A	⊙	⊙	⊙	⊙	○	○	○	△	△	△	×							
Competitor B	⊙	⊙	⊙	○	○	△	△	△	△	×								

Feed(mm/min)

Conditions

End Mill : 10mm

Material : SKD11(180HB)

Speed : 80m/min

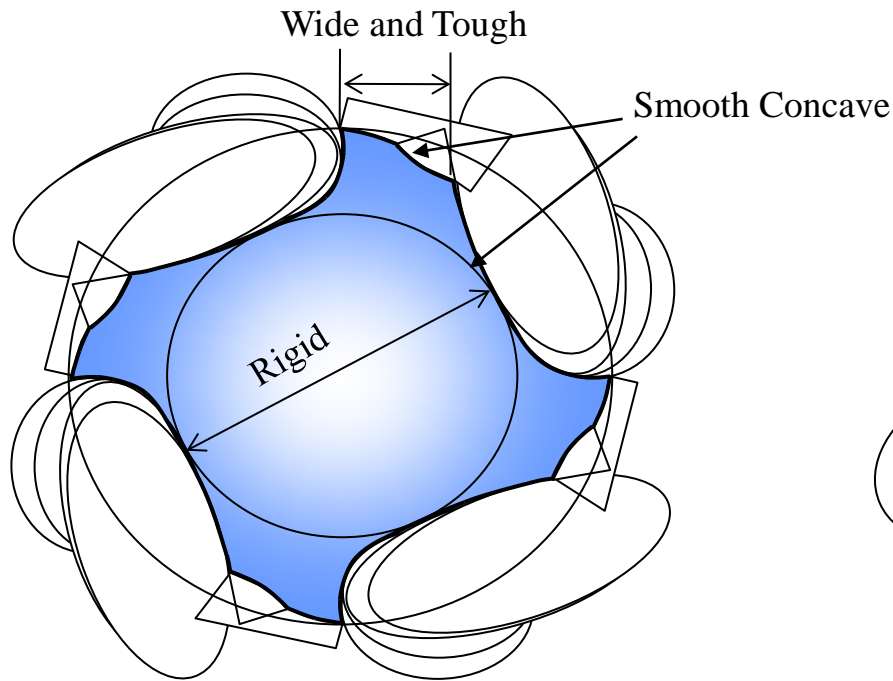
Coolant : Dry

Smooth FLOWing Chips

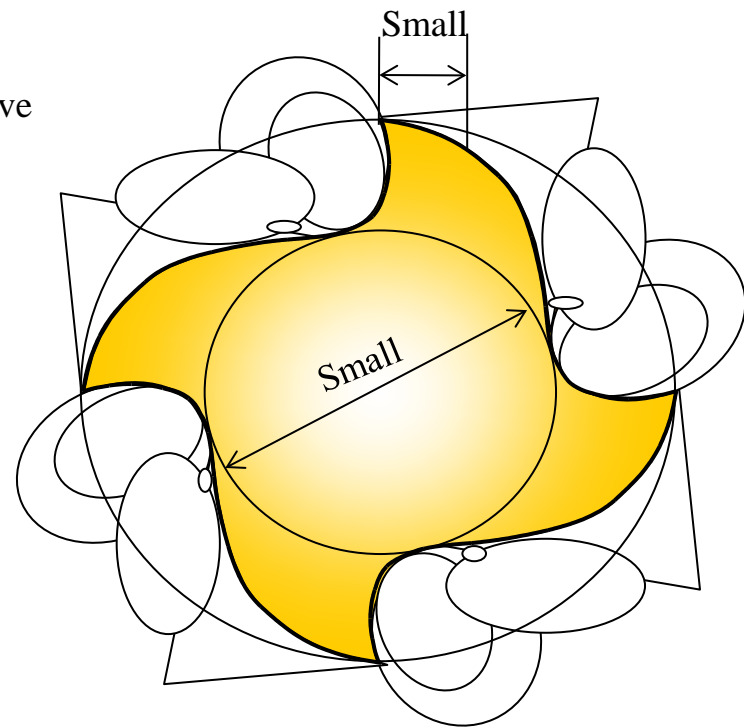


Feature of Geo X Mill

Cross Section of X's Mill Geo



Geo X Mill

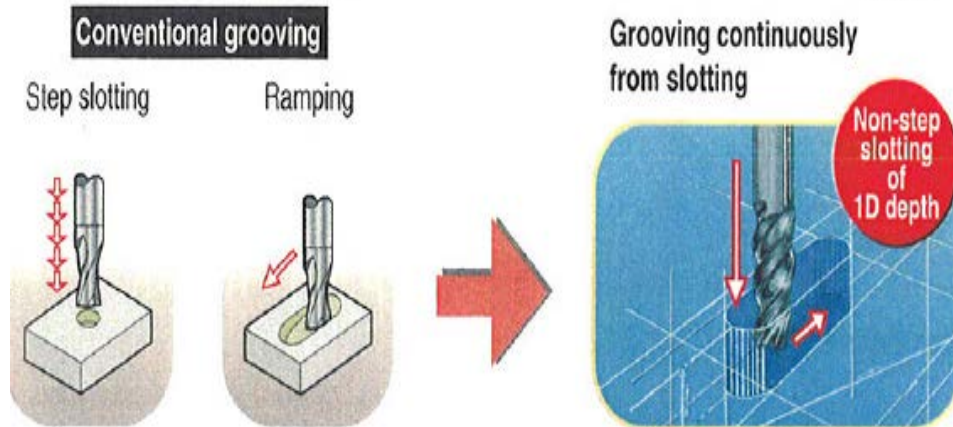


Conventional

X'-Mill Geo Slot



Shape



Features:

