

ULTRATOOL® Series 355 and 377 Series End Mills

Series 355

Ultra-Grain® Carbide End Mill

- Five Flute • 45 Degree RH Spiral
- SmoothEdge Honed • Coated



The Ultra-Tool® Series 355 End Mill is designed for the highest efficiency in the milling / finishing of steel, stainless, titanium and high temp alloys. Precision ground from Ultra-Grain® 1 for top strength, the 355 features a proprietary OD hone to minimize tool break-in and the latest generation of SmoothCoat® AlTiN PVD coating. S&P's on page #58.



Premium Series EM Specs:
Cutting Diam +.000/- .002
Shank Diam -.0000/- .00025
Radius ±.0005



new! Standard Radius sizes throughout the range!

Diam	LOC	OAL	Shank	Square EDP#	.015R EDP#	.030R EDP#	.060R EDP#	.090R EDP#	.125R EDP#	.190R EDP#	.250R EDP#	Ball EDP#	AT Coated
1/8	1/2	1-1/2	1/8	31550AT	27108AT	27114AT						27169AT	\$15.10
1/8	1"	3"	1/8	27100AT	27109AT	27115AT						27170AT	\$26.20
3/16	5/8	2"	3/16	31551AT	27110AT	27116AT						27171AT	\$19.10
3/16	1-1/4	3"	3/16	27101AT	27111AT	27117AT						27172AT	\$30.50
1/4	3/4	2-1/2	1/4	31552AT	31562AT	27118AT						27173AT	\$25.70
1/4	1"	4"	1/4	27102AT	27112AT	27119AT						27174AT	\$33.50
5/16	13/16	2-1/2	5/16	31553AT	27113AT	27120AT						27175AT	\$30.40
3/8	1"	2-1/2	3/8	31554AT	27502AT	27121AT	27128AT	27139AT	27150AT			27176AT	\$36.50
3/8	2"	4"	3/8	27103AT	27503AT	27122AT	27129AT	27140AT	27151AT			27177AT	\$59.10
7/16	1"	2-3/4	7/16	31555AT	27504AT	27123AT	27130AT	27141AT	27152AT			27178AT	\$47.00
1/2	1-1/4	3"	1/2	27244AT	27505AT	27245AT	27131AT	27142AT	27153AT			27179AT	\$62.70
1/2	2"	4"	1/2	27104AT	27506AT	27124AT	27132AT	27143AT	27154AT			27180AT	\$86.50
5/8	1-1/2	3-1/2	5/8	31557AT	27507AT	31567AT	27133AT	27144AT	27155AT			27181AT	\$110.30
5/8	2-5/8	5"	5/8	27105AT	27508AT	27125AT	27134AT	27145AT	27156AT			27182AT	\$151.60
3/4	1-5/8	4"	3/4	27246AT	27509AT	27247AT	27248AT	27249AT	27250AT	27251AT	27252AT	27253AT	\$152.00
3/4	2-5/8	5"	3/4	27254AT	27510AT	27256AT	27258AT	27260AT	27262AT	27264AT	27266AT	27268AT	\$224.70
3/4	4"	7"	3/4	27106AT	27511AT	27126AT	27136AT	27147AT	27158AT	27162AT	27166AT	27184AT	\$270.70
1"	1-1/2	4"	1"	31559AT	27512AT	31569AT	27137AT	27148AT	27159AT	27163AT	27167AT	27185AT	\$224.50
1"	2-5/8	5"	1"	27255AT	27513AT	27257AT	27259AT	27261AT	27263AT	27265AT	27267AT	27269AT	\$334.20
1"	4"	7"	1"	27107AT	27514AT	27127AT	27138AT	27149AT	27160AT	27164AT	27168AT	27186AT	\$412.30

ULTRATOOL®
PERFORMANCE
S E E R I E S



High Efficiency Milling (HEM) ratio

SmoothGrind®

SmoothContricity®

SmoothEdge®

SmoothCoat®

ULTRA-Grain®



Series 355/377 Geometry Enhancements

- ✓ Unequal indexing (variable pitch)
- ✓ Polished radial relief
- ✓ Unmeasurable runout
- ✓ Edge prep
- ✓ Special radius transition
- ✓ Opened free-cutting end cut

Series 377

Ultra-Grain® Carbide End Mill

- Seven Flute • 40 Degree RH Spiral
- SmoothEdge Honed • Coated



new! New 7-flute Series!

The Ultra-Tool® Series 377 End Mill targets the same materials as the 355, yet the seven flute design allows for faster metal removal rates. Precision ground from Ultra-Grain® 1 for top strength, the 377 features a proprietary OD hone to minimize tool break-in and the latest generation of SmoothCoat® AlTiN PVD coating. S&P's on page #58.



