High-Performance Solid Carbide Round Tools

for Die & Mold, Medical, Composite & Micro Machining

RoundTool® LABORATORIES

"Not just where machining is, but where machining will be."

Technical Flyer

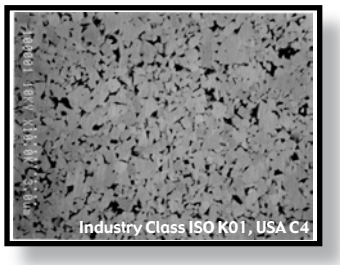
phone 714.898.9224 / 800.854.2431 / fax 714.891.7816
5451 McFadden Avenue • Huntington Beach, CA 92649
roundtool.com

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 (K_{1c}): 6.6
TRS (GPa): 3.8
Density (gm/cc): 14.90

ULTRA-Carb®

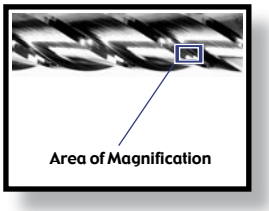


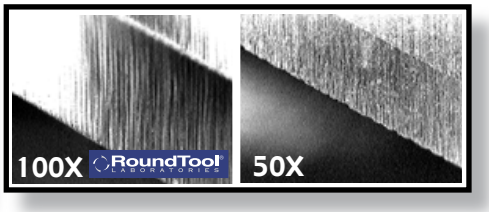
Ultra-Grain® 2
Cobalt Percentage: 8%
Grain Size (µm): ≤ 0.6
Hardness: 93.8 HRa
Fracture Toughness (K_{1c}): 5.8
TRS (GPa): 4.0
Density (gm/cc): 14.6

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 improved lubricity are just some of the benefits brought to you by the latest solid carbide rotary tooling advances from Tool Alliance. The following photographs display a RoundTool end mill primary relief featuring SmoothGrind (left) versus a major competitor's product (right). To fully demonstrate the difference, the RoundTool 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.

SFR
Shrink Fit Ready

4 SmoothEdge®

SE1 SE2 SE3 SE4 SE5

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 process ranges from SmoothEdge 1, a microblasting treatment using extremely fine aluminum oxide powder (note: this procedure is standard with any coated product) to SmoothEdge 5, which adds a double cycle of honing & lubricity treatments. All five will 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.

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.

