Introduction to

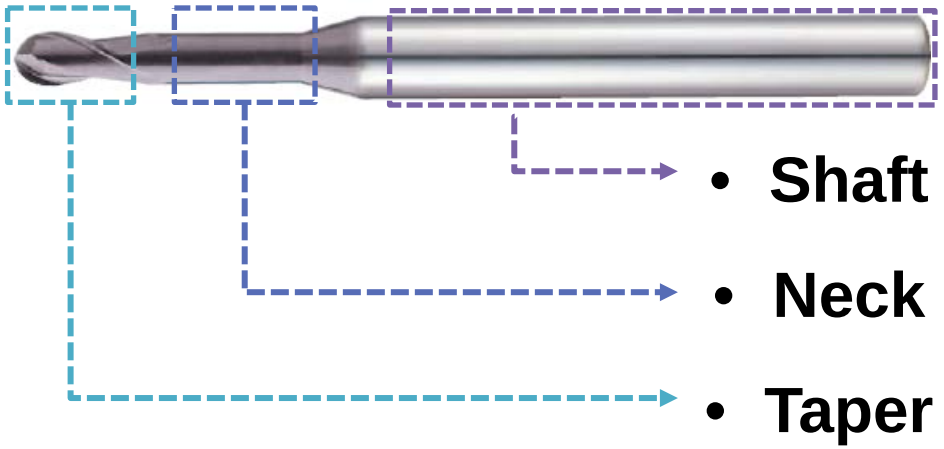
KORLOY ENDMILLS

- Table of contents -

1. Understanding E/M Tools Classification

- E/D Shape Classification

Shaft	Neck	Taper
Straight	Taper	Shape
Taper	Rib	No. Of Flutes
Side-lock	Step	Twist angle
	Length	Taper shape

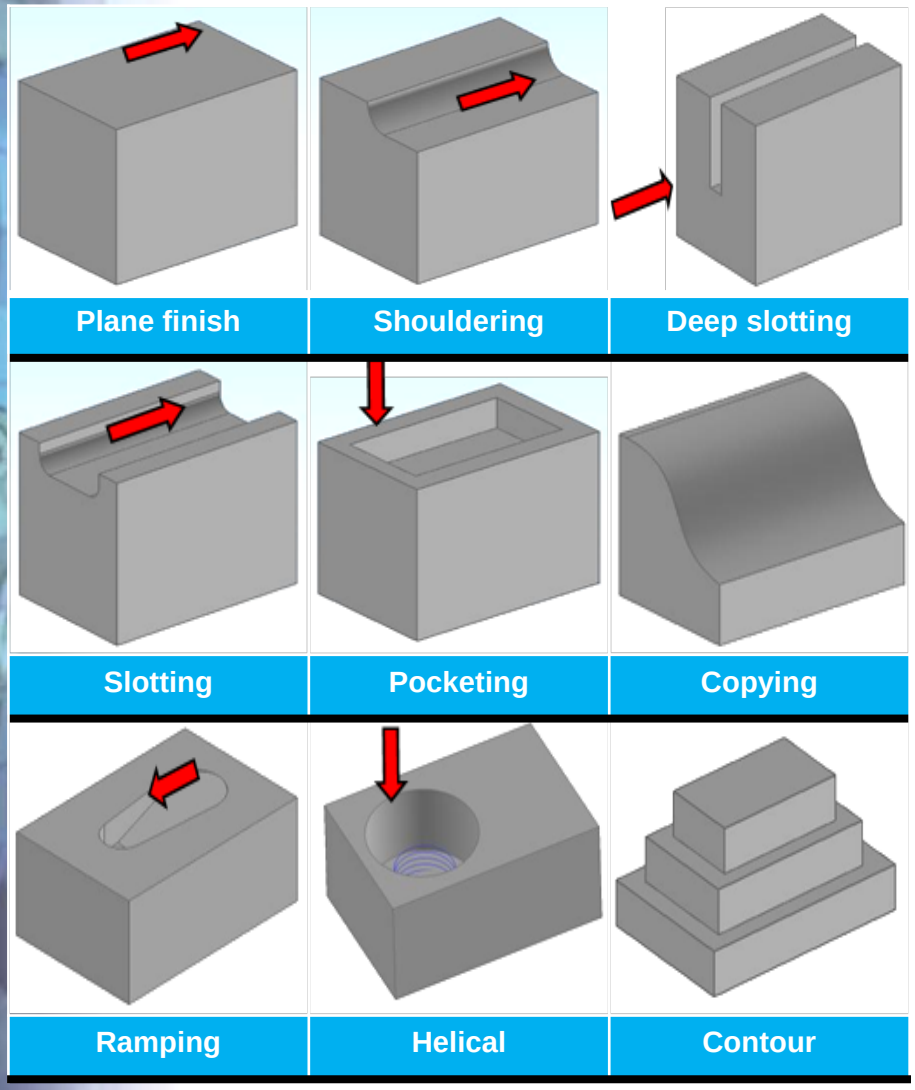


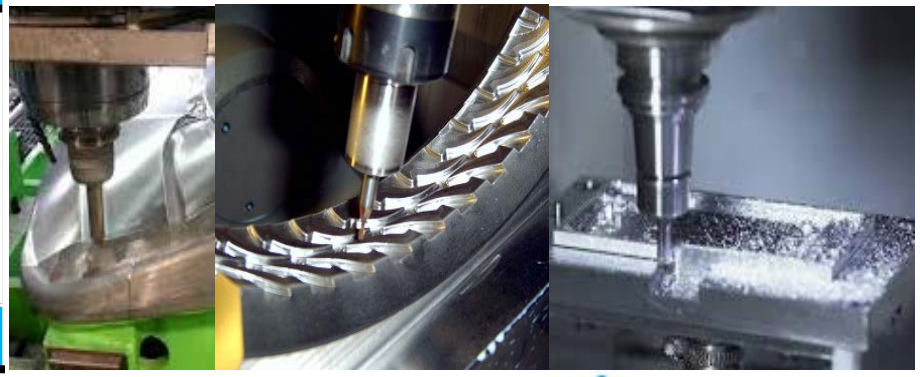
- KORLOY E/D Configuration

Series	Contents
H ENDMILL	Machining mold of high hardness metal (SKD11, SKD61 heat treatment)
Z ENDMILL, I+ ENDMILL, Z+ ENDMILL	Universal machining (Carbon steel less than HRc45, Alloy steel, STS, etc)
S+ ENDMILL	Machining Difficult-to-cut materials, Stainless steels and nonferrous metals
A+ ENDMILL	Machining of Aluminum
C-MAX	Machining of Copper, Copper alloys
D ENDMILL	Machining of Graphite
V ENDMILL	Inequal Indexing & Helix, high-efficient & high quality machining
F ENDMILL	High efficiency/High feed machining (or difficult applications / small deep groove)