Premium Series EM Specs:
Cutting Diam +.000/- .002
Shank Diam -.0000/- .00025
Radius ±.0005



new! Standard Radius sizes throughout the range!

Diam	LOC	OAL	Shank	Square EDP#	.015R EDP#	.030R EDP#	.060R EDP#	.090R EDP#	.125R EDP#	.190R EDP#	.250R EDP#	Ball EDP#	AT Coated
1/4	3/4	2-1/2	1/4	27400AT	27414AT	27416AT							\$25.70
1/4	1"	4"	1/4	27401AT	27415AT	27417AT							\$33.50
3/8	1"	2-1/2	3/8	27402AT	27490AT	27418AT	27430AT	27442AT	27454AT			27478AT	\$36.50
3/8	2"	4"	3/8	27403AT	27491AT	27419AT	27431AT	27443AT	27455AT			27479AT	\$59.10
1/2	1-1/4	3"	1/2	27404AT	27492AT	27420AT	27432AT	27444AT	27456AT			27480AT	\$62.70
1/2	2"	4"	1/2	27405AT	27493AT	27421AT	27433AT	27445AT	27457AT			27481AT	\$86.50
5/8	1-1/2	3-1/2	5/8	27406AT	27494AT	27422AT	27434AT	27446AT	27458AT			27482AT	\$110.30
5/8	2-5/8	5"	5/8	27407AT	27495AT	27423AT	27435AT	27447AT	27459AT			27483AT	\$151.60
3/4	1-5/8	4"	3/4	27408AT	27496AT	27424AT	27436AT	27448AT	27460AT	27466AT	27472AT	27484AT	\$152.00
3/4	2-5/8	5"	3/4	27409AT	27497AT	27425AT	27437AT	27449AT	27461AT	27467AT	27473AT	27485AT	\$224.70
3/4	4"	7"	3/4	27410AT	27498AT	27426AT	27438AT	27450AT	27462AT	27468AT	27474AT	27486AT	\$270.70
1"	1-1/2	4"	1"	27411AT	27499AT	27427AT	27439AT	27451AT	27463AT	27469AT	27475AT	27487AT	\$224.50
1"	2-5/8	5"	1"	27412AT	27500AT	27428AT	27440AT	27452AT	27464AT	27470AT	27476AT	27488AT	\$334.20
1"	4"	7"	1"	27413AT	27501AT	27429AT	27441AT	27453AT	27465AT	27471AT	27477AT	27489AT	\$412.30

ULTRATOOL®
PERFORMANCE
S E E R I E S



High Efficiency Milling (HEM) ratio

Application Data for High Performance Series 323, 355, 377, & 365 Series ULTRATOOL End Mills

The milling data presented below is for the 323, 355, 377, and 365 Series of Ultra end mills. When using SmoothCoat & SmoothEdge surface treatments, Surface Feet or Meters Per Minute can be increased from the stated levels by at least 25%.

Do not use a radial DOC exceeding more than 25% of diameter for Series 355 only.



Peripheral Milling data based on axial depth $\leq 100\%$ of tool diameter & radial depth of $\leq 25\%$ of tool diameter.



Slot Milling data based on axial depth of cut = 50% of tool diameter.

End Mill Specifications:

Diameter: $+.000 / -.002$
Shank Diameter: $+.0000 / -.0003$
LOC: $+.060 / -.000$
OAL: $\pm .060$
Helix: $\pm 2^\circ$

Milling;
Fractional

Material	SFPM	SFPM	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	1"
Steel	Peripheral	Slotting					Feed Per Tooth (FPT)					
1018 / 1020	300 to 600	200 to 400	.0007	.0012	.0015	.0018	.0020	.0025	.0030	.0035	.0040	.0045
4140 / 4340 / P20	250 to 500	200 to 350	.00065	.0010	.0012	.0015	.0018	.0022	.0025	.0030	.0035	.0040
Stainless Steel												
303 / 304 / 316	250 to 400	200 to 350	.0006	.0008	.0010	.0012	.0018	.0022	.0025	.0030	.0035	.0038
410 / 420 / 440C	200 to 300	150 to 250	.0006	.0008	.0010	.0012	.0018	.0022	.0025	.0030	.0035	.0038
15-5/17-4 $\leq 32\text{HRc}$	200 to 350	150 to 300	.0006	.0008	.0010	.0012	.0018	.0022	.0025	.0030	.0035	.0038
15-5/17-4 $\geq 32\text{HRc}$	150 to 250	150 to 250	.0004	.0006	.0008	.0010	.0015	.0020	.0020	.0025	.0030	.0035
Tool Steel												
A2/D2/H13 $\leq 32\text{HRc}$	200 to 300	150 to 250	.0005	.0008	.0010	.0012	.0018	.0022	.0025	.0030	.0035	.0035
A2/D2/H13 $\geq 32\text{HRc}$	150 to 250	100 to 200	.0004	.0006	.0008	.0010	.0015	.0020	.0020	.0025	.0030	.0035
Titanium												
6Al-4V	150 to 300	125 to 225	.0005	.0008	.0010	.0010	.0012	.0020	.0025	.0025	.0030	.0040
High Temp Alloys												
Inconel 625	100 to 150	75 to 125	.0005	.0007	.0010	.0012	.0012	.0018	.0020	.0020	.0025	.0030
Inconel 718	70 to 150	50 to 100	.0005	.0007	.0008	.0009	.0012	.0018	.0020	.0020	.0030	.0040
Cast Iron												
Gray Iron $\leq 32\text{HRc}$	150 to 400	150 to 300	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0030	.0040	.0045