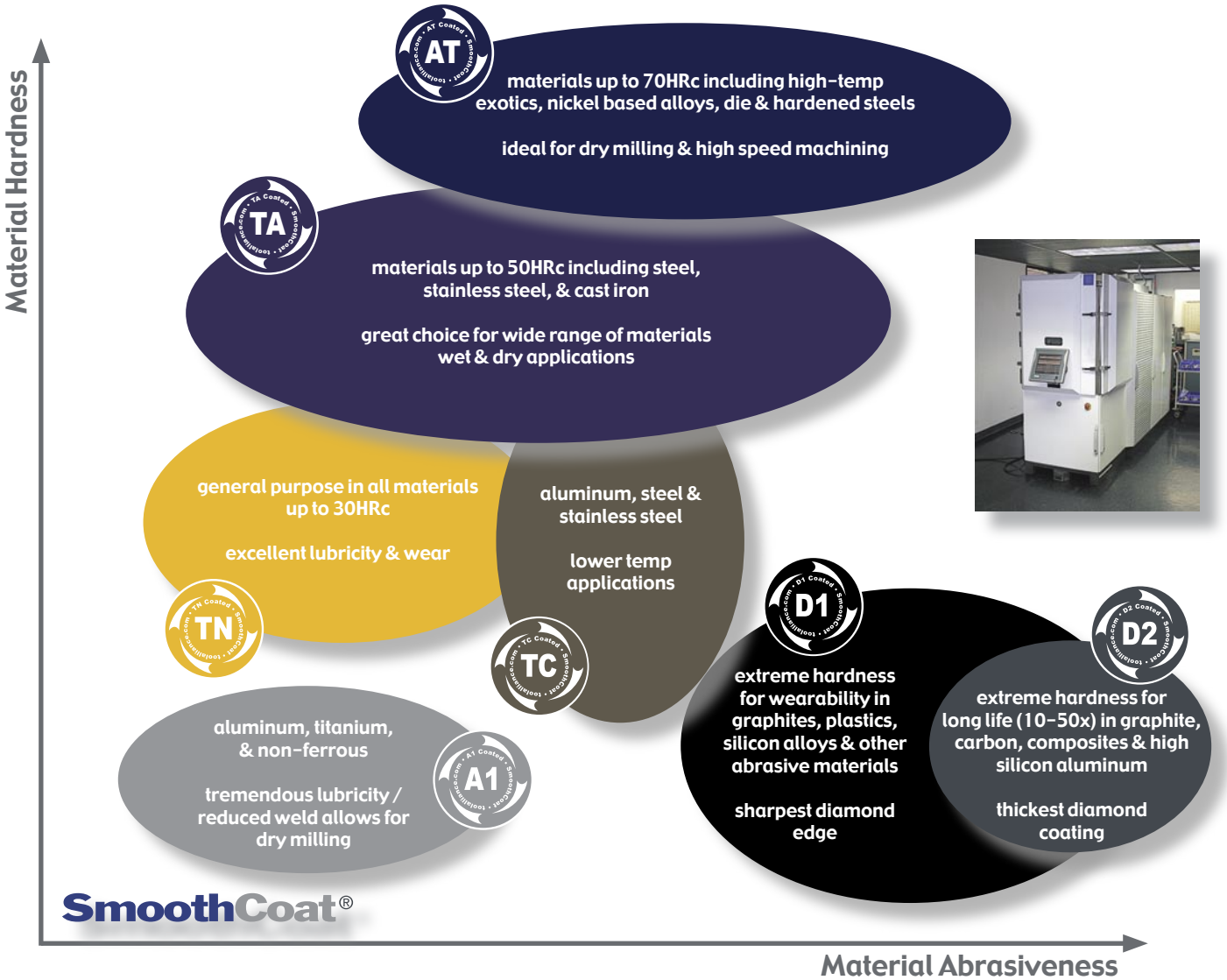
RoundTool Lab's Standard Coating Availability

The UC, AT, A1, TC, D1, or D2 suffix is within the full tool description.

Other Tool Alliance coatings: TA, TN

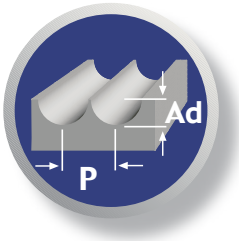
UC	AT	A1	TC	D1	D2
Uncoated	AlTiN HSN²	TiB2	TiCN	PVD Diamond	CVD Diamond

Standard Coatings available at respective "Coated" List Price



DM Series: Technical Data

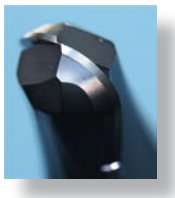
High strength, high hardness solid carbide ball end mills for high-speed machining of hardened alloys up to 65HRc.



- Designed for milling complex contours and shapes
- Proprietary cemented carbide grade and coating
- Maximum tool life and performance in HSM applications
- Pitch (P) and Axial depth (Ad) are expressed in % of cutter diameter
- If recommended speed is higher than machine tool's capacity, run at maximum RPM and reduce feed appropriately

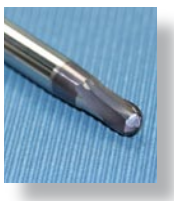
SFR DM Series End Mill Specs:
Cutting Diam +.0000/-.0008
Shank Diam -.0000/-.0002
Radius ±.0005

Material Hardness	30 - 40 HRc		40 - 45 HRc		45 - 55 HRc		55 - 60 HRc		60 - 65 HRc	
Depth of Cut	Ad = .1xD	P=.2xD	Ad = .05xD	P=.2xD	Ad = .03xD	P=.1xD	Ad = .02xD	P=.1xD	Ad = .01xD	P=.1xD
	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
Fractional Diameter	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
.032	38,800	39	38,800	39	38,800	39	38,800	34	37,600	21
.040	31,040	59	31,040	59	31,040	59	28,000	55	15,550	21
1/16"	31,040	74	31,040	74	31,040	74	28,000	70	15,550	23
.080	31,040	74	31,040	74	31,040	74	28,000	70	15,550	23
3/32"	31,040	74	31,040	74	31,040	74	28,000	70	15,550	23
1/8"	23,925	86	23,925	80	20,925	80	18,925	70	10,425	23
3/16"	14,550	97	14,550	91	12,550	83	11,050	75	6,400	23
1/4"	12,025	97	12,025	85	10,625	83	9,625	75	8,425	25
5/16"	9,300	72	9,300	72	8,100	62	7,300	56	4,100	19
3/8"	7,285	54	7,285	54	6,300	46	5,650	40	3,400	15
7/16"	6,425	49	6,425	49	5,600	43	5,100	39	3,000	14
1/2"	6,125	48	6,125	48	5,325	42	4,775	38	2,675	13