- **3- 4 Times Faster Grooving than Conventional End Mill**
- **Unique Design of End Teeth Provide Excellent Chip FLOW**
- **Well Balanced 3-Flutes make Efficient Slotting Possible**
- **Non-Step Slotting of 1D Depth Possible**

Work Materials:

- **Carbon Steels, Alloy Steels, Pre-Hardened Steels, Hardened Steels, Stainless Steel, Nickel Alloys, Titanium Alloys, Cast Irons**

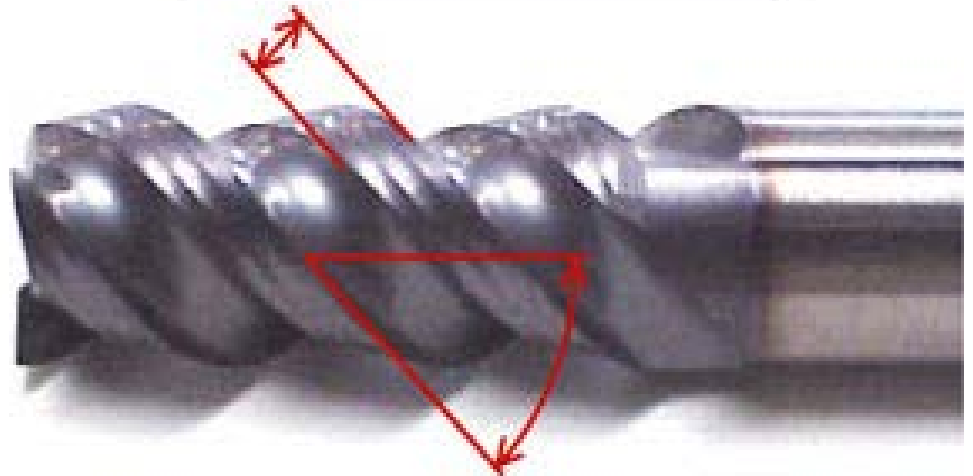
Geo Slot Geometry

Gash for good
chip discharge



3 flutes for drilling

Wide land width






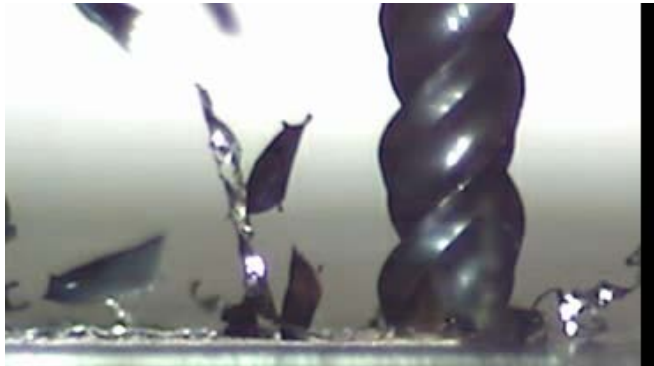
High helix for sharpness
& good chip discharge

Slotting Milling by Geo Slot



Smooth Chip Evacuation

(Material: Carbon Steel-Thin Plate)

	New	After 120 Grooves
Geo Mill Slot		
Competitor B		

Geo Mill Slot Chip Evacuation Good Even After 120 Grooves Milling

GS Mill Hard

GS Mill Hard

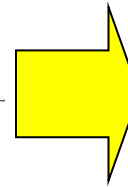
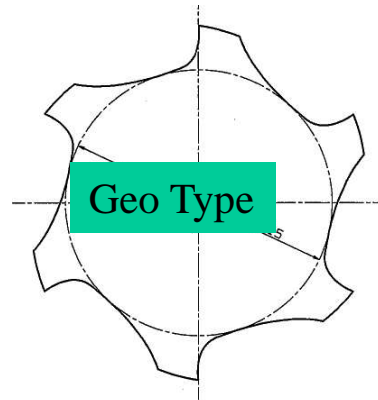
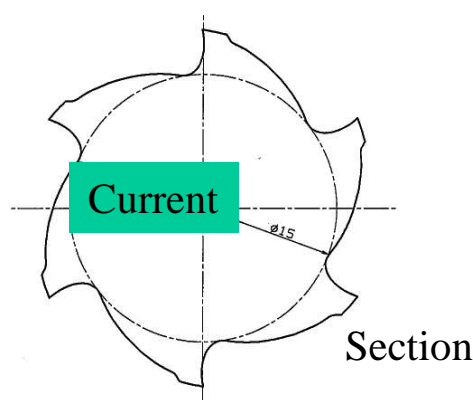


Milling Up to 70HRc

- **Features:**
 - High Speed Machining of Hardened Steels
 - For Machining Hardened Steels up to 70 Hrc
 - Nachi's New "GS Hard Coat" (Al-Ti-Cr Based Coating)
 - 3 Times Tougher Anti-Oxidization at 1,100° C
- **Work Materials:**
 - Pre-Hardened Steels, Mold Steels, Hardened Steels H13, D2, M3 (45-60 Hrc)

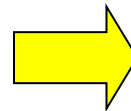
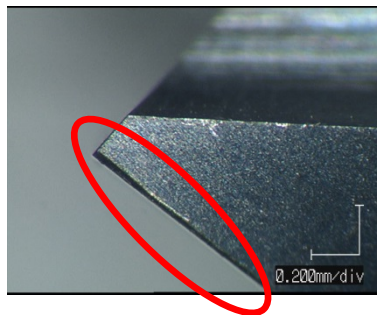
Features of GS-Mill Hard