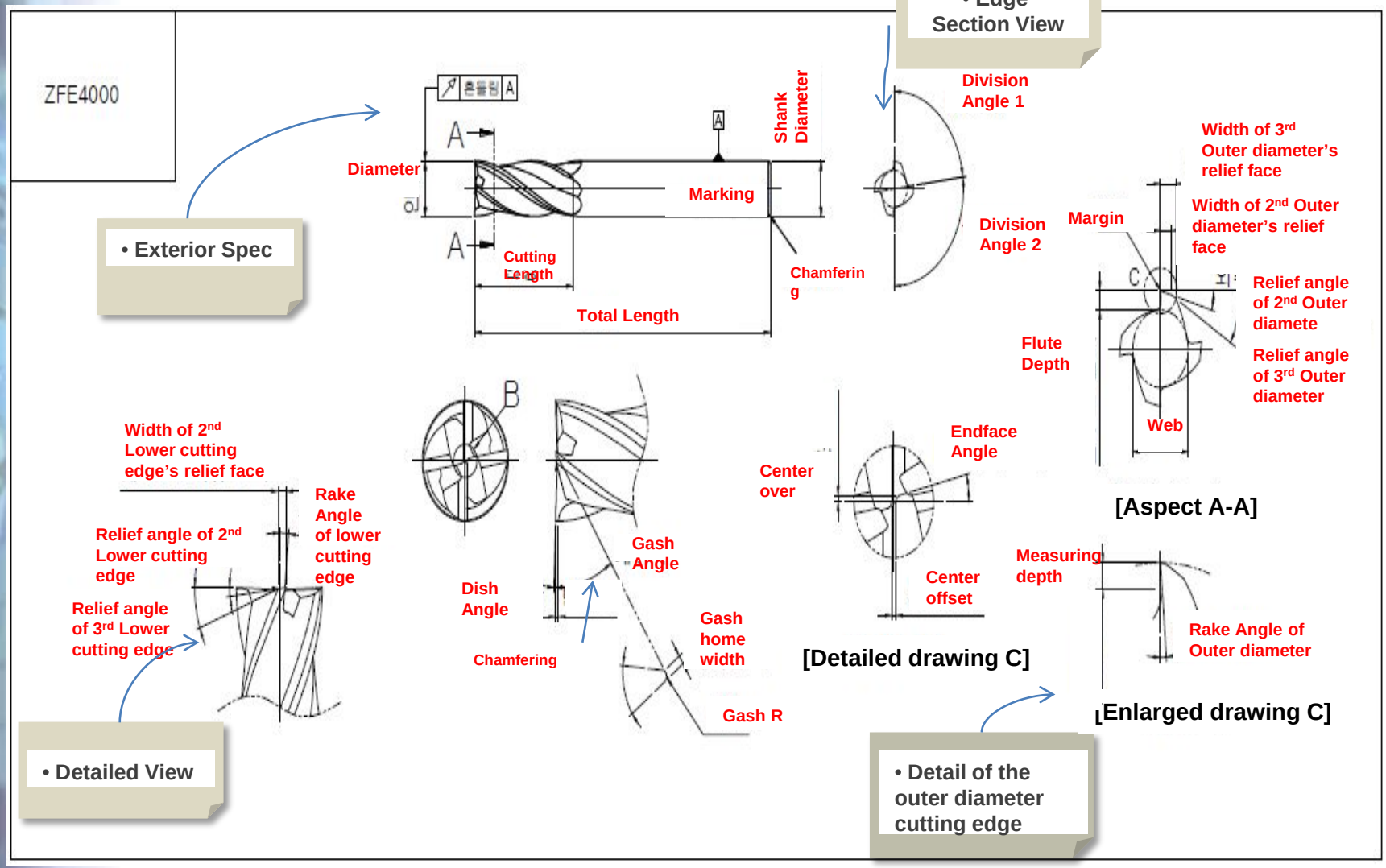
2. Understanding E/M tools – Tooling Method

- Mainly used for complicated shapes that requires small diameter machining
- Major Industries : Power Generators (Turbine Blades), aviation industry (engine/ turbine etc.), Medical industry(dental) Automobile parts (body mold, engine, chassis , tire mold etc.), Mobile phone mold, phone casings etc.





3. Understanding E/M tools - Shape



4. E/M manufacturing process

[KORLOY Manufacturing Process of Solid Endmills]

KORLOY material manufacturing process

Powder → Press → Partial sintering → Profiling → Complete sintering

Imported material

Outsourcing process

Cutting & Centerless

Machining (a) step(s)

External cutting edge machining

Edge treatment Marking

Coating

Inspection

Packaging

Gauge check

Non-contact Run-out gauge LSM

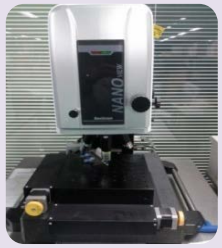
Contact Run-out gauge

Shape measurement

Helicheck

Zollar genius 3s

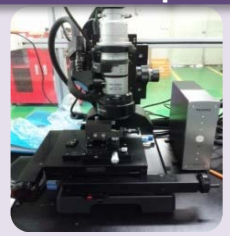
Surface roughness



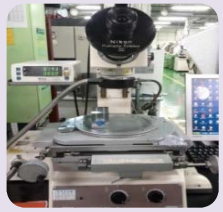
Surface roughness Measuring machine (Non-contact)

NANO View

Tool Microscope



Keyence Tool Microscope



Tool Microscope

Projector

Projector

NEW

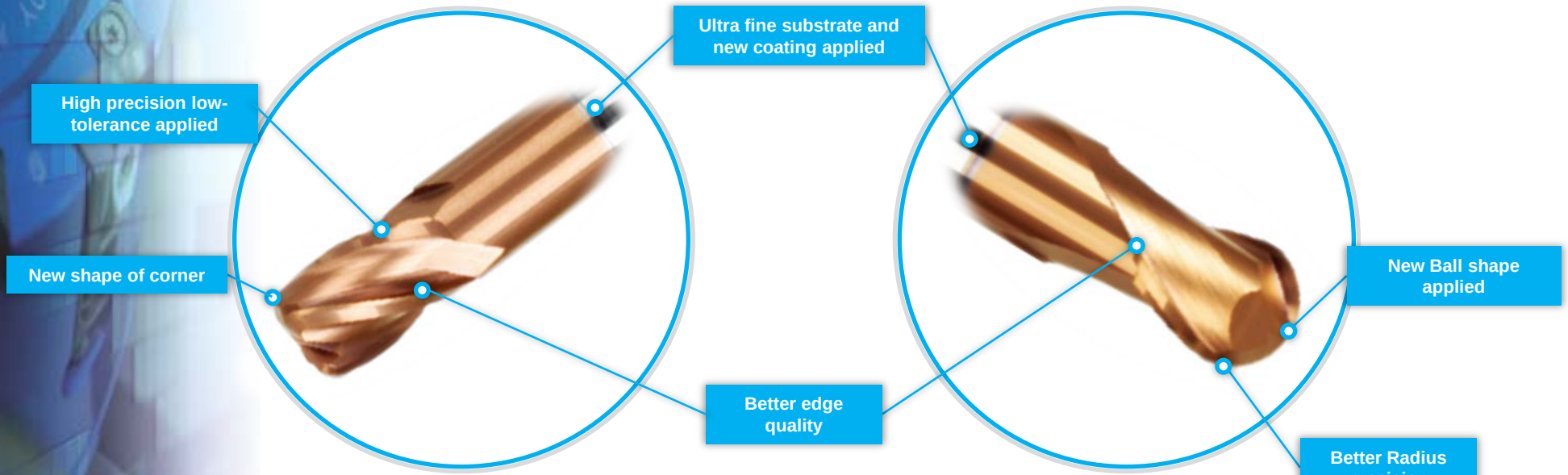
H-ENDMILL (Premium High hardened steel Endmill)

[Features]

+ **Shape: high precision tool made by extremely precise machines**
  - Special cutting edge design increases wear resistance and prolongs tool life
  - Special cutting edge designed for better chipping reduces the cutting load on the edge

+ **Coating material: Ultra fine substrate**
  - Provides high precision in high speed, high hardened materials machining
  - Improved chipping and wear resistance for a better tool life

+ **Coating: Proper CX grades for both dry and wet conditions**
  - New coating technology improves anti-corrosion performance and wear resistance
  - Excellent tool life in high hardened materials up to HrC45



NEW

[Product Performance]

- Cutting conditions : vc = 200m/min, fz = 0.1mm/t, ap=0.8mm, ae=0.1mm
- Workpiece : SKD11
- Tool used: H-ENDMILL SERIES / PBE080-100

120% Perform.