SFR DM Metric End Mill Specs:
Cutting Diam +0.00/-0.02mm
Shank Diam -0.000/-0.005mm
Radius ±0.013mm

Material Hardness	30 - 40 HRc		40 - 45 HRc		45 - 55 HRc		55 - 60 HRc		60 - 65 HRc	
Depth of Cut	Ad = .1xD	P=.2xD	Ad = .05xD	P=.2xD	Ad = .03xD	P=.1xD	Ad = .02xD	P=.1xD	Ad = .01xD	P=.1xD
	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
Metric Mill Diameter	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min
0.50 mm	38,800	991	38,800	991	38,800	991	38,800	864	37,600	533
1.0 mm	31,040	1,499	31,040	1,499	31,040	1,499	28,000	1,397	15,550	533
1.5 mm	31,040	1,880	31,040	1,880	31,040	1,880	28,000	1,778	15,550	584
2.0 mm	31,040	1,880	31,040	1,880	31,040	1,880	28,000	1,778	15,550	584
3.0 mm	31,040	1,880	31,040	1,880	31,040	1,880	28,000	1,778	15,550	584
4.0 mm	23,925	2,184	23,925	2,032	20,925	2,032	18,925	1,778	10,425	584
5.0 mm	14,550	2,464	14,550	2,311	12,550	2,108	11,050	1,905	6,400	584
6.0 mm	12,025	2,464	12,025	2,159	10,625	2,108	9,625	1,905	8,425	635
8.0 mm	9,300	1,829	9,300	1,829	8,100	1,575	7,300	1,422	4,100	483
10.0 mm	7,285	1,372	7,285	1,372	6,300	1,168	5,650	1,016	3,400	381
12.0 mm	6,425	1,245	6,425	1,245	5,600	1,092	5,100	991	3,000	356



HT Series: Technical Data

High strength, heavy core solid carbide end mills for high-speed machining of heat-treated & hardened materials up to 70HRc.

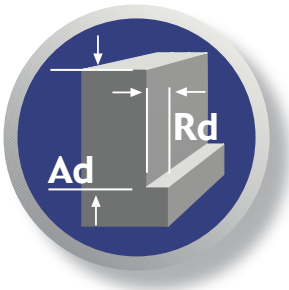
- Designed for peripheral milling (or toroidal slotting) • Proprietary cemented carbide grade and coating
- Maximum tool life and performance in HSM applications

SFR HT Series End Mill Specs: Cutting Diam +.000/-.002 Shank Diam -.0000/-.0002

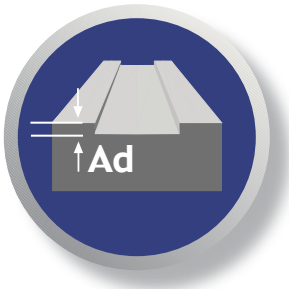
SFR HT Metric End Mill Specs: Cutting Diam +0.00/-0.05mm Shank Diam -0.000/-0.005mm

HTAT6

- Axial depth (Ad) and Radial depth (Rd) are expressed in % of cutter diameter.
- If recommended speed is higher than machine tool's capacity, run at maximum RPM and reduce feed appropriately.



