Ceramic End Mills

CERAMIC Corner Radius End Mills

Ultra high productivity for nickel based heat resistant alloys

CERAMIC

CERAMIC

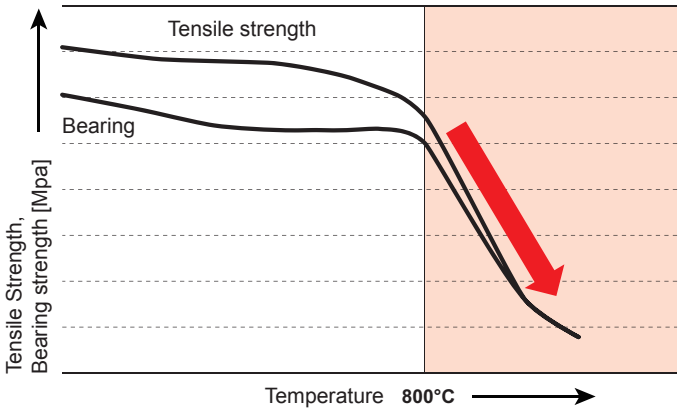
End Mill Series

From difficult-to-cut to easy-to-cut!

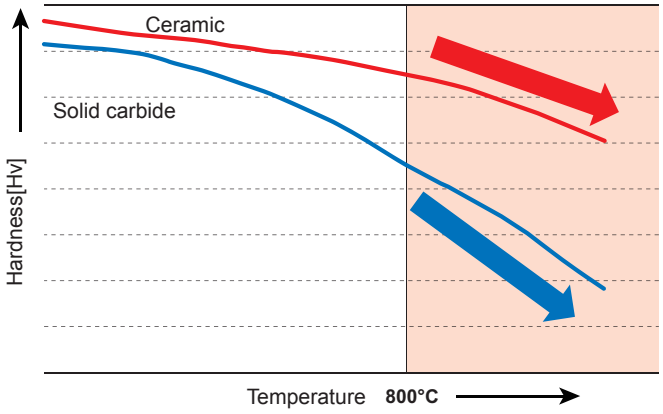
Generation of cutting heat

Feature of Ni based heat-resistant alloy

Ni based difficult-to-cut heat resistant alloys such as Inconel 718 soften at temperatures exceeding 800ºC. At these temperatures, difficult-to-cut materials become easier to machine because heir bearing and tensile strengths are lowered. Ceramic end mills can work effectively at these high temperatures and self generate the heat required to soften the machined material through ultra-high feeds and speeds.



High temperature hardness of cemented carbide and ceramic



Cemented carbide end mills are significantly reduced in strength when exceeding 800 degrees. However, the strength of ceramic end mills is not affected and therefore can be used at the high speeds and depths of cut required to generate sufficient heat to enable machining.

Features

Seamless grinding technology gives higher chipping resistance even during extreme roughing applications

Optimum ceramic grade for HRSA applications.

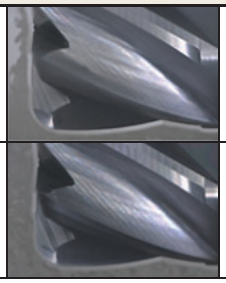
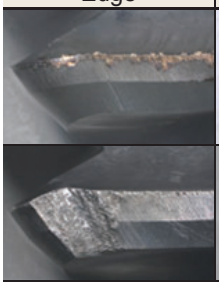
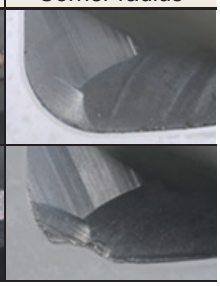
Optimized helix angle to reduce cutting force and to prevent pull-out during milling.

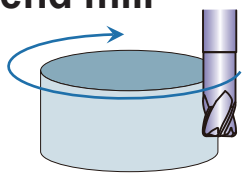
4-flute type for pocketing and slotting,
6-flute type for face machining and profiling.

Strong, negative flute and special rake edge withstands high temperatures and loads.