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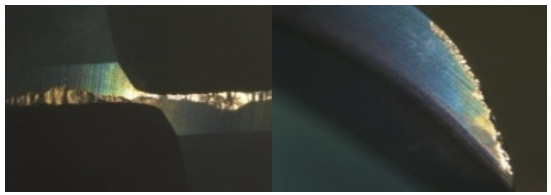
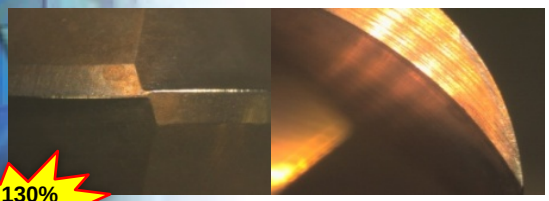


Competitor A

- Cutting condition : vc = 250m/min, fz = 0.125mm/t, ap=0.1mm, ae=0.2mm
- Workpiece : STAVAX
- Tool used : H-ENDMILL SERIES / PBE2080-100



130% Perform.

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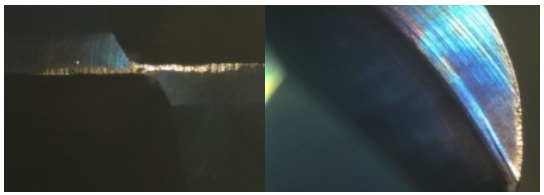
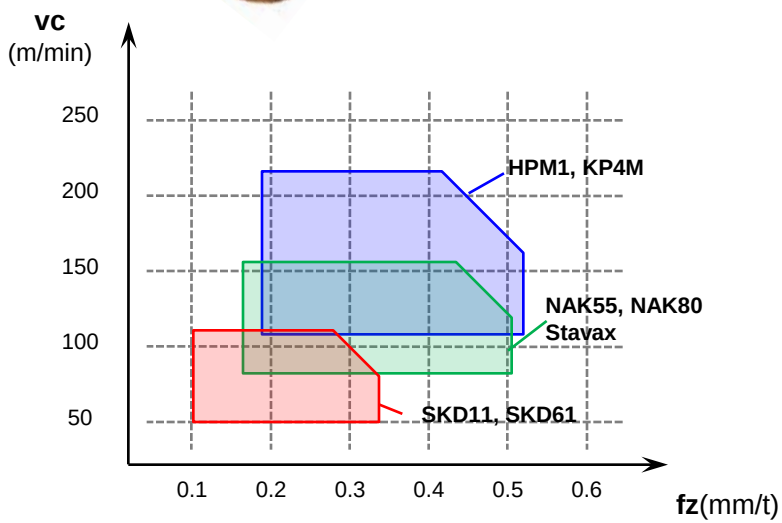


Competitor A



❖ Application area

[Line-Up]

- Radius (Standard) : Φ0.5 ~ Φ12.0
- Ball (Standard) : Φ0.5 ~ Φ12.0
- Flat (Standard): Φ0.5 ~ Φ12.0

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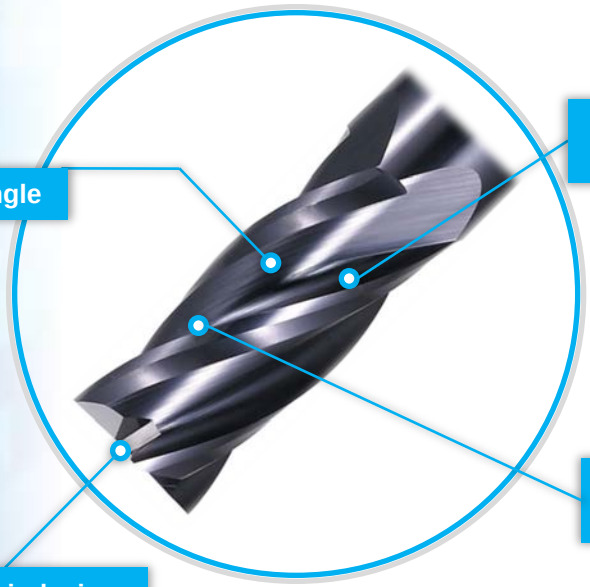
Z-ENDMILL (Premium Universal Endmill)

- Fine base material, New coating (AlCrN) applied, Better wear and chipping resistance
- New shape applied for better performance and wear resistance
- Applicable to various materials less than HrC 45 such as Steel, Alloy Steel, Cast iron, etc
- Better edge quality for chipping prevention and assuring long-term, stable performances

[Features]

- Flat type : irregular indexing and helix applied to minimize vibration and offer better performances, 35˚ Helix angle applied to improve wear resistance and machining performances
- Radius type : Radius part wear resistance and precision improved
- Ball type : New shape for ball part, Excellent wear resistance, Better performances

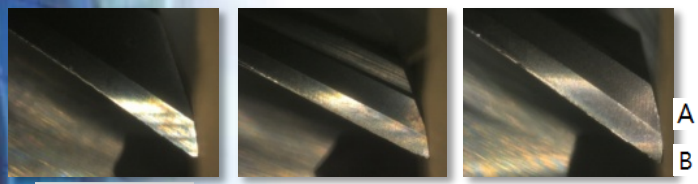


Unequal E/M shape applied (irregular NDEXING & 35˚Helix Angle)
=> Better vibration and chattering prevention
=> Cutting load reduced

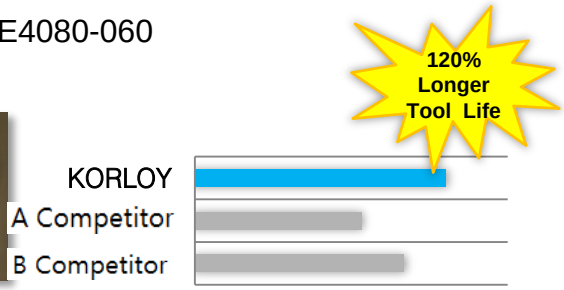
NEW

[Product Performance]

- Cutting conditions : vc = 120m/min, fz = 0.05mm/t, ap=8mm, ae=0.8mm
- Work piece : S45c
- Tool used: Z-ENDMILL SERIES / ZFE4080-060