- “Geo” Flute Geometry to Increase Both Chip Evacuation and Higher Rigidity
- Corner Chamfering to Minimize the Corner Wear
- New “GS Hard” Coating to Dissipate Heat and Smoother Chip Evacuation
- Ultra Micro Grain Carbide for Better Abrasion Resistance

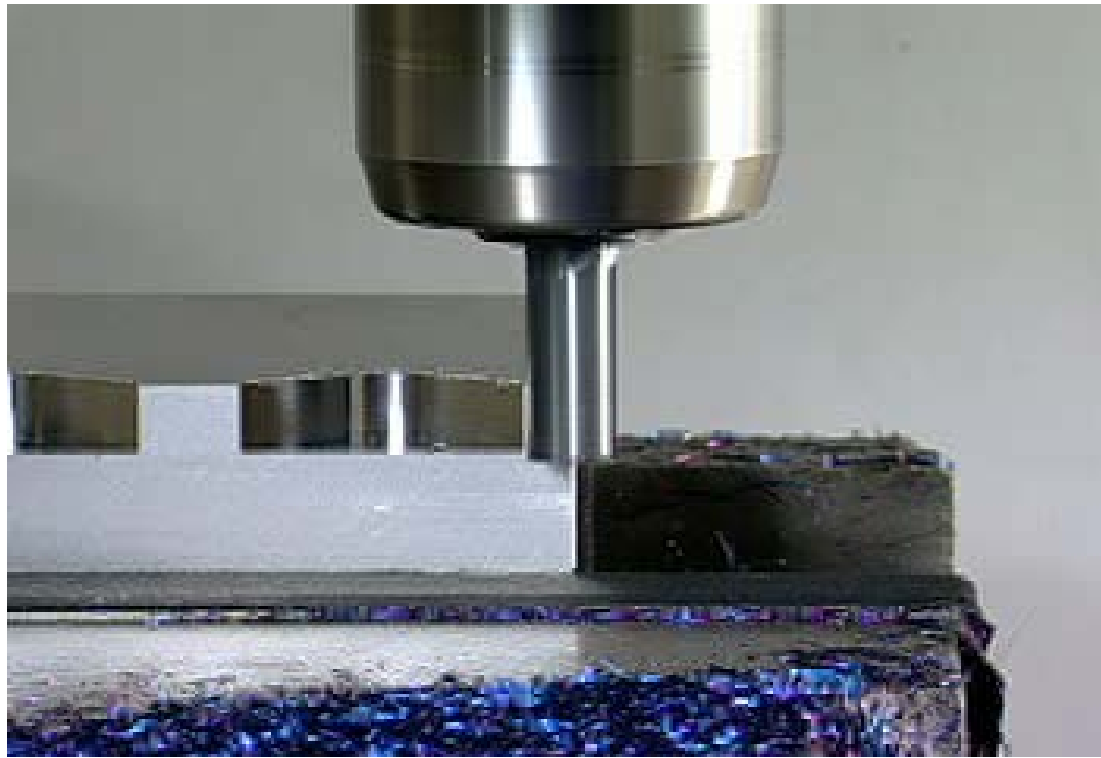


**Smooth Curvature Enables
Better Chip Evacuation
Wider Land Width Increases
Tool Rigidity**

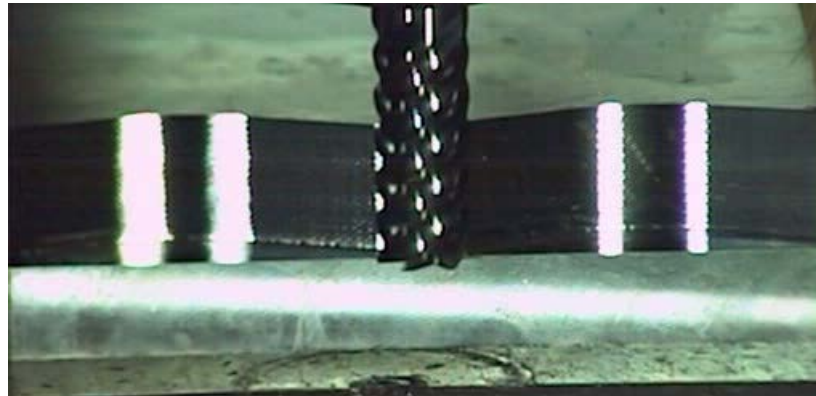
【Invention on Corner Edge】



**The Corner Chamfering Minimizes
the Corner Wear Effectively**

Movie SKD61(53HRC) Ultra High Speed

Dia: ϕ 10 6Flute Dry
V: 800m/min
F: 10, 000mm/min
aa: 10mm
ar: 0. 2mm
Material: SKD61(53HRC)



GS Mill Hard Ball



Durable Tool Life

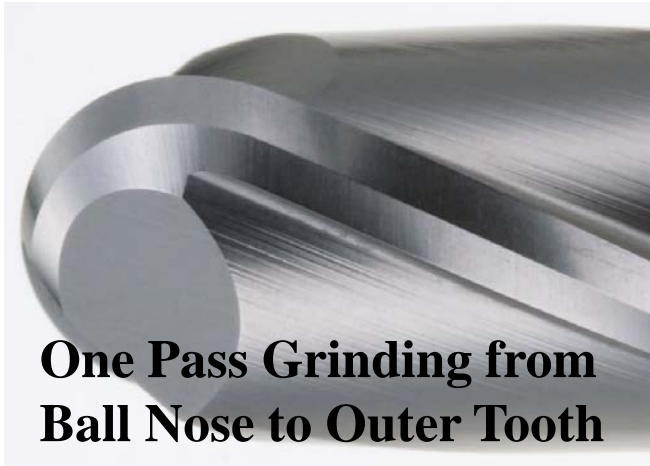
- Newly Developed “GS Hard Coating” with High Resistance to Wear and Lubrication Reduces Friction
- High TRS by Ultra-Micro Grain Carbide Protects Chipping as Well as Wear
- Excellent Work Surface