Cutting Performance

Tool life comparison with Inconel®718 (HRC45) Ceramic end mill

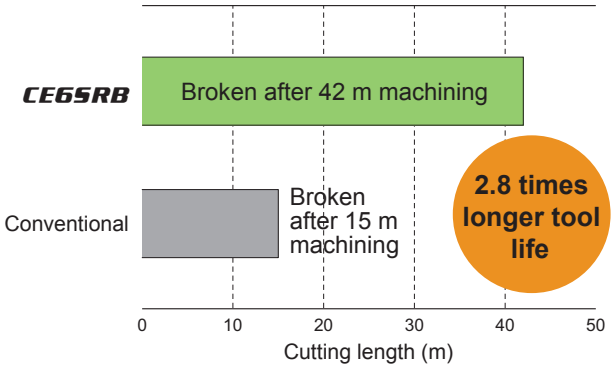
Before cutting			After cutting (12 m)	
			Edge	Corner radius
CE6SRB		Revolution : 19,098 min^{-1} Feed rate : 6,875 mm/min		
Carbide end mills 6 flute		Revolution : 1,910 min^{-1} Feed rate : 688 mm/min		

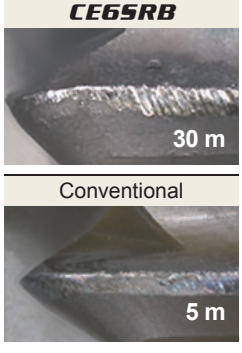


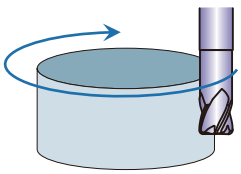
<Cutting condition>
Tool : ø10xR1.0
Depth of cut : ae=1.0 mm
ap=7.0 mm
Overhang : 20 mm
Cutting mode : Down cut
Ceramic : Dry No air blow
Solid Carbide : Wet cutting

Cutting efficiency 10 times

Tool life comparison-Inconel®718 (HRC 45)





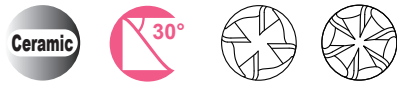


<Cutting condition>
Tool : ø12xR1.5
Revolution : 18,568 min^{-1} (700 m/min)
Feed rate : 6,684 mm/min (0.06 mm/tooth)
Depth of cut : ae = 2.4 mm
ap = 9.0 mm (Down cut)
Overhang : 24 mm
Cutting mode : Dry (No air blow)

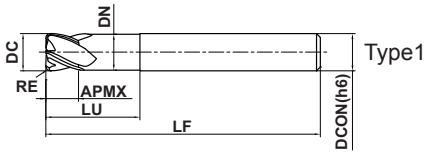
Ceramic End Mills

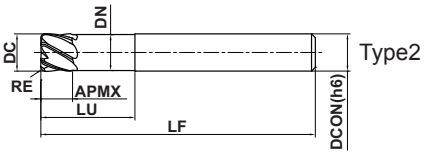
CE4SRB/CE6SRB

Corner radius end mill, short cut length, 4-6 flute



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-Hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
					◎		





R					
	DC≤12				
	0.02 - 0.02				
	DC=6	DC=8,10	DC=12		
	- 0.008 - 0.028	- 0.009 - 0.029	- 0.011 - 0.031		
h6	DC=6	DC=8,10	DC=12		
	0 - 0.008	0 - 0.009	0 - 0.011		

- Ceramic corner radius end mill with high heat resistance.
- Capable of softening Ni based alloys by generating heat during machining

Order Number	DC	RE	APMX	LU	DN	LF	DCON	No. of Flutes	Stock	Type
CE4SRBD0600R050	6	0.5	4.5	12	5.85	50	6	4	●	1
CE4SRB**D0800R100**	8	1.0	6.0	16	7.85	60	8	4	●	1
CE4SRB**D1000R100**	10	1.0	7.5	20	9.70	65	10	4	●	1
CE4SRB**D1200R150**	12	1.5	9.0	24	11.70	70	12	4	●	1
CE6SRBD0600R050	6	0.5	4.5	12	5.85	50	6	6	●	2
CE6SRB**D0800R100**	8	1.0	6.0	16	7.85	60	8	6	●	2
CE6SRB**D1000R100**	10	1.0	7.5	20	9.70	65	10	6	●	2
CE6SRB**D1200R150**	12	1.5	9.0	24	11.70	70	12	6	●	2

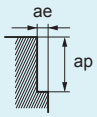
(Note 1) Never use ceramic end mills to cut titanium alloys.
Doing so will cause a risk of ignition and can be extremely dangerous.

RECOMMENDED CUTTING CONDITIONS

CE4SRB

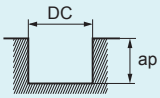
Shoulder Milling

(mm)

Work material	Inconel			
DC	n (m/min)	fz (mm/t.)	ap	ae
6	≥350	≤0.06	≤4.5	≤1.2
8	≥350	≤0.06	≤6.0	≤1.6
10	≥350	≤0.06	≤7.5	≤2.0
12	≥350	≤0.06	≤9.0	≤2.4
Depth of cut	 DC:Dia.			