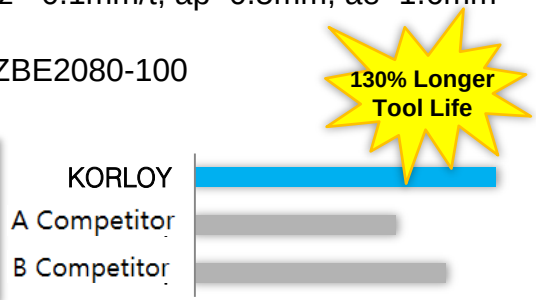


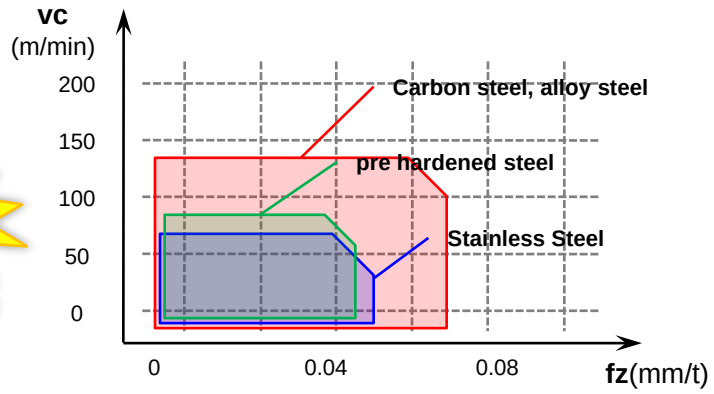
KORLOY | Competitor A's | Competitor B's



- Cutting condition : vc = 130m/min, fz =0.1mm/t, ap=0.5mm, ae=1.6mm
- Work piece : S45c
- Tool used: : Z-ENDMILL SERIES / ZBE2080-100

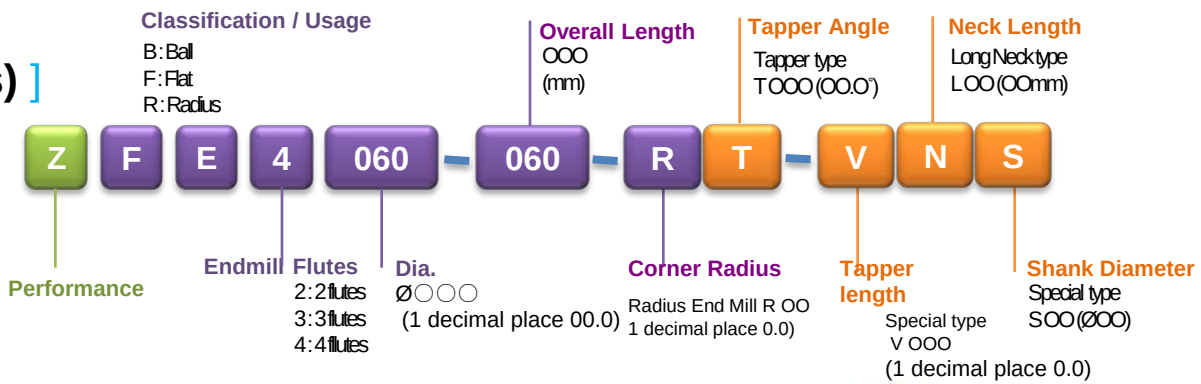
KORLOY | Competitor A's | Competitor B's





[Product Designation (Series)]

- Flat (Standard) : Φ0.4 ~ Φ16.0
- Ball (Standard) : Φ0.4 ~ Φ12.0
- Radius : Available in 2015
  (Special products are



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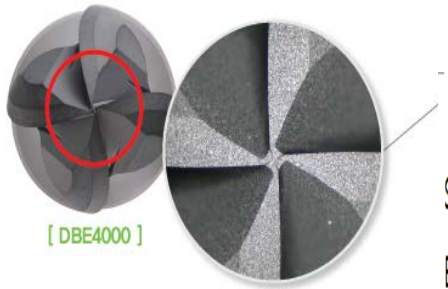
D-ENDMILL (Graphite Cutting, Diamond Coating Endmill)

[Product Feature Features and Uses]

Tangential cutting edge shape

- One-pass grinding method applied
- One-pass grinding method applied
- D- Endmill Ball type 2 flutes, 4 flutes



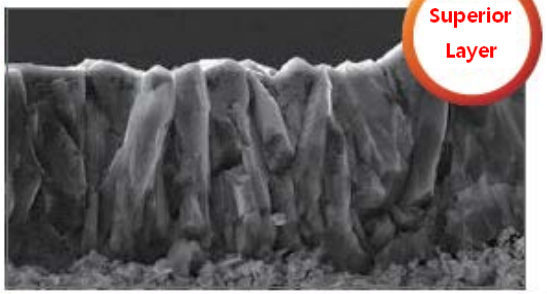
[DBE4000]

CenterMatch Ball Shape (4 Edges)

Shape of Ball point is suitable for high feed machining

Enhanced rigidity and excellent surface finish

ND3000 Coating layer

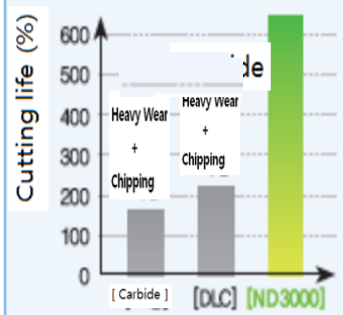


ND3000 Surface

[Performance Comparison Example]

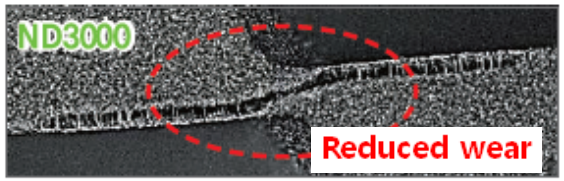
[Cutting performance Test]

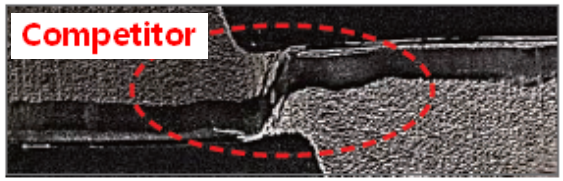
- Graphite, special carbon processing



→ 6 times more life than carbide

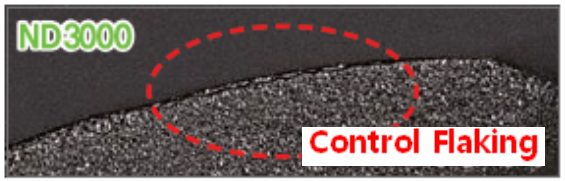
1. Reduced flank wear

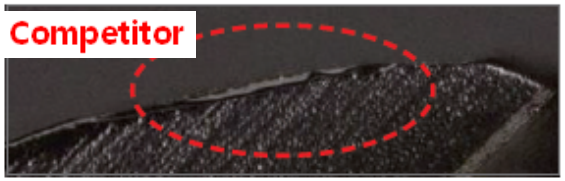




→ Excellent flank wear resistance control wear

2. Control Flaking wear at cutting edge





→ Excellent surface adhesion with Flaking control

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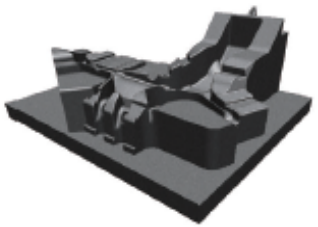
D-ENDMILL (Graphite Machining, Dia coating Endmill)

[Machining Example]



Graphite Mold

Cutting conditions : vc = 180m/min, fz = 0.1mm/t, ap=0.2mm, dry machining

Tool used : DBE2060-110-N250S06

D Endmill	10 hours of machining
Competitor	8 hours of machining

25% BETTER

Graphite Mold

Cutting conditions : vc = 300m/min, fz = 0.1mm/t, ap=0.15mm, dry machining

Tool used : DBE2060-080-N250S06

D Endmill	6 hours of machining
Competitor	5 hours of machining

25% BETTER

Graphite Mold

- Cutting conditions : vc = 100m/min, fz = 0.11mm/t, ap=0.26mm, dry machining
- Tool used : DBE4060-110-N250S06

D Endmill	8 hours of machining
Competitor	6.5 hours of machining

20% BETTER

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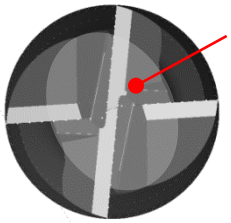
New!

