Ceramic End Mills

CERAMIC Corner Radius End Mills

Ultra high productivity for nickel based heat resistant alloys

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CERAMIC

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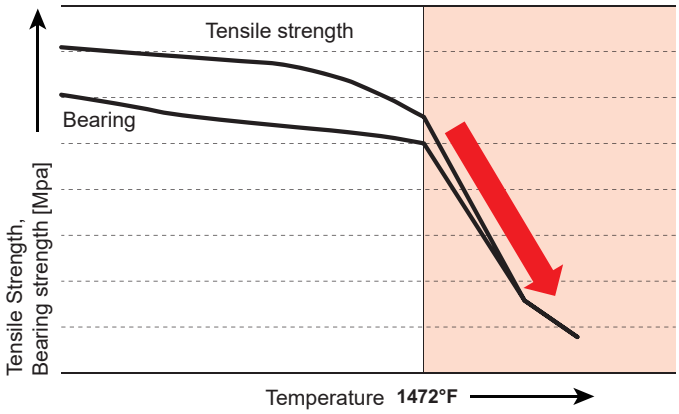
From difficult-to-cut to easy-to-cut!

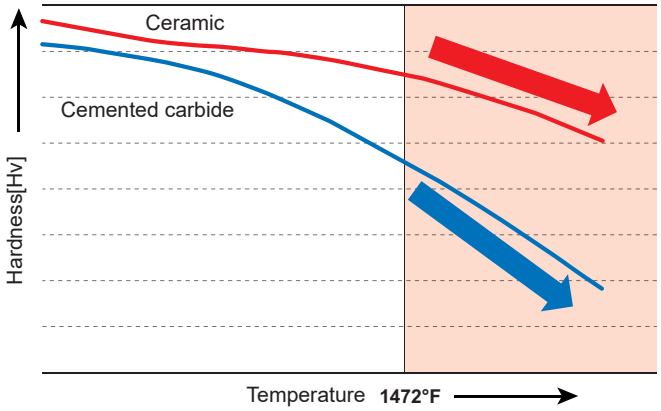
Generation of cutting heat theory

Feature of Ni based heat-resistant alloy

Ni based difficult-to-cut heat resistant alloys such as Inconel®718 soften at temperatures exceeding 1472ºF. At these temperatures, difficult-to-cut materials become easier to machine because their 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



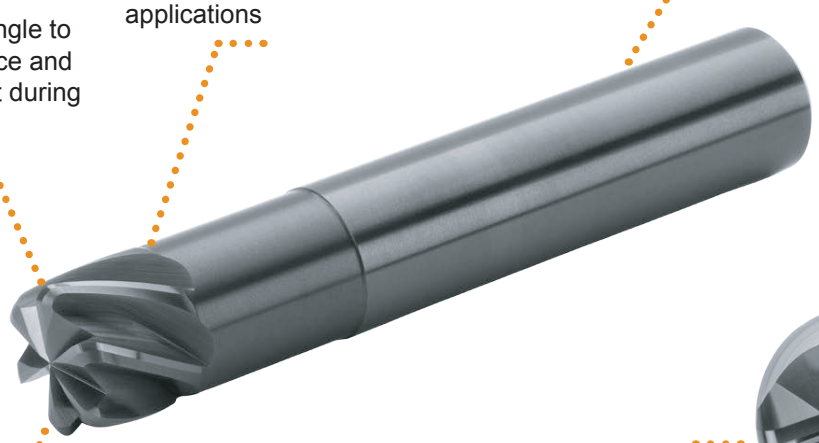
Cemented carbide end mills whose material strength is significantly reduced in a temperature zone exceeding 1472ºF, cannot increase machining speed and perform large depth of cut machining at high temperatures, in contrast ceramic end mills can preform machining at high temperatures because the strength is not reduced even at 1472°F.

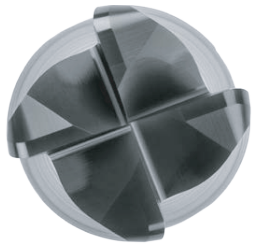
Features

Seamless grinding technology provides greater chipping resistance even during extreme roughing applications

Optimum ceramic grade for Heat Resistant Super Alloy applications.

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



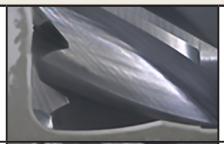
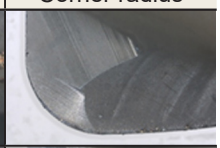
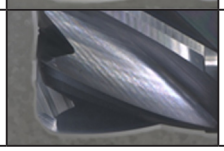
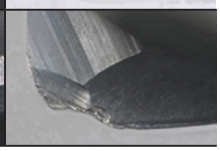


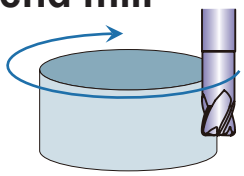
4-flute type for pocketing and slotting,
6-flute type for face machining and profiling.