Slot Milling

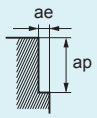
(mm)

Work material	Inconel		
DC	n (m/min)	fz (mm/t.)	ap
6	≥350	≤0.03	≤1.0
8	≥350	≤0.03	≤1.5
10	≥350	≤0.03	≤2.0
12	≥350	≤0.03	≤2.5
Depth of cut	 DC:Dia.		

CE6SRB

Shoulder Milling

(mm)

Work material	Inconel			
DC	n (m/min)	fz (mm/t.)	ap	ae
6	≥350	≤0.06	≤4.5	≤1.2
8	≥350	≤0.06	≤6.0	≤1.6
10	≥350	≤0.06	≤7.5	≤2.0
12	≥350	≤0.06	≤9.0	≤2.4
Depth of cut	 DC:Dia.			

1) The outermost layer of the material may be affected by heat.
   Ensure a minimum of 0.3mm final machining allowance remains.
2) The recommended ramping angle is 1.5 degree. By Shoulder milling=25% and Slot milling=50% from the cutting conditions shown.
3) Gradually increase the depth of cut (Shoulder milling=ae and Slot milling=ap) starting from 0.05DC.

CERAMIC CORNER RADIUS END MILLS

PRECAUTION

Cutting Conditions

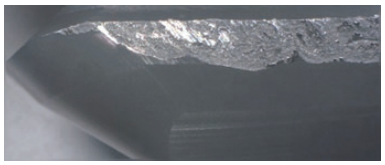
Requires high cutting speeds (from 350m/min to 1000m/min)

High speed cutting is required to generate the heat needed to soften materials without causing abrasion or other damage.
Cutting speeds from 350m/min to 1000m/min is recommended.

Recommendation for air blow

Do not use the coolant, it can cause thermal cracking.
Air blow is not used for the purpose of cooling and should not be directed at the tool. It should be used for good chip evacuation only.

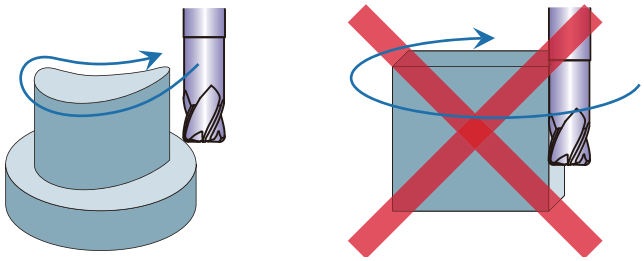
Example of thermal cracking



Applications

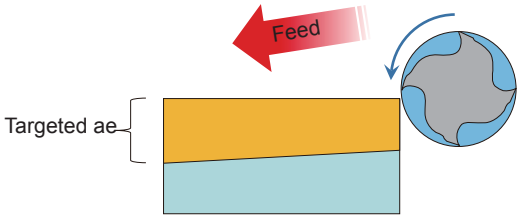
Recommendations for continuous cuttting

Continuous cutting is highly recommended. Damage or chipping can occur during interrupted cutting.



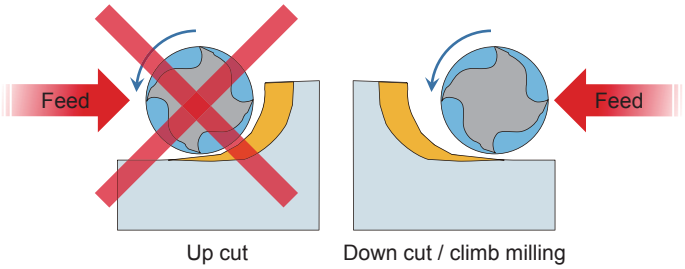
Continuous cutting　　Interrupted machining

Using maximum width and depth of cut from the start of machining may cause damage.
Increase the width of cut (ae) gradually to maintain tool life.



Method: Down cut (climb milling)

Down cut / climb milling is highly recommended. Up cutting can be unstable.

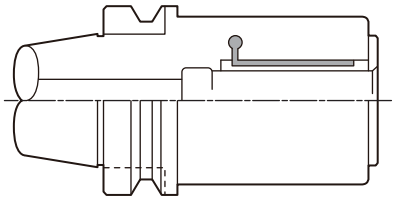


Up cut　　Down cut / climb milling

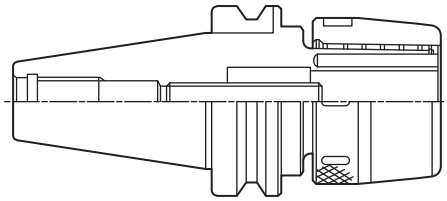
Others

Tool holder recommendation - Hydraulic chuck

First recommendation for tool holding is a hydraulic chuck, second recommendation is a precision milling chuck.
Collet chucks are not suitable.