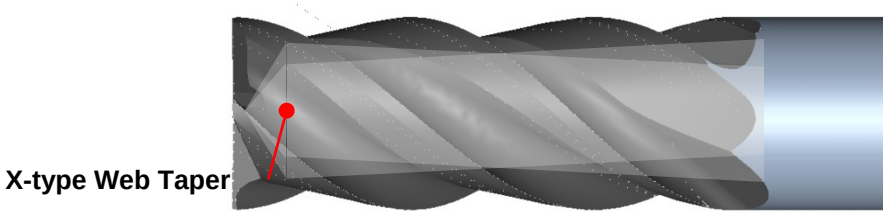
V ENDMILL (Irregular Helix Angle Endmill)

▸ Irregular Indexing angle

[Product Features]

▸ Irregular Helix angle





✓ **Ellipse Web**
- Regular fz per blade and improved rigidity ensuring a stable machining.

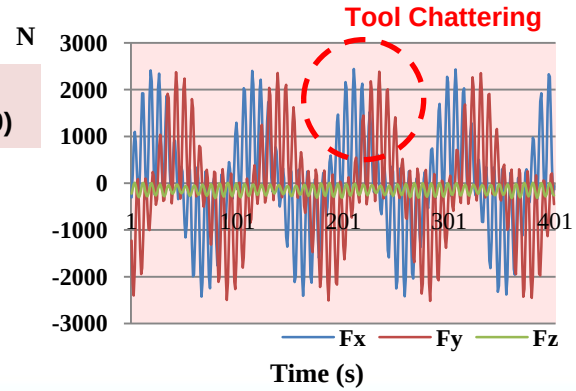
✓ **X-type Web taper**
- Taper and back taper are applied to the ellipse web. It therefore provides the proper flute size for irregular helix and leads to excellent cutting performances.

[Comparison of Cutting Performances]

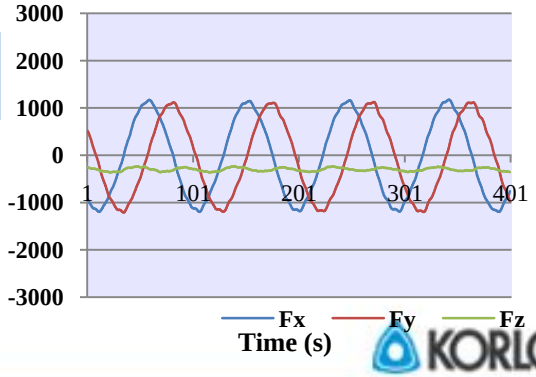
✓ **Cutting conditions**
: n=3183.1(min^{-1}), vf=713(mm/min), ae=Slotting, ap=8.0mm

✓ **Measuring equipment**
: Dynamometer (Kistler)

i-max (IFE4080-060)



V-max (VFE4080-060)



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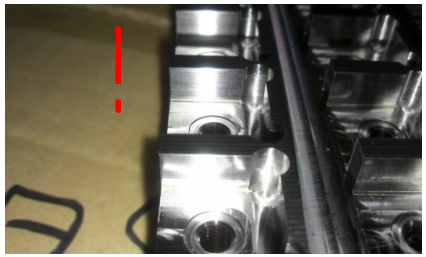
V ENDMILL (Irregular Helix Angle Endmill)

Work-piece

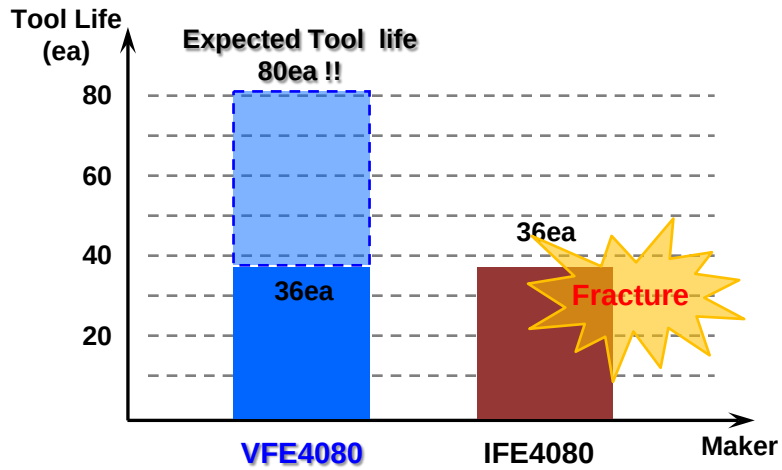


Name	Tool Holder		
Use	Tool Holder tip pocket		
Material	SNCM439	**Hardness**	$H_RC32~35$

Cutting Conditions	
Cond.	n=6000min^{-1} , vc=150m/min, vf=600mm/min, fz=0.025mm/t. ap=7 mm, ae=0.8mm _ Coolant=Water type
Machine	HASS
Holder	SDC (ER Collet)

Tool	**KORLOY**	**VFE4080 (PC215F) _ Ø8/4刃**
	KORLOY	**IFE4080 (PC220) _ Ø8/2刃**

Result



Tool failure	①Wear	②Chip control	③Chipping	✓④Fracture			
	⑤Roughness	⑥Precision	⑦Burr	⑧Etc			

Analysis

1. Higher performance than current tool (Home test)
2. Improved productivity if applied to the recommended application area of V-max.
3. Results are better than universal endmill but, have to set up a specific target.

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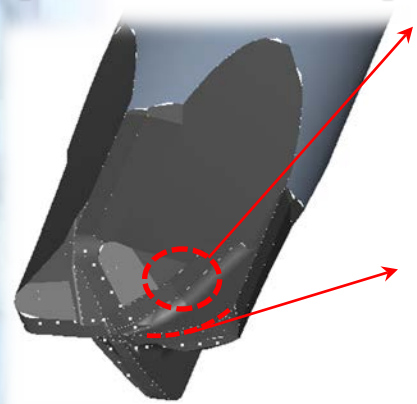
New!

F ENDMILL (Irregular Helix Angle Endmill)

✓ Higher Feed, higher radial depth of cut than standard radius type endmill.
High performances by increasing MRR (Material Removal Rate).