Application Data for Series 323, 355, 377, and 365 High Performance End Mills (continued); Peel Milling



Recommendations are based upon a **radial cut depth of 10%** of the end mill's diameter and **axial cut depth of 50-85%** of the tool's LOC.

Peel milling can be performed wet or dry (with AT coating); please consult technical@toolalliance.com for specific application data.



See it run now!

Series 323, 355, 377, and 365 Peel Milling

Surface Feet Per Minute (SFPM) and Feed Per Tooth (FPT) recommendations by tool diameter and material:

Scan the Quick Code and watch the Series 365 milling various materials on the Tool Alliance YouTube channel.

Material	SFPM	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	1"
Steel	Peripheral					Feed Per Tooth (FPT)					
1018 / 1020	400 to 600	.001-.003	.001-.004	.0015-.005	.002-.008	.002-.008	.003-.010	.003-.010	.003-.010	.004-.012	.004-.012
4140 / 4340 / P20	350 to 500	.001-.002	.001-.003	.001-.004	.0015-.006	.0015-.006	.002-.007	.002-.007	.002-.007	.0025-.008	.0025-.008
Stainless Steel											
303 / 304 / 316	300 to 500	.001-.002	.001-.003	.0015-.004	.002-.006	.002-.006	.003-.008	.003-.008	.003-.008	.003-.010	.003-.010
410 / 420 / 440C	250 to 400	.001-.002	.001-.003	.0015-.004	.002-.006	.002-.006	.003-.008	.003-.008	.003-.008	.003-.010	.003-.010
15-5/17-4 $\leq 32\text{HRc}$	300 to 500	.001-.002	.001-.003	.0015-.004	.002-.006	.002-.006	.003-.008	.003-.008	.003-.008	.003-.010	.003-.010
15-5/17-4 $\geq 32\text{HRc}$	200 to 300	.0005-.002	.0005-.002	.001-.003	.0015-.005	.0015-.005	.002-.006	.002-.006	.002-.006	.003-.008	.003-.008
Tool Steel											
A2/D2/H13 $\leq 32\text{HRc}$	250 to 350	.001-.002	.001-.003	.0015-.004	.002-.006	.002-.006	.003-.008	.003-.008	.003-.008	.003-.010	.003-.010
A2/D2/H13 $\geq 32\text{HRc}$	200 to 300	.001-.002	.001-.003	.0015-.004	.002-.006	.002-.006	.003-.008	.003-.008	.003-.008	.003-.010	.003-.010
Titanium											
6Al-4V	250 to 300	.001-.002	.001-.003	.0015-.004	.002-.006	.002-.006	.003-.008	.003-.008	.003-.008	.003-.010	.003-.010
High Temp Alloys											
Inconel 625	125 to 200	.0005-.002	.0005-.002	.001-.003	.0015-.005	.0015-.005	.002-.006	.002-.006	.002-.006	.003-.008	.003-.008
Inconel 718	100 to 150	.0005-.002	.0005-.002	.001-.003	.0015-.005	.0015-.005	.002-.006	.002-.006	.002-.006	.003-.008	.003-.008
Cast Iron											
Gray Iron $\leq 32\text{HRc}$	250 to 500	.001-.002	.001-.003	.001-.004	.0015-.006	.0015-.006	.002-.007	.002-.007	.002-.007	.0025-.008	.0025-.008

1

ULTRA-Grain®

Components of Guaranteed Quality

COMPONENT #1: Carbide Substrate From being the first Company to introduce MicroGrain carbide to the mass-market round tool industry through the present day, Tool Alliance® has consistently innovated new powder and grade combinations for demanding applications. We recognize that our material is the very first Significant Characteristic. By creating partnerships with a limited number of tungsten powder and cemented-carbide material suppliers, we are able to guarantee that our customers receive precision-tolerance tools ground from only the purest, finest grades available worldwide. The following photographs of Ultra-Carb® 1 and Ultra-Grain® 1 respectively demonstrate the complexity of the compound we commonly refer to as Cemented Carbide. Taken at magnification of 10,000 X through an SEM (Scanning Electron Microscope), the visible grains are tungsten while the cobalt binder appears as dark shadows. The largest tungsten grains appearing in the Ultra-Carb photo are less than one micron in size. Note that these grades are two samples representing more than a dozen different substrates we use throughout our product lines, each having a particular application niche. Compared to other industry participants, you will find that Tool Alliance offers the best month-to-month and year-to-year consistency in carbide grain structure.