Peripheral milling



Slot milling

Material Hardness	35 - 45 HRc		45 - 55 HRc		55 - 65 HRc		65 - 70 HRc	
Depth of cut Peripheral:	Ad = 1.5xD Rd=.1xD		Ad = 1.0xD Rd=.05xD		Ad = 1.0xD Rd=.03xD		Ad = 1.0xD Rd=.02xD	
Depth of cut Slotting:	Ad = .1xD		Ad = .1xD		Ad = .05xD		Ad = .02xD	
	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
Fractional Mill Diameter	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
1/8"	18,000	85	13,500	48	11,000	33	7,600	21
3/16"	12,000	86	9,000	54	7,500	36	5,000	21
1/4"	9,200	100	7,500	72	5,600	40	3,800	20
5/16"	7,000	05	5,600	74	4,200	50	3,000	27
3/8"	5,600	105	4,300	76	3,500	50	2,500	27
1/2"	3,800	90	3,000	55	2,500	30	1,500	15

Material Hardness	35 - 45 HRc		45 - 55 HRc		55 - 65 HRc		65 - 70 HRc	
Depth of cut Peripheral:	Ad = 1.5xD Rd=.1xD		Ad = 1.0xD Rd=.05xD		Ad = 1.0xD Rd=.03xD		Ad = 1.0xD Rd=.02xD	
Depth of cut Slotting:	Ad = .1xD		Ad = .1xD		Ad = .05xD		Ad = .02xD	
	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
Metric Mill Diameter	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min
3.0 mm	19,500	2,300	14,000	1,280	11,900	900	8,050	600
4.0	14,000	2,600	11,000	1,670	9,000	1,050	6,000	600
5.0	10,750	2,600	7,300	1,550	5,550	1,100	4,400	510
6.0	9,700	2,500	7,600	1,850	6,000	1,280	3,700	510
8.0	7,000	2,700	5,600	1,900	4,200	1,280	2,800	640
10.0	5,600	2,765	4,400	2,000	3,600	1,450	2,250	685
12.0	4,650	2,750	3,700	1,790	3,000	1,150	1,900	500

Technical Data: GRD1 & GRD2 Diamond Coated Series

Speeds and Feeds for milling graphite and abrasive materials.
Use maximum spindle RPM to achieve up to 3000 SFPM.

- D1 & D2 coated GR Series will likely utilize your maximum possible spindle speed
- For reference, the chart below displays your achievable SFPM based upon your machining center
- Tool life should be 10-50 times that of uncoated carbide with improved accuracy and finish
- Long life allows unattended machining and part completion without tooling change
- Premium carbide substrate and special material preparation increases coating adhesion

Diam	mm	100 SFPM 30 M/min	250 SFPM 75 M/min	500 SFPM 150 M/min	3000 SFPM 900 M/min	Roughing Feed Rate CPT	Finishing Feed Rate CPT	Roughing Feed mm per tooth	Finishing Feed mm per tooth
1/64	0.4	24000	60000	max rpm	max rpm	.0002 - .0005	.0002 - .0003	0.005 - 0.013	0.005 - 0.008
1/32	0.8	12000	30000	60000	max rpm	.0005 - .001	.0003 - .0006	0.013 - 0.025	0.008 - 0.015
1/16	1.5	6100	15300	30500	max rpm	.0008 - .002	.0005 - .0013	0.203 - 0.051	0.013 - 0.033
3/32	2.5	4100	10200	20400	max rpm	.001 - .0022	.0008 - .0015	0.025 - 0.056	0.020 - 0.038
1/8	3.0	3050	7640	15300	max rpm	.001 - .0025	.001 - .002	0.025 - 0.064	0.025- 0.051
3/16	4.5	2050	5100	10200	61000	.002 - .0035	.001 - .0025	0.051 - 0.090	0.025 - 0.064
1/4	6.0	1500	3820	7640	45800	.0025 - .0045	.001 - .0035	0.064 - 0.114	0.025 - 0.090
5/16	8.0	1220	3050	6120	36700	.003 - .005	.001 - .004	0.076 - 0.127	0.025 - 0.102
3/8	10.0	1020	2550	5100	30500	.003 - .006	.001 - .004	0.076 - 0.152	0.025 - 0.102
7/16	11.0	875	2200	4365	26200	.004 - .008	.001 - .005	0.102 - 0.203	0.025 - 0.127
1/2	12.0	765	1900	3820	23000	.005 - .012	.001 - .006	0.127 - 0.305	0.025 - 0.152

Metric dimensions and recommendations displayed in blue type. M/min = surface meters per minute. SFPM = surface feet per minute. Feed rates displayed in chip load per tooth.