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

Cutting Performance

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

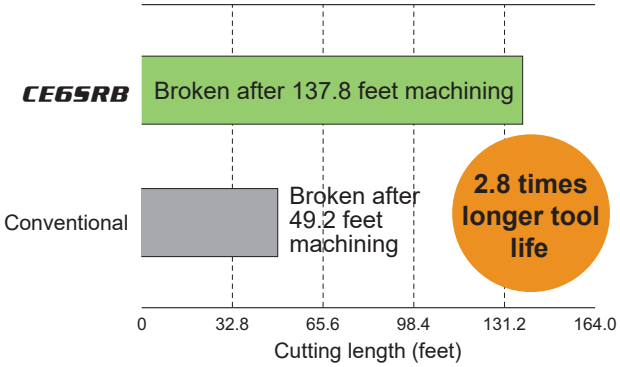
Before cutting			After cutting (39.4 feet)	
			Edge	Corner radius
CE6SRB		Revolution: 19,098 RPM (1968 SFM) Feed rate: 271 IPM		
Carbide end mills 6 flute		Revolution: 1,910 RPM (197 SFM) Feed rate: 27 IPM		



<Cutting condition>
Tool : ø10xR1.0
Depth of cut : ae=.039 inch
ap=.276 inch
Overhang : .787 inch
Cutting mode : Down cut
Ceramic : Dry
No air blow
Carbide : Wet

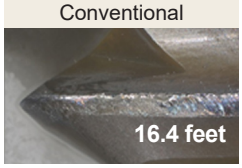
Cutting efficiency 10 times greater than solid carbide end mill

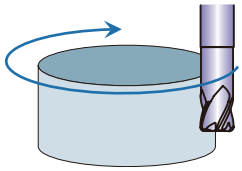
Comparison with Inconel®718 (HRC45) Ceramic end mill



CE6SRB

Conventional



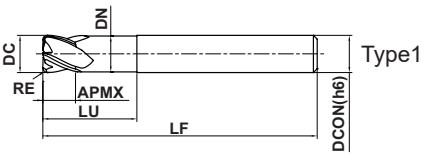


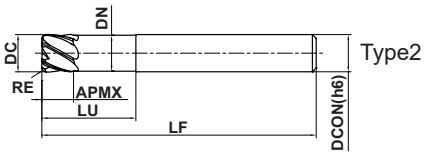
<Cutting condition>
Tool : ø12xR1.5
Revolution : 18,568 RPM (2.295 SFM)
Feed rate : 263 IPM (.002 IPT)
Depth of cut : ae=.094 inch
ap=.354 inch (Down cut)
Overhang : .945 inch
Cutting mode : Dry (No air blow)

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	Aluminium 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		
DCON=6	DCON=8,10	DCON=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

Unit : mm

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

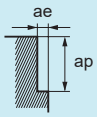
(Note 1) Never use ceramic end mills to cut titanium alloys.
Doing so will cause a risk of ignition and can be extremely dangerous.

● : Inventory maintained.

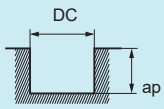
RECOMMENDED CUTTING CONDITIONS

CE4SRB

Side milling

Work Material	Inconel			
Dia. **DC** (mm)	Vc=1970SFM (1150-3300) RPM	fz=.0016IPT IPM	ap (inch)	ae (inch)
6	32000	151.2	.177	.047
8	24000	113.4	.236	.063
10	19000	89.8	.295	.079
12	16000	75.6	.354	.094
Cutting Condition	 DC:Dia.			

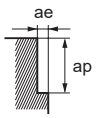
Slotting

Work material	Inconel		
Dia. **DC** (mm)	Vc=1970SFM (1150-3300) RPM	fz=.0008IPT IPM	ap (inch)
6	32000	100.8	.059
8	24000	75.6	.098
10	19000	59.8	.118
12	16000	50.4	.157
Cutting Condition	 DC:Dia.		

*Leave .012" of material on bottom and side

CE6SRB

Side milling

Work material	Inconel			
Dia. **DC** (mm)	Vc=1970SFM (1150-3300) RPM	fz=.0016IPT IPM	ap (inch)	ae (inch)
6	32000	226.8	.177	.047
8	24000	170.1	.236	.063
10	19000	134.6	.295	.079
12	16000	113.4	.354	.094
Cutting Condition	 DC:Dia.			

* 1) The outermost layer of the material may be affected by heat.
Ensure a minimum of 0.012" final machining allowance remains.
2) The recommended ramping angle is 1.5 degree. When conducting ramping it is recommended to reduce the feed rate by 50% from the cutting conditions shown.
3) Gradually increase the width of cut starting from 0.05 x DC (cutter diameter) to maximum width of cut, this will help maintain tool life. See illustration on page 5.

CERAMIC RADIUS END MILLS

PRECAUTION

Cutting Conditions

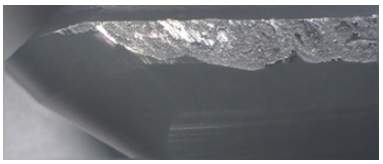
Requires high cutting speeds (from 1150 SFM to 3280 SFM)

High speed cutting is required to generate the heat needed to soften materials without causing abrasion or other damage.
Cutting speeds from 1150 SFM to 3280 SFM are recommended.

Recommendation for air blow

Do not use 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.