Accurate Surface

- The Ball Nose Accuracy is Applied by $+3 \sim -7\mu\text{m}$
- The “One-Pass” Grinding Guarantees Excellent Surface Even on the Perpendicular Wall

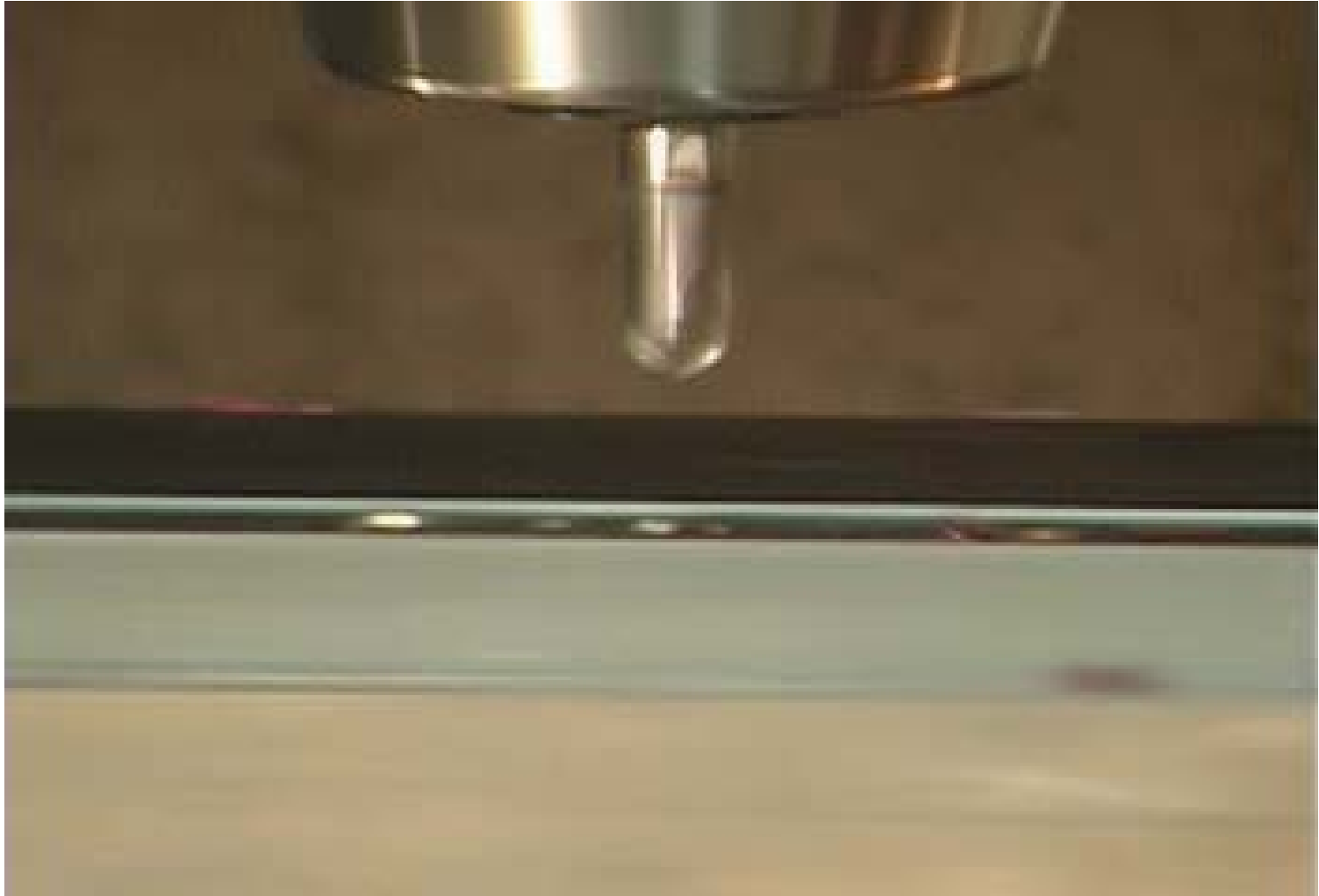
Work Materials:

Pre-Hardened Steels, Mold Steels, Hardened Steels H13, D2, M3 (45-60 Hrc)



**One Pass Grinding from
Ball Nose to Outer Tooth**

**High Performance Milling SFM=750 RPM=9500 Feed= 80 ipm
(End Mill R4, Mold Steel, 53HRC, R4, Radial Depth= 4mm, axial
Depth=.025))**