Ultra-Carb® 1
Cobalt Percentage: 6%
Grain Size (µm): ≤ 0.8
Hardness: 93.5 HRA
Fracture Toughness (K1c): 6.6
TRS (GPa): 3.8
Density (gm/cc): 14.90

ULTRA-Carb®



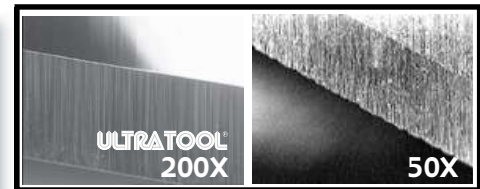
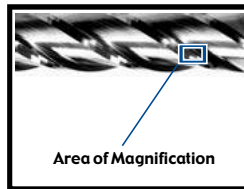
Ultra-Grain® 1
Cobalt Percentage: 10%
Grain Size (µm): ≤ 0.7
Hardness: 92.7 HRA
Fracture Toughness (K1c): 7.9
TRS (GPa): 4.1
Density (gm/cc): 14.30

ULTRA-Grain®

2

SmoothGrind®

COMPONENT #2: The Grinding Process After selecting the best material available, Tool Alliance has perfected the manufacturing technology to optimize 100% of its physical properties. We call this process SmoothGrind®. Years in development, SmoothGrind is the result of a proprietary combination of material, abrasive, coolant, machine-tool, software, and grinding method technologies that produce cutting tools with superior qualitative characteristics. Sharper and longer lasting cutting edges, enhanced work piece finishes, and much improved lubricity are just some of the benefits brought to you by the latest solid carbide rotary tooling advances from Tool Alliance. The two photos above display an Ultra-Tool end mill primary relief featuring SmoothGrind (left) versus a major competitor's product (right). To fully demonstrate the difference, the Ultra end mill is shown at double the magnification. Note the straight line of our end mill's primary relief in comparison to the jagged edge of the competing product. Keep in mind the competitive end mill is a very good product that has a large following, yet the difference is substantial.



SmoothGrind® Competitor's

3

SmoothContricity®



COMPONENT #3: The Tooling Process All the best physical ingredients are wasted unless they are all pulled together in a comprehensive system that maximizes their respective attributes. Tool Alliance calls this process SmoothContricity®. Our customer base represents the leading edge of machine tool utilization, and SmoothContricity ensures that optimum results can be obtained in a variety of ways; minimized run-out (TIR), industry-leading tolerances on diameter & radius, and 100% Shrink Fit Ready (SFR) shanks. Combined, these attributes allow our consumers to reach full machining potential and position the cutting tool as a systematic contributor to process consistency and repeatability.



Shrink Fit Ready

4

SmoothEdge®

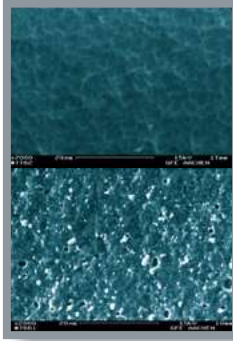


.0001 SmoothEdge atop cylindrical margin atop primary relief.



COMPONENT #4: The Edge Preparation Process

Our cutting edges are literally too sharp for certain materials. For our carbide inserts and now increasingly for our solid carbide round tools, proper edge preparation can yield huge productivity improvements to "out of the box" tool application. Using a treatment we call SmoothEdge® and performed on machine tools developed in our own R&D lab, we've taken the mystery out of tool "break-in" and provided a consistency that can be counted on time and again. The processes range from a microblasting treatment using extremely fine aluminum oxide powder to a diamond-lapping compound to brushes. All are application-specific to sound and run smooth from the first cut and protect your tooling investment from unnecessary potential for chipping during your initial tooling paths. Big productivity gains can be achieved in certain applications as well due to improved chip formation and evacuation. Learn more about SmoothEdge on Page #55.