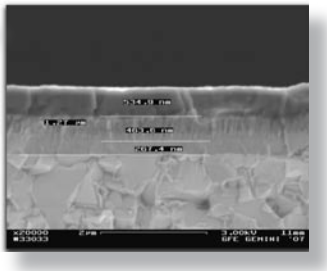
Typical Applications for D1 & D2 Diamond:

- Graphite Carbon: EDM Electrodes
- Carbon Fiber Composites: Brake Discs
- Reinforced Plastics: Medical Products
- Copper Alloys: Mold Cavities
- Aluminum-Silicon Alloys: Engine Parts
- Reinforced Plastics: Circuit Boards
- Green Ceramics: Insulators
- Brass Magnesium: Valves

About our D1 & D2 Diamond Coatings:

RoundTool Laboratories Diamond Coated End Mill Series are a perfect match on graphite molds for EDM. Our D1 and D2 coatings offer industry-leading wear resistance when subjected to the abrasive properties of EDM graphite parts. RoundTool offers two versions of diamond; D1 is a PVD applied diamond while our D2 is a CVD application. Supporting both Series is a carbide end mill specially designed and manufactured with graphite milling in mind. While other companies simply coat standard off-the-shelf end mills, the GR-D1 and GR-D2 represent customized engineering featuring higher helix & heavier core, which in turn offer freer cutting and less deflection. These two series have also achieved great success in other applications featuring highly abrasive materials.

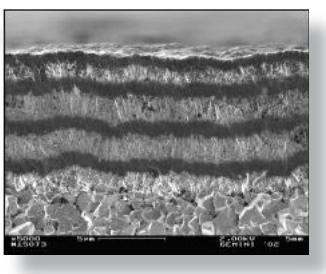
SmoothCoat® D1



SmoothCoat® D1: RoundTool Lab's new generation of D1 raises the bar on PVD diamond coatings. D1 PVD Diamond is a smooth amorphous diamond coating that also maintains an extremely upsharp cutting edge. D1 offers the highest value proposition in a large majority of applications. Short, medium, and long running jobs all benefit from D1's unique attributes, and small diameter end mills particularly are complimented by the smooth & thin coating structure. These end mills will produce the finest finish and most accurate cut of our diamond selection. D1 end mills also have a quick turnaround time with our in-house coating facility.

Type: PVD Color: Shiny Black Thickness: 1-2 micron

SmoothCoat® D2



SmoothCoat® D2: RoundTool Lab's new generation of D2 is a "grown on" CVD diamond coating that offers the highest wear resistance in machining graphite and abrasive non-metals. Tool life can be increased by up to 50x that of standard uncoated carbide end mills. With long tool life and minimal wear, D2 coated end mills improve part accuracy and workpiece tolerance levels. D2 end mills have a longer lead time due to the amount of time spent in the coating vessel physically growing the diamond crystalline structure.

Type: CVD Color: Flat Dark Grey Thickness: 8-12 micron

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new! MP, SS, NF, LR & GR Series: Technical Data

Speeds and Feeds for a variety of materials.

- Tight diameter tolerances of ± .0005 (0.013mm)
- Proprietary cemented carbide grades
- Both series feature extended lengths of cut without loss of strength
- If recommended speed is higher than machine tool's capacity, run at maximum RPM and reduce feed appropriately

Peripheral Milling: Full length of cut possible if radial depth ≤ 10% of tool diameter.

Slot Milling: Based on axial depth < 20% of tool diameter.