For Mold & Die

**“Machining to Zero” with the
Mold Meister Ball End Mill**

Features of Mold Meister Ball



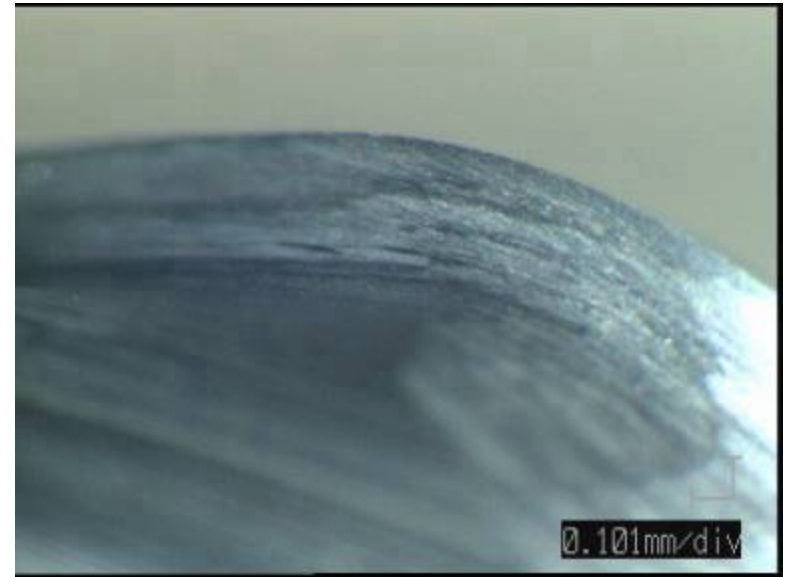
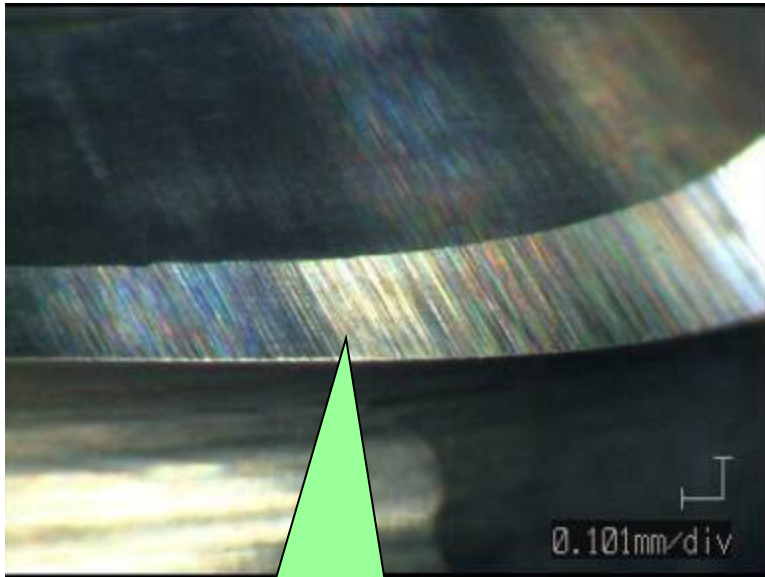
Features:

- **Precision Carbide End Mill**
Best Suited for “Machining to Zero”
- **Seamless Ball Tolerance**
Drastically Reduces Polishing Time
- **High Precision Ball Tolerance**
 $\pm 3\mu\text{m}$, Ball Accuracy Range 180°
- **Highly Suitable for Mold and Die Work**

Work Materials:

- **Pre-Hardened Steels, Mold Steels, Hardened Steels H13, D2, M3 (45-60 Hrc)**

Appearance of Mold Meister Ball



**Seamless
One Pass Grinding**

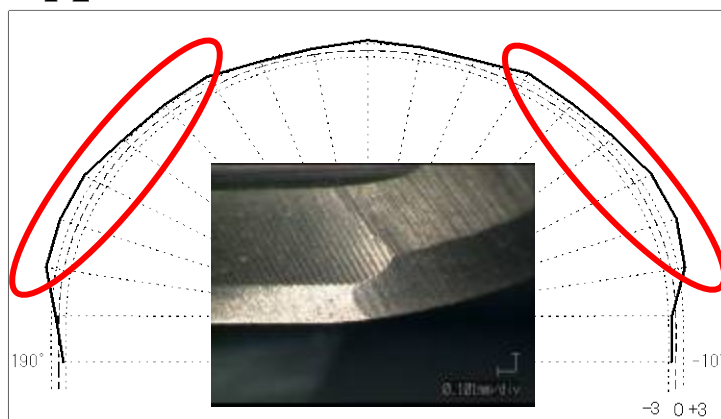
Actual Measurement of Competitor's Accuracy

Competitor A R1

Nominal: $\pm 5\mu\text{m}$

A

他社ボール検査成績書



測定角度 Angle	測定値 R
-10°	0.9971
0°	0.9985
10°	1.0058
20°	1.0085
30°	1.0082
40°	1.0058
50°	1.0050
60°	1.0067
70°	1.0031
80°	1.0034
90°	1.0049
100°	1.0029
110°	1.0025
120°	1.0051
130°	1.0041
140°	1.0043
150°	1.0076
160°	1.0077
170°	1.0073
180°	1.0013
190°	1.0014

製番 Serial Number	
型番 Model Number	
R公差 R Tolerance	R 1

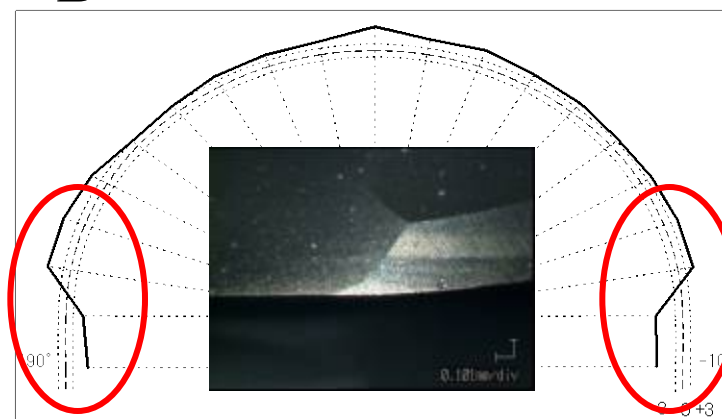
R実測値 R Accuracy	R 1.0000 +0.0085 -0.0015	
R最大値 R-Max	20°	R 1.0085
R最小値 R-Min	0°	R 0.9985
外径 Diameter	ϕ 1.9985	