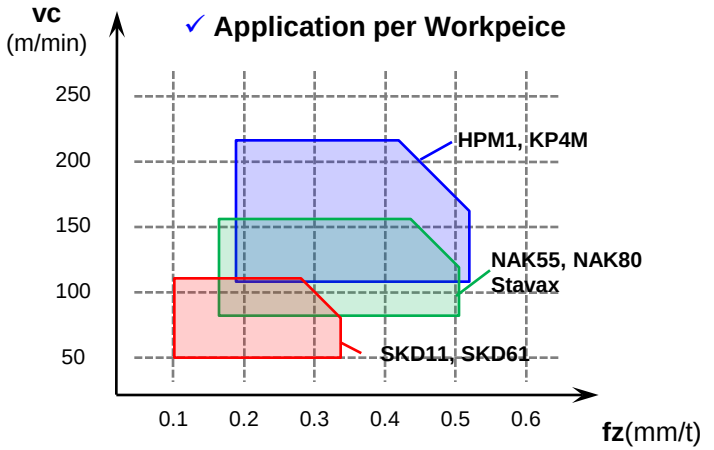
[Product Features]



✓ Wider chip pocket area highly efficient operation

✓ High feed machining possible by dispersing cutting forces

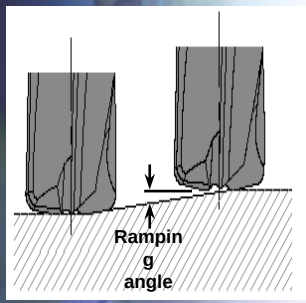
✓ **Application per Workpeice**



[Feed Max]

✓ **Operation**

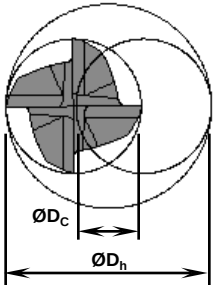
✓ **Ramping**



Ramping angle	Feed
1°	100%
2°	80%
3°	60%
4°	50%

※ In recommended cutting conditions.

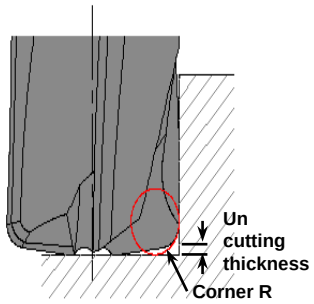
✓ **Helical**



Dia. (ØD)	Min	Max
6.0	7.8	12
8.0	10.2	16
10	12.4	20
12	14.9	24

※ ØDc : Dia. of tool
ØDh : Dia. for machining

✓ **CAM Program Data**



Dia. (ØD)	Tool Corner R	CAM Corner R	Uncut
6.0	0.5	0.7	0.21
8.0	0.5	0.8	0.32
10	1	1.3	0.36
12	1.2	1.6	1.45

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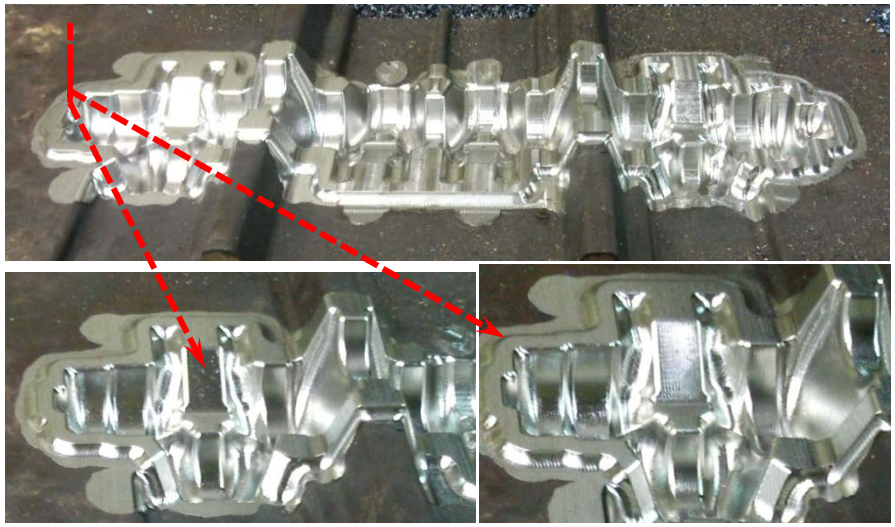
F ENDMILL (Irregular Helix Angle Endmill)

Tool Condition

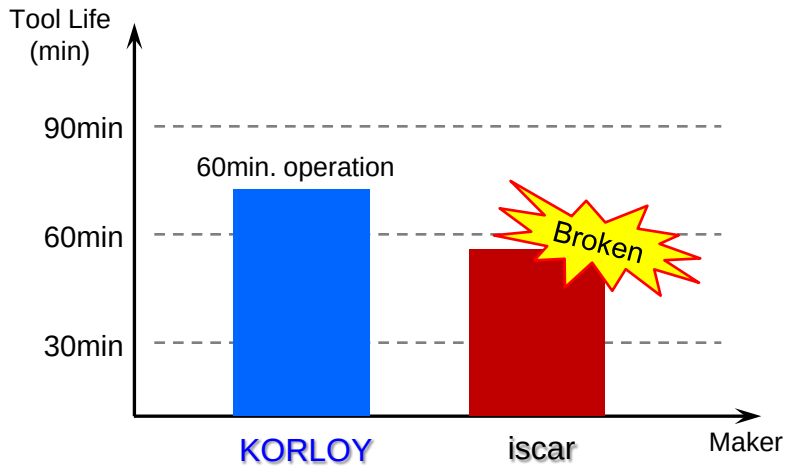


Name	Automobile Part Mold		
Use	Crankshaft Mold		
Material	SKD61+SKT4	**Hardness**	H_RC 45~50

Cutting Conditions	
Cond.	n=4000min^{-1} , vc=150.8m/min, vf=4000mm/min, fz=0.25mm/t. ae=6 mm, ap=3.6mm Dry machining
Machine	Haford_Taiwan MCT
Holder	ER Collet

Tool	**KORLOY**	**FME4120-120-R12 (PC203F) _ Ø12/4**
	KTT	**Feedmill_EFFI-S4 _ Ø12/4**

Result



Tool failure	①Wear ②Chip control ✓③Chipping ✓④Fracture
	⑤Roughness ⑥Precision ⑦Burr ⑧Etc

Analysis

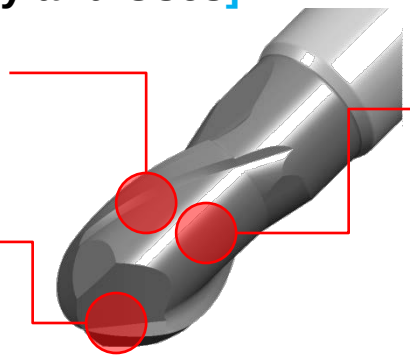
1. Optimized performance of Feed-max is shows its great results in Roughing operation for a Crankshaft Mold.
2. Same result related to the tool performance between F-max Endmill and Competitor's Endmill, but better tool life.
3. We have sold this item with Ø6. Ø8. Ø10 and Ø12 as per customers request.