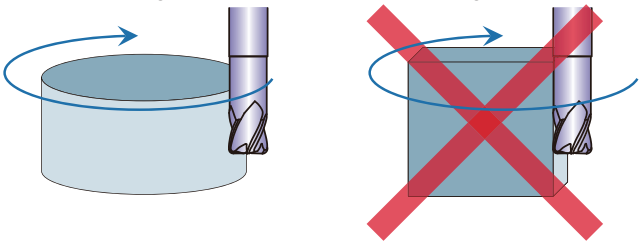
Example of thermal cracking



Applications

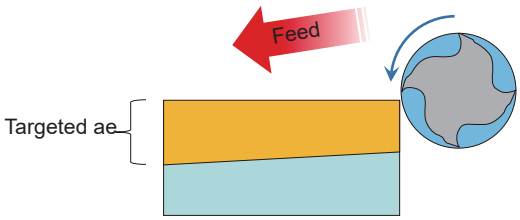
Recommendations for cutting

Applications where continuous machining are common is highly recommended for ceramic end mills.
Chipping or damage can occur during severe interrupted machining.



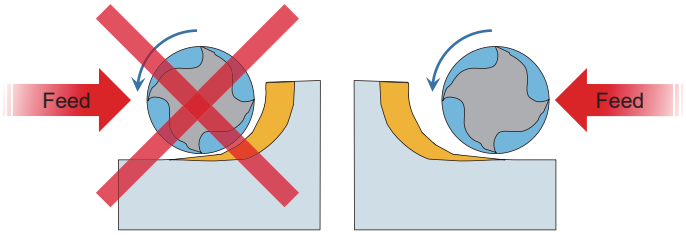
Continuous machining　　Interrupted machining

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.

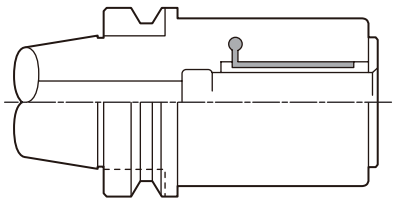


Up cut　　Down cut / climb milling

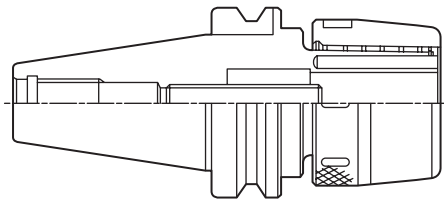
Others

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

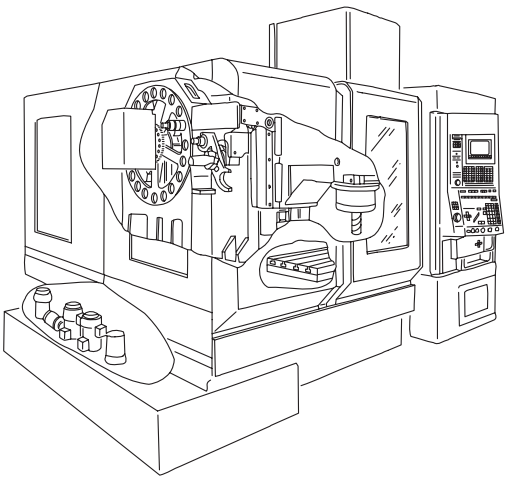
Do not remove any built up edge manually from the end mill after machining as this may cause chipping.
The built up edge will be removed by the heat generated during the next cutting cycle.

Final machining allowance of more than .012 inch

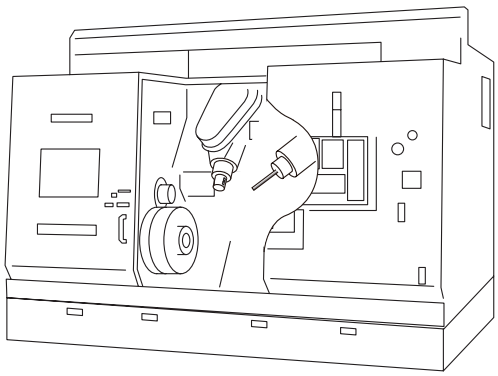
Leave a minimum of .012 inch finishing allowance. Machining with ceramic end mills at high temperatures can affect the outermost layer of the machined material, therefore a final machining allowance must remain.

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.

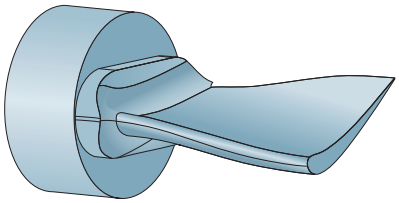
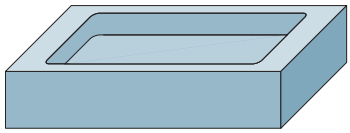


Covered machining center



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 (SFM)	2,060	2,295
	Feed per Tooth (IPT)	.001	.002
	Depth of Cut (inch)	ap=.028, ae=.047	ap=.059, ae=.197
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 3.937 × 3.937 × .394 inch is completed without a prepared hole in 2 min 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 using rotating tools, please make a trial run to check run-out, vibration and abnormal sounds etc.

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

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