Hydraulic chuck



Precision milling chuck

Do not remove the built up edge

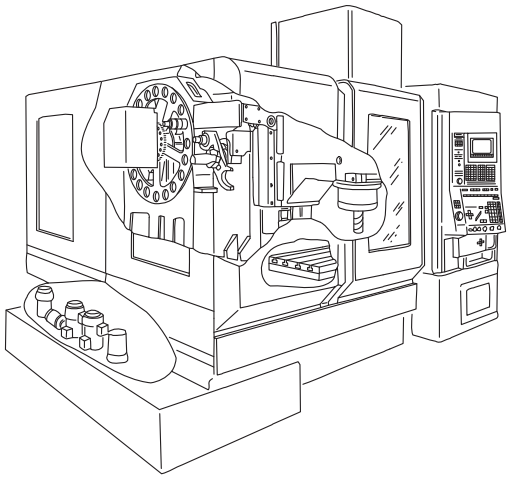
Do not remove any built up edge manually after machining as this may cause chipping.
The built up edge will be removed by the heat generated during the next cutting cycle.

Final machining allowance of more than 0.3mm

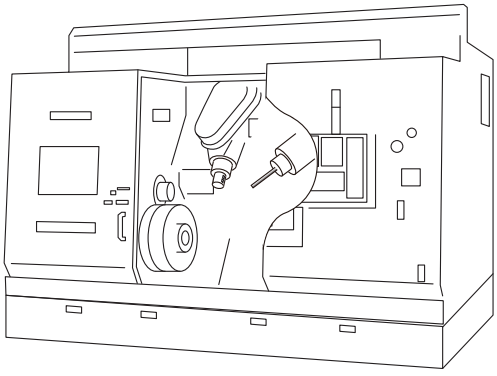
Leave a minimum of 0.3mm finishing allowance. Machining with ceramic end mills at high temperatures can affect the outermost layer of the machined material, therefore a final machining allowance must remain.

Do not use open type machines

The chips generated during machining are at extremely high temperatures.
Ensure the inside of the machine is free from any combustible materials.

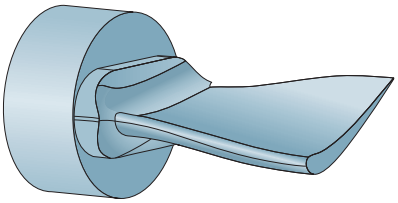
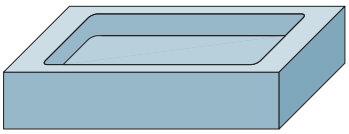


Covered machining center



Covered turn mill type machine

APPLICATION EXAMPLES

Cutter Body		CE6SRBD1000R100	CE6SRBD1200R150
Workpiece		Inconel®718 	Inconel®718 
Component		Turbine blade	Pocket component
Process		Blade machining	Pocket machining
Cutting Conditions	Cutting Speed (m/min)	628	700
	Feed per Tooth (mm/t.)	0.03	0.06
	Depth of Cut (mm)	ap=0.7, ae=1.2	ap=1.5, ae=5.0
Cutting mode		Dry (No air blow)	Air blow
Machine		Turn mill center	Vertical machining center
Results		Cutting efficiency 3 times compared to carbide end miils.	Pocket milling of 100mm×100mm×10mm is completed without a prepared hole in 2min 40 seconds.

For Your Safety
●Don't handle inserts and chips without gloves. ●Please machine within the recommended application range and exchange expired tools with new ones in advance of breakage. ●Please use safety covers and wear safety glasses. ●When using compounded cutting oils, please take fire precautions. ●When attaching inserts or spare parts, please use only the correct wrench or driver. ●When using rotating tools, please make a trial run to check run-out, vibration and abnormal sounds etc.

MITSUBISHI MATERIALS CORPORATION

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Overseas Sales Dept, Asian Region
KFC bldg., 8F, 1-6-1 Yokoami, Sumida-ku, Tokyo 130-0015, Japan
TEL +81-3-5819-8771 FAX +81-3-5819-8774

Overseas Sales Dept, European & American Region
KFC bldg., 8F, 1-6-1 Yokoami, Sumida-ku, Tokyo 130-0015, Japan
TEL +81-3-5819-8772 FAX +81-3-5819-8774

http://www.mitsubishicarbide.com/en/
(Tools specifications subject to change without notice.)

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