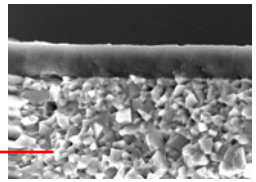
C-Max (Endmill for Copper, Copper Alloy)

[Features of Geometry and Uses]

Optimal cutting edge for copper and nonferrous metals machining

Good quality due to high precision of the cutting edge





PC210C

▶ Coating layer(K-Silver)

Enhancing wear resistance and lubrication

: Superior lubricity, wear resistance & chipping resistance

▶ Substrate

Optimal for wear and chipping resistance

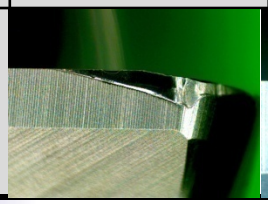
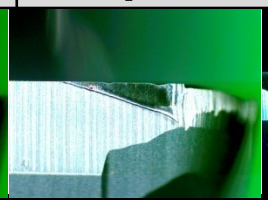
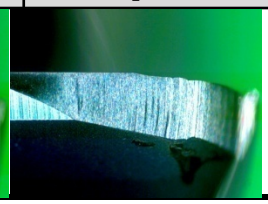
- ✓ Superior lubricity, wear&chipping resistance due to the K-Silver coating layer and optimal substrate
- ✓ Optimal for machining copper and nonferrous metal
- ✓ Wide line up(ball, flat, radius & long neck type)
- ✓ Long tool life and good surface roughness when machining electrodes

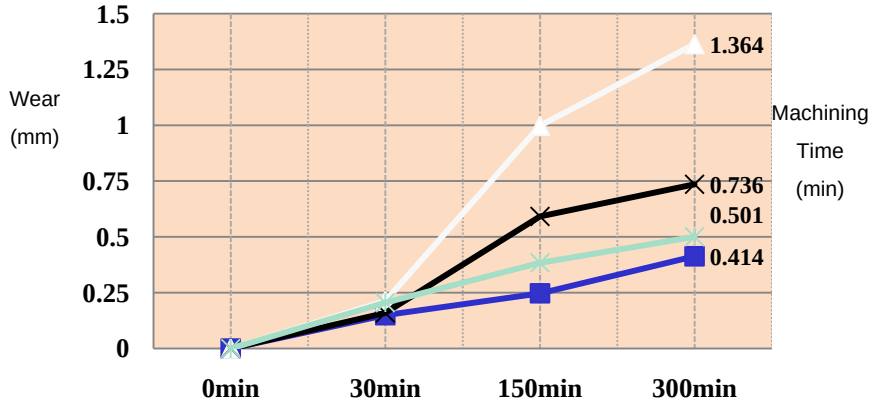
[Machining Example]

✓Electrode Machining

- Work piece : Cu (Pure Copper)
- Cutting Conditions : vc=70(m/min), fz=0.083(mm/t), ae=3.0, ap=0.6,
- Designation : CRE4100-070-R10

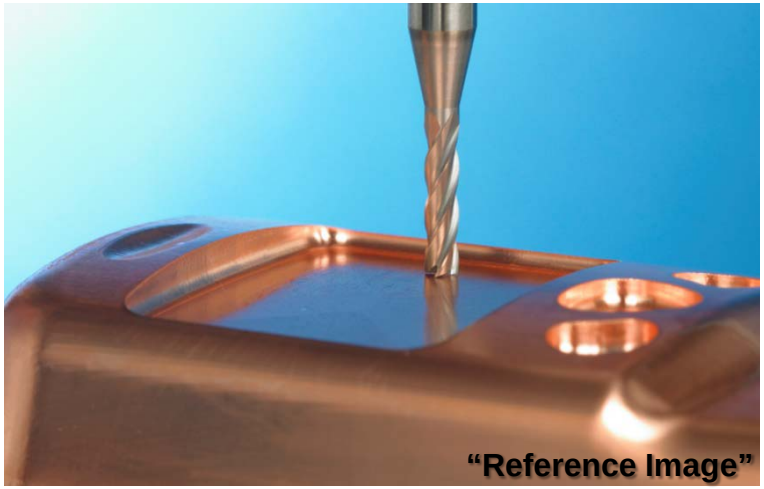
✓Test result

	KORLOY	Competitor 1	Competitor 2
Flank Wear			



C-Max (Endmill for Copper, Copper Alloys)

Work-piece

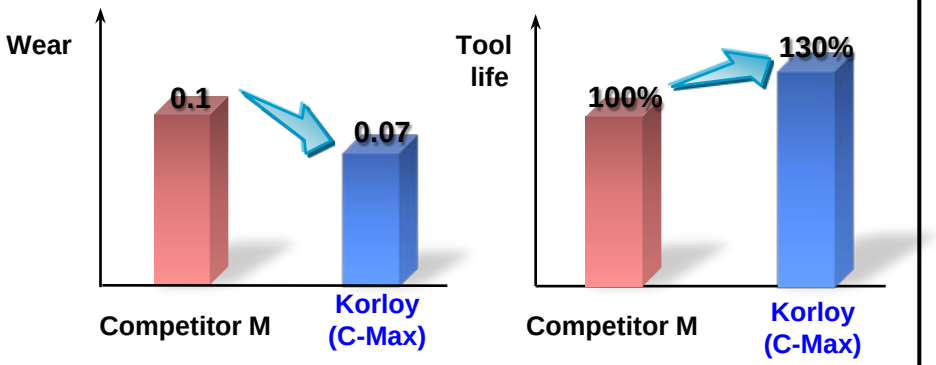


Name	Electronics Mold		
Use	Digital Camera Electrode		
Material	Copper	**Hardness**	-

Cutting Conditions	
Cond.	vc=188m/min(20,000rpm), vf=2,000mm/min, ap=1.0mm, ae=0.1mm_Coolant=Water type
Machine	MIKRON/CSM600UFANUC, +GF+ Agiecharmilles
Holder	Shrinking chuck

Tool		
	KORLOY	**CFE4030-050-V12S6(PC210C)_ Ø3/4刃**
	CompetitorM	**Ø3/4刃**

Result



Tool failure	①Wear ②Chip control ③Chipping ④Fracture
	⑤Roughness ⑥Precision ⑦Burr ⑧Etc

Analysis

1. Tool life: 130%(UP)

2. Quality :

High quality of surface for electrode machining due to minimized wear.

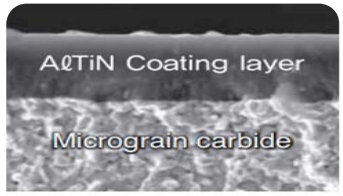
Our customers are satisfied with the improved wear resistance and excellent tool life compared to the competitors.

WE CREATE YOUR TOMORROW!

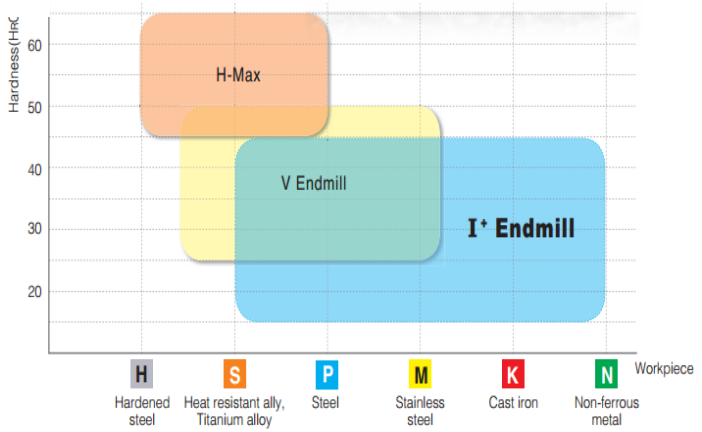
I+ Endmill (Universal & Economic Endmill)

[Features of Geometry and Uses]