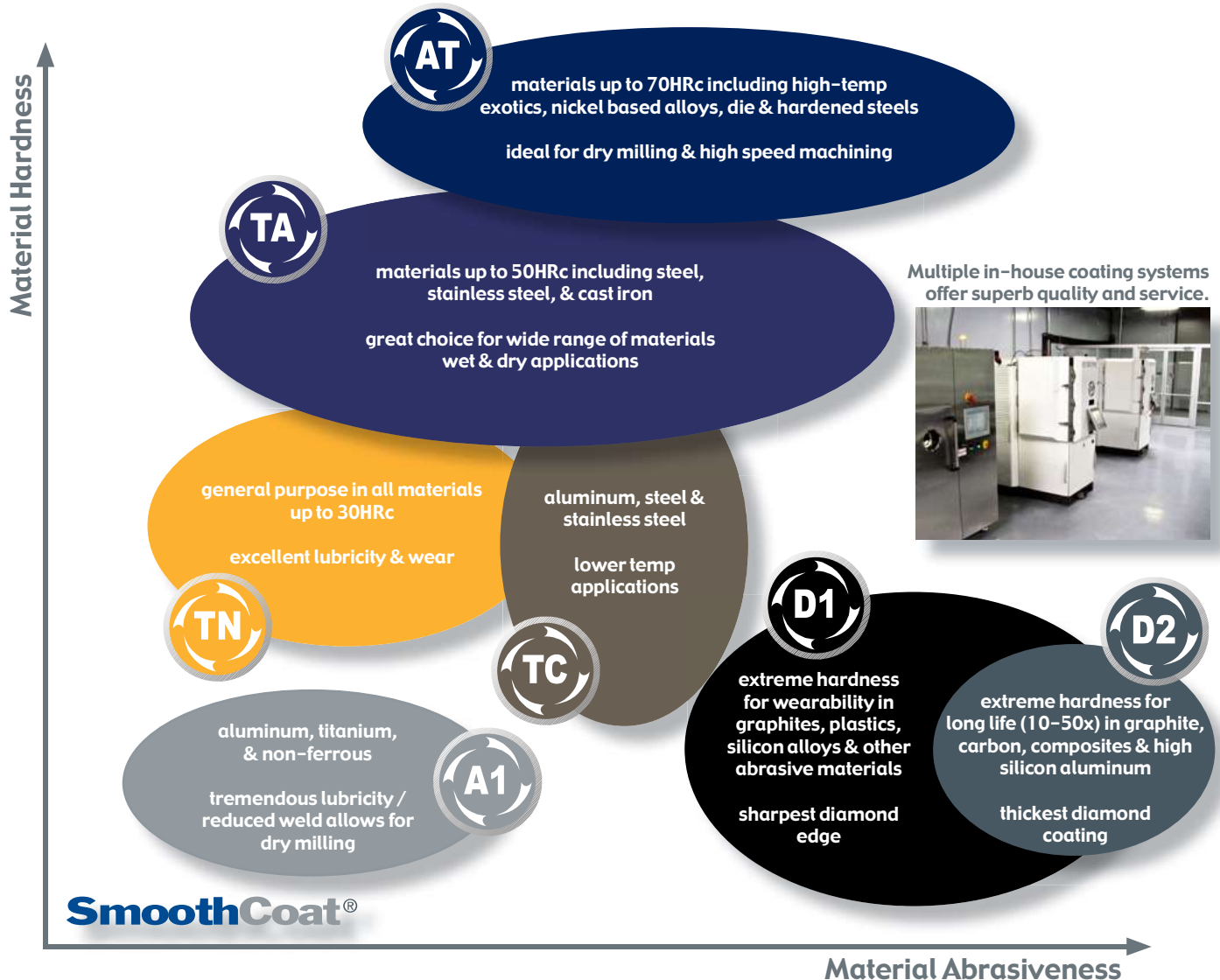


Our coating @ 2,000X (top).
Everybody else's (bottom).

SmoothCoat® 5

COMPONENT #5: The Coating Process The challenge of finding a coating method to leverage 100% of the inherent assets of our carbide grade and grinding technologies was difficult. What we finally discovered was such a perfect fit and so logical for our product lines that we invested heavily into the process we now call SmoothCoat®. Much more than simply the standard arc-deposited PVD coating, SmoothCoat involves sputter multi-layering and a multi-step prep & post operation called Micro-Blasting. The advantages of this procedure include relieving of tensile stresses underneath the cutting edge, increased stability of the coating surface, and perhaps most importantly, elevating SmoothGrind even another notch by leveling and activating the cemented carbide substrate. The result is a smooth, shiny, tough, and durable surface that can withstand tomorrow's machining requirements and outlast competitive coatings. Additionally, we've made it a standard feature on thousands of our standard catalog items. Our coating services are performed within our own factories for quality & extremely quick turnaround times.

Coating Availability Order by adding the suffix TA, TN, AT, TC, A1, D1, or D2 to the EDP #.