Competitor B R3

Nominal: $\pm 5\mu\text{m}$

B

他社ボール検査成績書



測定角度 Angle	測定値 R
-10°	2.9894
0°	2.9890
10°	3.0063
20°	3.0060
30°	3.0051
40°	3.0042
50°	3.0055
60°	3.0059
70°	3.0081
80°	3.0072
90°	3.0113
100°	3.0062
110°	3.0057
120°	3.0051
130°	3.0035
140°	3.0032
150°	3.0074
160°	3.0092
170°	3.0095
180°	2.9930
190°	2.9910

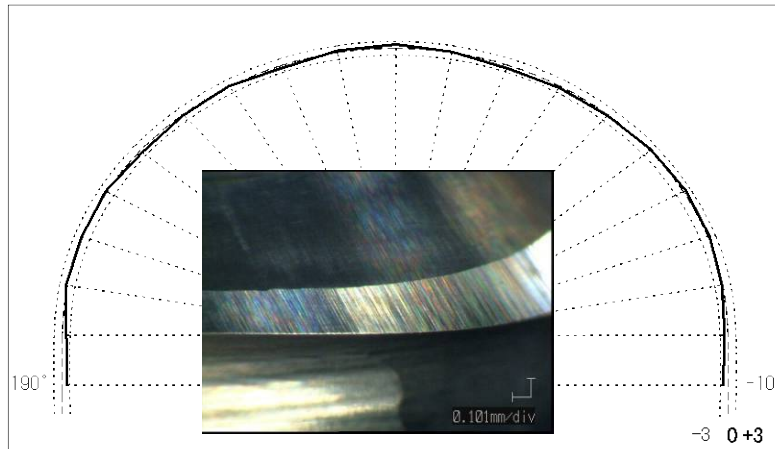
製番 Serial Number	
型番 Model Number	
R公差 R Tolerance	R 3

R実測値 R Accuracy	R 3.0000 +0.0113 -0.0110	
R最大値 R-Max	90°	R 3.0113
R最小値 R-Min	0°	R 2.9890
外径 Diameter	ϕ 5.9804	

Nachi R1 Nominal: $\pm 3\mu\text{m}$

NACHI

モールドマイスターボール検査成績書
Measurements of MOLD MASTER BALL Accuracy



Nachi Inspection Sheet

Inspection Sheet with all End Mills

Highly Accurate Milling is Possible with this Tool

▪ CAM
▪ M/C Easy Compensation

Reduce Time for Polishing and Rectification Drastically

測定角度 Angle	測定値 R
-10°	0.9982
0°	0.9987
10°	0.9998
20°	1.0008
30°	1.0011
40°	1.0006
50°	0.9996
60°	0.9992
70°	0.9987
80°	1.0002
90°	1.0017
100°	1.0008
110°	0.9989
120°	1.0002
130°	0.9996
140°	0.9990
150°	1.0005
160°	1.0004
170°	1.0006
180°	0.9985
190°	0.9982

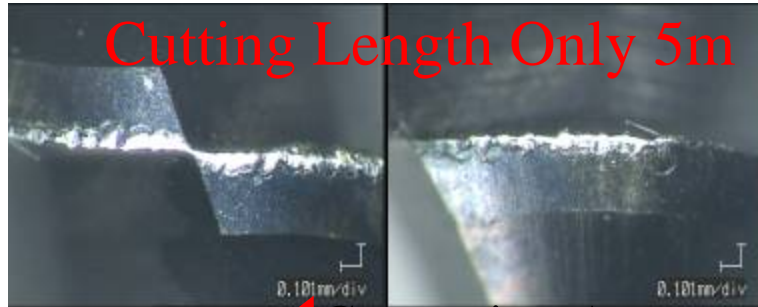
製番 Serial Number	DI-001
型番 Model Number	2MMR1
R公差 R Tolerance	R 1 ± 0.003

R実測値 R Accuracy	R 1.0000 +0.0017 -0.0015	
R最大値 R-Max	90°	R 1.0017
R最小値 R-Min	180°	R 0.9985
外径 Diameter	ϕ 1.9972	

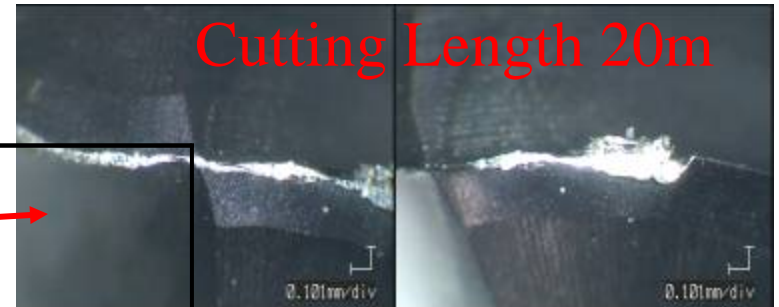
Tool Life Comparison in Hardened Steel Milling

Conditions

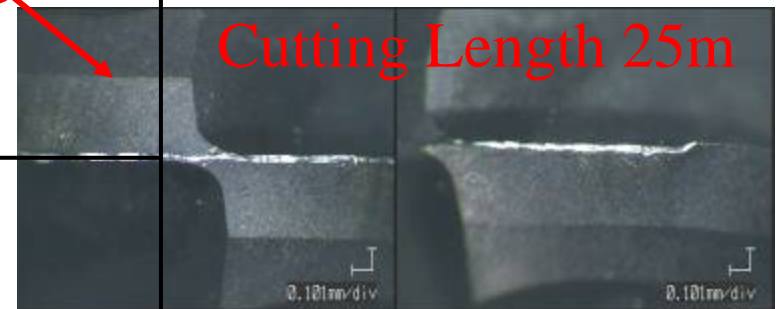
- Material SKD11(60HRC)
- Speed $V=151\text{m/min}$ ($S=12,000\text{min}^{-1}$)
- Feed $F=1,400\text{mm/min}$ ($f=0.058\text{mm/t}$)
- Cut Depth $=0.5\text{mm}$, $P_f=0.4\text{mm}$
- DRY(Air BLow) • Vertical MC(BT40)