Fractional Data

	Peripheral Milling SFPM	Slotting SFPM	Feed Per Tooth based on End Mill Diameter						
			<1/16"	1/16"	1/8"	3/16"	1/4"	3/8"	1/2"
Non-Ferrous									
6061 T6 Aluminum	up to 2000	up to 1500	.0002	.0004	.0008	.0012	.0015	.002	.003
Copper, Brass, Bronze	up to 1200	up to 1000	.0002	.0004	.0008	.0012	.0015	.002	.003
Plastics	up to 2000	up to 1500	.0003	.0006	.001	.002	.003	.004	.005
Steels									
1018, 1020	150 to 300	125 to 250	.0002	.00025	.0005	.001	.0015	.002	.0025
4140, 4340, P20	125 to 250	125 to 225	.00015	.00025	.0005	.0007	.001	.0015	.002
A2, D2, H13 ≤ 32HRC	125 to 225	100 to 150	.00015	.00025	.0005	.0007	.001	.0015	.002
A2, D2, H13 ≥ 32HRC	100 to 125	100 to 125	.0001	.00015	.0003	.0005	.0008	.0010	.0015
Stainless Steels									
15-5, 17-4 ≤ 32HRC	150 to 350	100 to 225	.00015	.00025	.0005	.0007	.001	.0015	.002
15-5, 17-4 ≥ 32HRC	100 to 125	100 to 150	.0001	.00015	.0003	.0005	.0008	.0010	.0015
303, 304, 316	150 to 300	125 to 225	.00015	.00025	.0005	.0007	.001	.0012	.0015
420, 440C	150 to 250	125 to 225	.00015	.00025	.0005	.0007	.001	.0015	.0015
High Temp Alloys									
Inconel 625	75 to 150	75 to 125	.0001	.00015	.0005	.0007	.001	.0015	.002
Inconel 718	50 to 120	50 to 110	.0001	.00013	.0003	.0005	.001	.0015	.0015
6Al-4V Titanium	100 to 150	75 to 125	.0001	.00015	.0005	.0007	.001	.001	.0015
Cast Iron									
Gray Iron ≤ 32HRC	150 to 300	125 to 250	.0002	.00025	.0005	.0007	.001	.0015	.002
Ductile Iron	150 to 250	125 to 250	.0002	.00025	.0005	.0007	.001	.0015	.002

Metric Data

	Peripheral Milling M/Min	Slotting M/Min	Feed Per Tooth based on End Mill Diameter							
			<2.0mm	3.0 mm	4.0 mm	5.0 mm	6.0 mm	8.0 mm	10 mm	12 mm
Non-Ferrous										
6061 T6 Aluminum	up to 600	up to 450	0.007	0.025	0.025	0.030	0.038	0.050	0.050	0.076
Copper, Brass, Bronze	up to 365	up to 300	0.007	0.025	0.025	0.030	0.038	0.050	0.050	0.076
Plastics	up to 600	up to 450	0.009	0.025	0.025	0.050	0.076	0.100	0.100	0.130
Steels										
1018, 1020	45 to 90	38 to 76	0.005	0.015	0.018	0.025	0.038	0.050	0.050	0.065
4140, 4340, P20	38 to 76	38 to 68	0.005	0.012	0.014	0.018	0.025	0.038	0.038	0.050
A2, D2, H13 ≤ 32HRC	38 to 68	30 to 45	0.005	0.012	0.014	0.018	0.025	0.038	0.038	0.050
A2, D2, H13 ≥ 32HRC	30 to 38	30 to 38	0.005	0.010	0.010	0.012	0.020	0.025	0.025	0.038
Stainless Steels										
15-5, 17-4 ≤ 32HRC	45 to 110	30 to 68	0.005	0.012	0.014	0.018	0.025	0.038	0.038	0.050
15-5, 17-4 ≥ 32HRC	30 to 38	30 to 45	0.005	0.010	0.010	0.012	0.020	0.025	0.025	0.038
303, 304, 316	45 to 90	38 to 68	0.005	0.012	0.014	0.018	0.025	0.030	0.030	0.038
420, 440C	45 to 76	38 to 68	0.005	0.012	0.014	0.018	0.025	0.038	0.038	0.038
High Temp Alloys										
Inconel 625	22 to 45	22 to 38	0.005	0.012	0.012	0.018	0.025	0.038	0.038	0.050
Inconel 718	15 to 36	15 to 34	0.005	0.010	0.010	0.012	0.025	0.038	0.038	0.038
6Al-4V Titanium	30 to 45	22 to 38	0.005	0.012	0.012	0.018	0.025	0.025	0.025	0.038
Cast Iron										
Gray Iron ≤ 32HRC	45 to 90	38 to 76	0.005	0.012	0.014	0.018	0.025	0.038	0.038	0.050
Ductile Iron	45 to 76	38 to 76	0.005	0.012	0.014	0.018	0.025	0.038	0.038	0.050