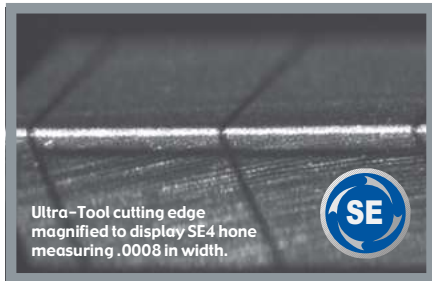


ULTRATOOL® Technical Data

SmoothEdge®

The Edge Preparation Process

Our cutting edges are literally too sharp for certain materials. For our carbide inserts and now increasingly for our solid carbide round tools, proper edge preparation can yield huge productivity improvements to “out of the box” tool application. Using a process we call **SmoothEdge®** and performed on machine tools developed in our own R&D lab, we’ve taken the mystery out of tool “break-in” and provided a consistency that can be counted on time and again. All five types of **SmoothEdge** will yield different benefits dependent upon application. **SmoothEdge** will make your tools sound and run smooth from the first cut and protect your tooling investment from unnecessary potential for chipping during initial tool paths.



Combine SmoothEdge with our other value added features to design the ultimate cutting solution.

SmoothGrind®

- Lubricity
- Sharpness
- Polished Cutting Edges
- Hardness & Adhesion
- Masked Shanks
- Coating Uniformity
- Minimized TIR
- Shrink Fit Ready (SFR)
- Tight Tolerances

SmoothCoat®

SmoothConcricity®

Primary SmoothCoat recommendations:



A1 for SE2



TA for SE4



AT for SE5

Our newest technology can achieve incredible productivity increases in specific applications. Many of our new Series include SmoothEdge as a standard feature, while on others it can be added as a same day post treatment for a small charge. Ask your Inside Sales representative about SmoothEdge today!



SmoothEdge 1

A microblasting treatment using extremely fine aluminum oxide powder to smooth the carbide surface while generating a very light edge preparation. This feature comes standard with any SmoothCoat® coating.

Uses: Highly recommended for most milling and drilling applications.



SmoothEdge 2

A lapping treatment to create extreme lubricity & smoothness with minimal edge prep on uncoated tools.

Uses: Highly recommended for milling and drilling of aluminum and other non-ferrous applications using UnCoated, A1, or TC coated tools.



SmoothEdge 3

Combines microblasting and lapping for a light hone with extreme lubricity.

Uses: Highly recommended for a wide range of general purpose machining applications using coated tools.



SmoothEdge 4

Adds a proprietary hone to the blasting and lapping cycles for a medium edge prep with excellent lubricity.

Uses: Highly recommended for milling and drilling applications involving general steels, stainless, and cast iron.



SmoothEdge 5

Doubles the honing and lapping cycle for maximum edge strength; a robust edge preparation combined with excellent lubricity characteristics.

Uses: Highly recommended for milling and drilling applications involving stainless, high-temp alloys, and exotics.

ULTRATOOL® Technical Data

With so many variables present in the machining process, it is essential to optimize every possible factor to achieve world-class efficiency. Your choice of a genuine Ultra-Tool® Solid Carbide product is an excellent first step in the process. Ultra-Tool® Solid Carbide products are high-performance tools that will perform best in a machining environment characterized by rigid fixturing and minimal spindle runout. Attention to proper speed and feed will eliminate vibration, chatter, and overheating as well as extending tool life. Generally speaking, the peripheral speed of solid carbide tools will vary with the hardness of the material being cut. The harder the material, the slower the speed. High speed and insufficient feed will cause work surface glazing and poor tool life. Chipping of cutting edges is an indication of chatter which can be caused by too high of speed, too light of cut, or improper support of the tool or workpiece. Handling is also very important; sharpened cutting edges should never be allowed to come into contact with any hard object (or another tool) in a non-machining environment as they will chip easily. Keep your Ultra-Tool® products in their original protective packaging until ready for use.

The guidelines on the following pages are generalities designed to demonstrate the operating window within which you may experience the best results. The charts and information provided should prove valuable in longer tool life with greatly reduced operational costs. This information is for uncoated product: SmoothCoat products will have significantly higher speed and feed rates. For more information contact an Ultra-Tool® Factory Engineer, Sales Manager or consult our websites at ultra-tool.com and toolalliance.com. eMails can be sent to technical@toolalliance.com.

Ultra-Tool International, Inc. is constantly striving to improve its processes, specifications, and tolerances. As such, products are subject to change without prior notice.

WARNING: Grinding or other use of this tool may produce hazardous dust and fumes which may endanger health. Grinding or modification should be done by professionals only. To avoid adverse health effects, read the material safety data sheet for this product. Utilize adequate ventilation and appropriate protection. Cutting tools may shatter when broken; eye protection in vicinity of use is strongly advised. MSDS available at www.ultra-tool.com.