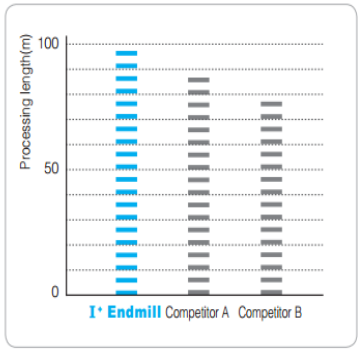
- **Tough substrate & wear-resistant coating layer**
  - Improved chipping resistance & tool life by applying an excellent coating layer
- **Broad machining area**
  - Applicable for roughing, medium and finishing operations
  - Applicable for workpieces of hardness below 45 HrC
- **Improvement of productivity**
  - Excellent cutting performances & cost effectiveness.
- **Product line up**
  - IPBE : I Plus Ball Endmill (Φ1~ Φ20)
  - IPFE : I Plus Flat Endmill (Φ1~ Φ20)
  - IPRE : I Plus Radius Endmill (Φ1~ Φ12)

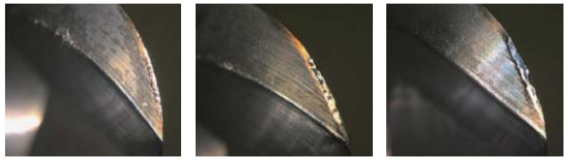


PC320

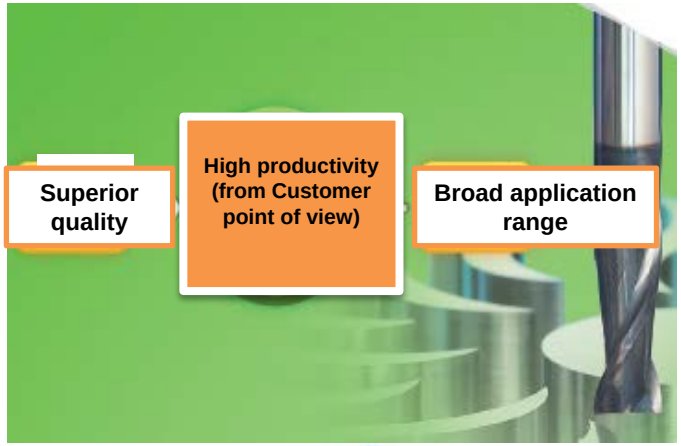


[Comparison of Cutting Performances]





- **Workpiece** : SM45C
- **Curring condition** : Cutting Diameter=Ø8.0 n(min^{-1})=5173 vc(m/min)=130.0 vf(mm/min)=1034 fz(mm/t)=0.1
  ap(mm)=0.5 ae(mm)=1.6 Dry
- **Tool** : IPBE2080-060



KORLOY Inc.

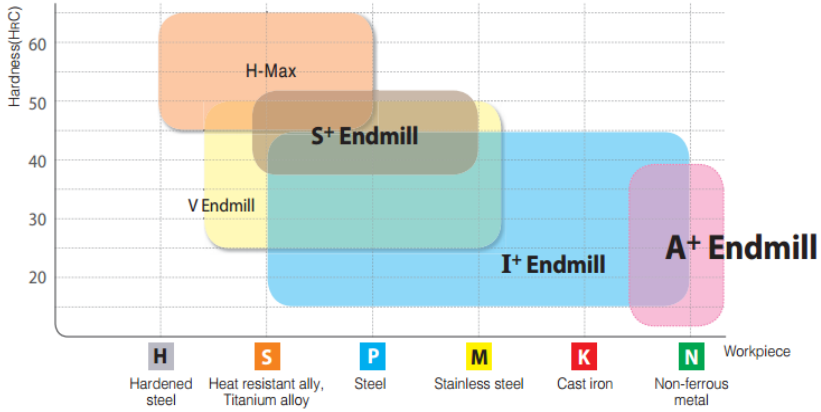
WE CREATE YOUR TOMORROW!

A+ Endmill (Endmill for Aluminum cutting)

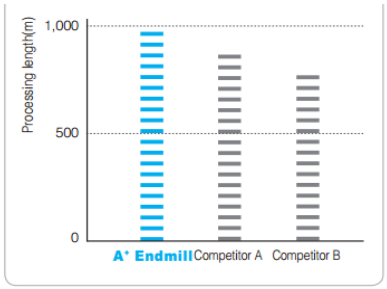
[Features of Geometry and Uses]

- **Exclusive U-shaped flute**
  - Provides excellent chip evacuation even in high feed machining.
  - U shaped and buffed flute reduces the built-up-edges.
- **Double relief angle**
  - Provides high rigidity of cutting edge and in turn ensures high productivity.
- **Sharp cutting edge**
  - Applicable for both roughing and finishing (Shouldering, slotting, ramping etc.)

[Application Area]



[Comparison of Cutting Performances]



A+ Endmill | Competitor A | Competitor B

- **Workpiece** : A7075
- **Curring condition** : diameter=Ø8.0, n(min^{-1})=8000, vc(m/min)=200, vf(mm/min)=1200, fz(mm/t)=0.05
  ap(mm)=8, ae(mm)=2.0, wet
- **Tool** : APFE3080-060

KORLOY Inc.

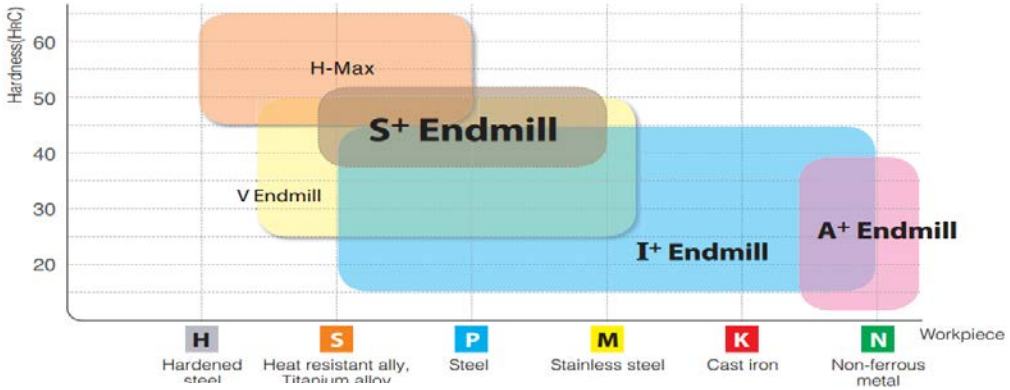
WE CREATE YOUR TOMORROW!

S+ Endmill (Endmill for Hard to Cut Materials)

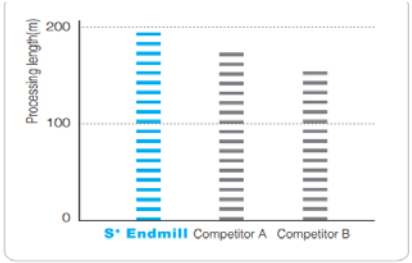
[Features of Geometry and Uses]

- Strong cutting edge ensuring a longer tool life.
- Special coating with high oxidation resistance
- High rake angle and curvilinear chip pocket allowing better chip evacuation.
- Special cutting edge preventing the hardening of tools.
- Optimal machinability in stainless steel applications
- Applicable for steel, alloy steel and hardening steel machining
- Applicable for multiple cutting operations (Shouldering, Slotting and Ramping etc.)

[Application Area]



[Comparison of Cutting Performances]



- **Workpiece** : STS304
- **Curring condition** : diameter=Ø8.0, n(min⁻¹)=4000, vc(m/min)=100, vf(mm/min)=480, fz(mm/t)=0.04
  ap(mm)=8, ae(mm)=0.8, dry
- **Tool** : SPFE4080-060

KORLOY Inc.

We create Your Tomorrow !

감사합니다.

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