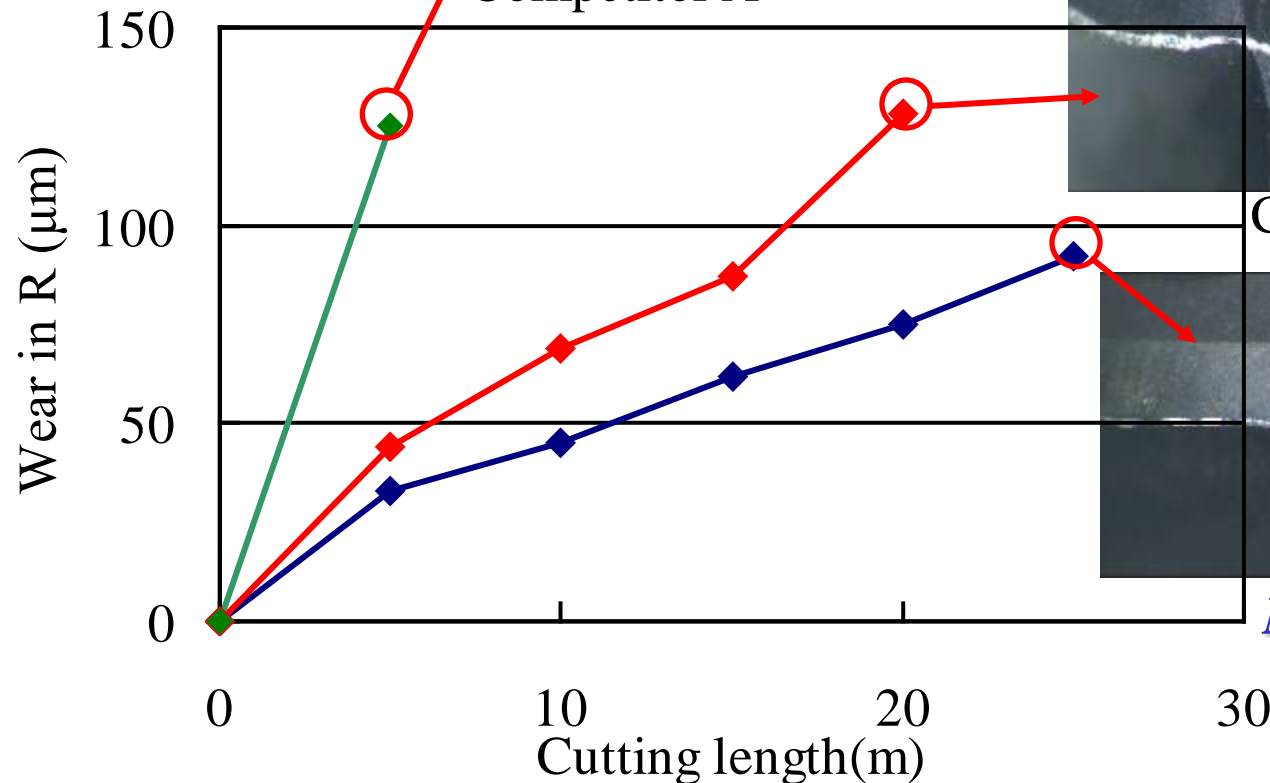
Competitor A



Competitor B



NACHI Mold Meister



AG Mill Roughing (For Roughing Operations)

Features:

- Increased Performance in Roughing Operations
- Improved “Chip Breaking” Action with Both Fine and Heavy Tooth Serrations
- Made from HSS-Co Material
- Next Generation TiALN Coating for Improved Performance and Extended Tool Life
- Higher Radial Depths of Cut due to Improved Tool Geometry and Tooth Serrations



AG-MILL Roughing

Features of Material and Coating

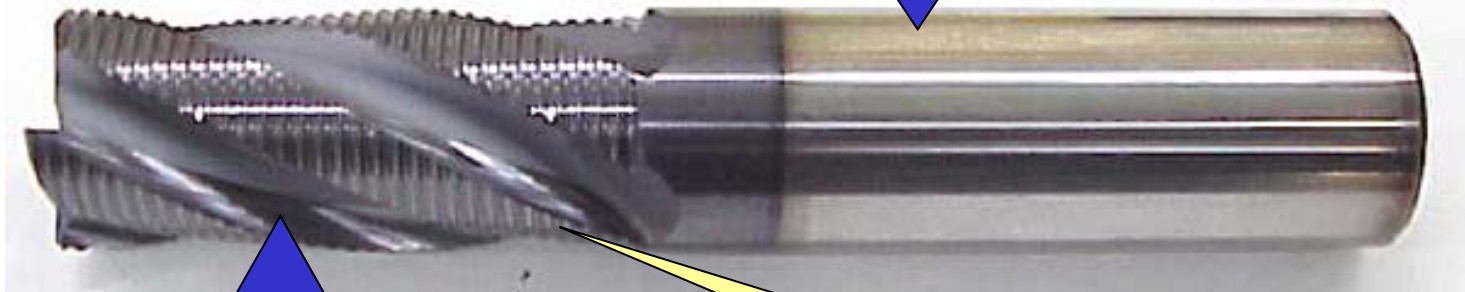
**Wear
Resistance**

Compatibility

**Chipping
Resistance**

High Alloyed Cobalt HSS

**Appearance of AG-Mill
Roughing Regular Length Short**



AG Coating

- **Heat Resistance**
- **Oxidization**
- **High Hardness**
- **High Toughness**

**Fine Pitch
Nick**

* Excellent Chipping and Wear Resistance Compared to HSS Co TiCN:



Work Materials:

- Suitable for Semi-Finish Operations in Structural Steels, Carbon Steels, Alloy Steels, Molds Steels, Stainless Steels, Nickel Alloys, Titanium, and Cast Iron
- Available in Fractional & Metric Sizes
- Fractional Size Range: 1/4" - 2"
- Metric Size Range: 6mm – 50mm

AG Mill Heavy (Roughing & Finishing)

Features:

- **Increased Performance in Semi-Finish Operations**
- **Made from HSS-Co Material**
- **Next Generation TiALN Coating for Improved Performance and Extended Tool Life**
- **Higher Radial Depths of Cut due to Improved Tool Geometry and Tooth Serrations in Semi-Finish Operations**
- **Excellent for Roughing in Nickel Alloys, Titanium, Inconel and Stainless**



AG-MILL Heavy (Roughing & Finishing)

* 3X the Tool Life than Regular TiCN HSS-Co End Mills.

Groove milling of AG-MILL Heavy

Excellent Chipping & Wear Resistance

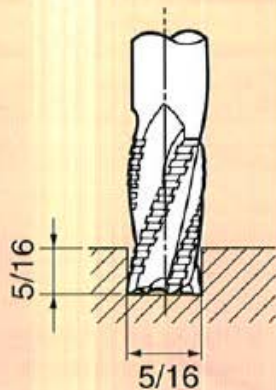
Tool : $\phi 5/16$ (AGHV)

Work Material : 1050 (S50C) 190HB

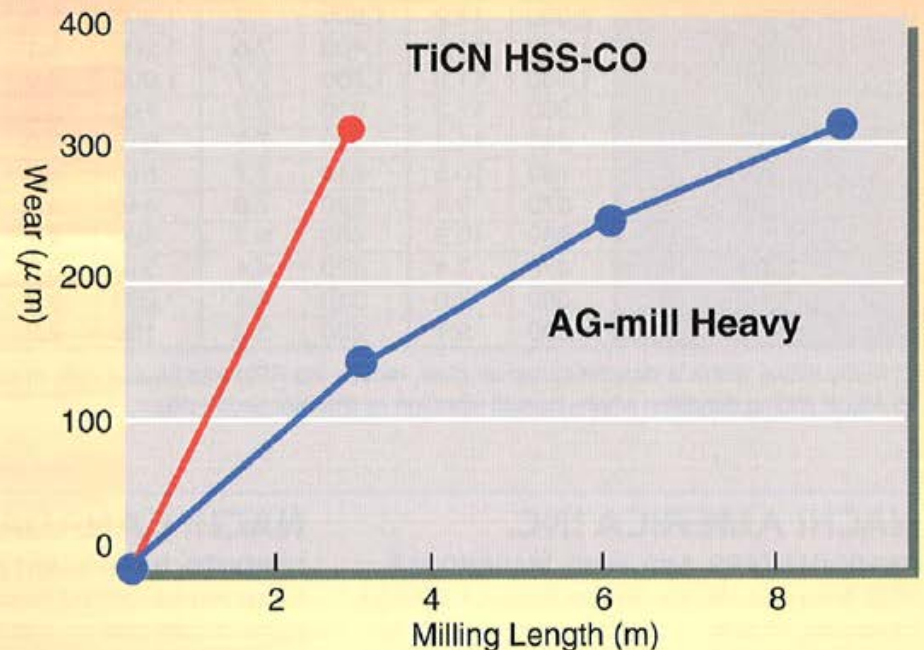
Cutting Speed : 2,390 RPM (197SFM) (60m/min)

Feed : 14.3 IPM (363mm/min),
0.0015 IPT (0.038mm/tooth)

Cutting Fluid : Wet



3X the Tool Life



Work Materials:

- Suitable for Semi-Finish Operations in Structural Steels, Carbon Steels, Alloy Steels, Molds Steels, Stainless Steels, Nickel Alloys, Titanium, and Cast Iron
- Available in Fractional & Metric Sizes
- Fractional Size Range: 1/4" - 2"
- Metric Size Range: 3mm – 50mm

DLC Mill for Aluminum



Dry Milling of Aluminum

DLC (Diamond Like Carbon) is an Amorphous Material with High Hardness and Low Friction and has Similar Characteristics to Diamond Coating

Excellent Chip Evacuation

Dry Machining and Extra Long Tool Life is Achieved with DLC Coating

Materials

Aluminum 1060, 6061, Aluminum Alloys 4032, 5052, 7075, and Copper Alloys.

Series

L6231HD 1/8 to 1", 2 Flute, HSS-Co

L9330 1.5 to 20mm, 2 Flute, Carbide

Genac VGX End Mills

Variable Helix-Variable Index

Variable Helix-Variable Index End Mills

Genac VGX End Mill

- High Performance
- Carbide
- AG Coated

Variable Helix-Variable Index Reduce Vibration

- Faster Feed Rates
- Improved Surface Finish

Materials

- Carbon Steel, Medium Alloys, Stainless Steel, Titanium, Thigh Tem Alloys, and Cast Iron

Series

- L6000 1/8 to 1, 4 Flute, Carbide
- L6100 1/4 to 1, 4 Flute, Carbide, Extended Length
- L6200 1/8 to 1, 4 Flute, Carbide, Ball Nose



Thank You