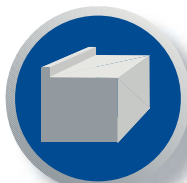
Commonly Used Formulas:

Surface Feet Minute (SFM)=RPM x Diam. x .262
 Revolutions Per Minute (RPM)=3.82 x (SFM / Diam.)
 Feed Rate (IPM)=IPT x #teeth x RPM
 Drilling (IPM)=IPR x RPM
 Feed Per Tooth (IPT)=IPM / (#teeth x RPM)
 Convert Inches to millimeters: Multiply by 25.4
 Convert millimeters to Inches: Multiply by .03937

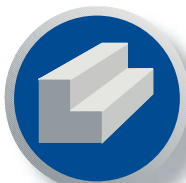
Tech Help Call, eMail us at technical@toolalliance.com, or copy / fax us this page for detailed assistance beyond what printed materials can provide. Please have the following information available to assure we can promptly process a response.

Checklist:

- Tool Description
- Application Description
- Work Piece Material
- Hardness (HRc)
- Current Speed (RPM or SFPM)
- Current Feed (CPT or IPM or FPR)
- Axial DOC
- Radial DOC
- Hole Depth (drilling)
- Machine Tool



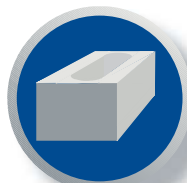
Face Milling



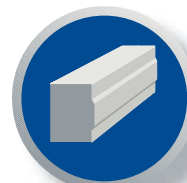
End Milling



Slot Milling



Pocket Milling



Peripheral Milling

Application Tips for ULTRA TOOL® Solid Carbide Products

Trouble Shooting for Ultra-Tool® Carbide End Mills

Problem	Cause	Solution
Chipping	• Feed rate too high	• Reduce feed rate
	• Up milling (conventional)	• Change to down milling (climb)
Wear	• Cutting edge too sharp	• Hone cutting edge or allow break-in
	• Chattering	• Reduce RPM
Breakage	• Loose tool	• Remove, clean, and retighten
	• Workpiece rigidity	• Tighten workpiece holding method
Chattering	• Tool rigidity	• Shorten LOC, place shank further up holder
	• Low cutting speed	• Increase RPM
Short Life	• Loose toolholder	• Remove from spindle, clean and replace
	• High cutting speed	• Reduce RPM
Chip Packing	• Low feed rate	• Increase feed rate
	• Up milling (conventional)	• Change to down milling (climb)
Poor Surface Finish	• Hard material	• Use coated tool
	• Poor chip evacuation	• Reposition coolant lines, use air blasting
Burring or Workpiece Chipping	• Improper cutter helix	• Change to recommended helix angle
	• Poor coolant	• Replace coolant or correct mixture
Workpiece Inaccuracy	• Feed rate too high	• Reduce feed rate
	• Depth of cut too large	• Reduce depth of cut
Tool Wear / Chipping	• Poor tool rigidity	• Shorten LOC, place shank further up holder
	• Tool wear	• Replace/regrind sooner
Heavy Burr	• Poor chip evacuation	• Reposition coolant lines, use air blasting
	• Poor coolant	• Replace coolant or correct mixture
Blue Chips	• Speed and feed too high	• Reduce feed rate
	• Poor toolholder rigidity	• Replace with shorter/more rigid holder
Long Chips	• Poor spindle rigidity	• Use larger spindle or different machine tool
	• Workpiece rigidity	• Tighten workpiece holding method
Solutions Key for Drills	• Relief angle too high	• Regrind with smaller relief angle
	• Depth of cut too large	• Reduce depth of cut
Poor Finish	• Poor tool rigidity	• Shorten LOC, place shank further up holder
	• Cutter/workpiece friction	• Use coated tool
Hole Size Inaccuracy	• Hard material	• Use coated tool
	• Poor material condition	• Use coated tool, clean material surface
Non-Cylindrical Hole	• Improper cutter angle	• Use coated tool, clean material surface
	• Poor coolant	• Replace with proper primary relief angle
Heavy Burr	• Feed rate too high	• Reduce feed rate or increase speed
	• Low cutting speed	• Increase RPM or reduce feed rate
Blue Chips	• Insufficient chip room	• Use tool with less flutes, increase helix
	• Insufficient coolant	• Increase volume of coolant
Long Chips	• Feed rate too high	• Reduce feed rate
	• Low cutting speed	• Increase RPM
Poor Surface Finish	• Tool wear	• Replace or regrind tool
	• Edge build up	• Increase RPM, switch to higher helix tool
Burring or Workpiece Chipping	• Depth of cut too large	• Reduce depth of cut
	• Chip welding	• Increase volume of coolant
Workpiece Inaccuracy	• Tool wear	• Replace or regrind tool
	• Improper helix angle	• Change to recommended helix angle
Heavy Burr	• Feed rate too high	• Reduce feed rate
	• Depth of cut too large	• Reduce depth of cut
Blue Chips	• Tool deflection	• Shorten LOC, place shank further up holder
	• Loose/worn toolholder	• Repair or replace
Long Chips	• Poor toolholder rigidity	• Replace with shorter/more rigid toolholder
	• Poor spindle rigidity	• Use larger spindle or different machine tool
Poor Finish	• Insufficient number of flutes	• Use tool with higher flute quantity
	• Tool deflection	• Shorten LOC, place shank further up holder

Trouble Shooting for Ultra-Tool® Carbide Drills

Problem	Cause	Solution (see key below)
Heavy Wear at Outer Edge	• Insufficient coolant	• 5, 6
	• Incorrect speed & feed	• 1, 2, 8
Chipping at Outer Cutting Edge	• Loose tool, tool movement	• 8, 10, 11, 12, 14, 16, 17, 21
	• Workpiece movement	• 8, 12, 13, 21
Drill Point Chipping	• Poor coolant conditions	• 5, 6
	• Incorrect speed & feed	• 1, 2, 3, 4
Margin Wear	• Loose tool, tool movement	• 10, 11, 12, 14
	• Incorrect speed & feed	• 1, 2, 3, 4
Tool Breakage	• Drill centering	• 8, 10, 11, 12, 21
	• Drill margin rubbing wall	• 20 (check drill for backtaper)
Poor Tool Life	• Poor chip evacuation	• 5, 6, 8, 20
	• Poor coolant conditions	• 5, 6
Drill Walk	• Workpiece movement	• 8, 13, 21
	• Loose tool, tool movement	• 8, 10, 11, 12, 14, 16, 17, 21
Chip Welding	• Workpiece movement	• 8, 12, 13, 21
	• Wrong drill type	• 9, 15, 16, 18, 19, 20
Hole Size Inaccuracy	• Poor coolant conditions	• 5, 6
	• Loose tool	• 14
Non-Cylindrical Hole	• Wrong drill type	• 9, 18
	• Loose tool, tool movement	• 8, 10, 11, 12, 14, 16, 17
Heavy Burr	• Workpiece movement	• 13
	• Incorrect speed & feed	• 1, 2
Blue Chips	• Wrong drill type	• 18, 21
	• Loose tool, tool movement	• 8, 10, 11, 12, 14, 16, 17
Long Chips	• Workpiece movement	• 13
	• Incorrect speed & feed	• 1, 2
Solutions Key for Drills	• Wrong drill point	• 8, 10, 11, 21
	• Material condition	• 11, 12, 15, 16, 17
Poor Finish	• Poor coolant conditions	• 5, 6
	• Tool wear	• 7, 8, 21
Hole Tolerance	• Wrong drill type	• 9, 18
	• Loose tool, tool movement	• 8, 10, 11, 12, 14, 16, 17
Heavy Burr	• Workpiece movement	• 13
	• Incorrect speed & feed	• 1, 2
Blue Chips	• Wrong drill type	• 18, 21
	• Loose tool, tool movement	• 8, 10, 11, 12, 14, 16, 17
Long Chips	• Workpiece movement	• 13
	• Incorrect speed & feed	• 1, 2
Solutions Key for Drills	• Wrong drill point	• 8, 10, 11, 21
	• Material condition	• 11, 12, 15, 16, 17

Trouble Shooting for Ultra-Tool® Carbide Reamers

Problem	Cause	Solution
Chatter	• High cutting speed	• Lower RPM or increase feed rate
	• Feed rate too low	• Increase feed rate
Tool Wear / Chipping	• Workpiece movement	• Tighten workpiece rigidity
	• Toolholder rigidity	• Tighten toolholder or reduce float
Tool Breakage	• Tool rigidity	• Use shorter tool, place further up holder
	• Incorrect feed rate	• Increase feed rate (typically)
Poor Finish	• Incorrect speed	• Reduce speed (typically)
	• Poor hole condition	• Work-hardened hole; change drilling type
Hole Tolerance	• Abrasive material	• Use proper coolant, coated reamer
	• Poor chip evacuation	• Use/increase coolant, use helical reamer
Heavy Burr	• Poor coolant	• Replace coolant or correct mixture
	• Insufficient coolant	• Increase coolant volume
Blue Chips	• Workpiece alignment	• Use bushing, floating holder, lead chamfer
	• Workpiece movement	• Use larger diameter starter drill
Long Chips	• Excessive stock removal	• Increase feed rate (typically)
	• Incorrect feed rate	• Reduce speed (typically)
Poor Surface Finish	• Tool wear	• Sharpen or replace reamer
	• Bottoming of hole	• Adjust stop depth, check preset
Burring or Workpiece Chipping	• Coolant conditions	• Increase, replace, or correct coolant
	• Insufficient stock removal	• Use smaller diameter starter drill
Heavy Burr	• Poor set up	• Use bushing, floating toolholder
	• Excessive stock removal	• Use larger diameter starter drill