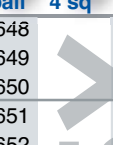
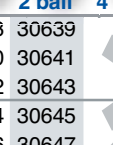
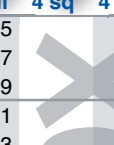
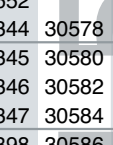
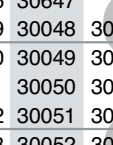
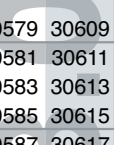
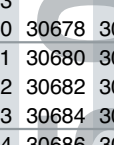


Solid Carbide Micro End Mills by ULTRA-TOOL

The Ultra-Tool® selection of micro solid carbide end mills is unmatched in quality and range. Three different length of cut (LOC) to diameter ratios (Micro = 1.5X, Micro Long = 3.0X, & Micro eXtra Long = 5.0X), two & four flute, square & ball nose, plus coated & UnCoated. Square & Ball prices are identical. These tools match great carbide substrate with superb characteristics. 1/8" shank diameter x 1.5" OAL (metric sizes=3.0 x 38mm).

Series 330MS / 330MB 2-flute 1.5X Series 320MS / 320MB 4-flute 1.5X							Series 330MLS / 330MLB 2-flute 3X Series 320MLS / 320MLB 4-flute 3X							Series 330MXLS / 330MXLB 2-flute 5X Series 320MXLS / 320MXLB 4-flute 5X						
Ø	LOC = 1.5X Diameter						LOC = 3.0X Diameter						LOC = 5.0X Diameter							
																				
	2 sq	2 ball	4 sq	4 ball	price	coated	2 sq	2 ball	4 sq	4 ball	price	coated	2 sq	2 ball	4 sq	4 ball	price	coated		
.005	30000	30648			\$16.00	\$17.00	30638	30639			\$19.00	\$20.00	30654	30655			\$22.00	\$23.00		
.006	30001	30649			\$16.00	\$17.00	30640	30641			\$19.00	\$20.00	30656	30657			\$22.00	\$23.00		
.007	30002	30650			\$16.00	\$17.00	30642	30643			\$19.00	\$20.00	30658	30659			\$22.00	\$23.00		
.008	30003	30651			\$16.00	\$17.00	30644	30645			\$19.00	\$20.00	30660	30661			\$22.00	\$23.00		
.009	30004	30652			\$16.00	\$17.00	30646	30647			\$19.00	\$20.00	30662	30663			\$22.00	\$23.00		
.010	33244	33344			30578	30608	\$14.00	\$15.00			30009	30048	30579	30609			\$17.00	\$18.00	30210	30310
.011	33245	33345	30580	30610	\$14.00	\$15.00	30010	30049	30581	30611	\$17.00	\$18.00	30211	30311	30680	30681	\$20.00	\$21.00		
.012	33246	33346	30582	30612	\$14.00	\$15.00	30011	30050	30583	30613	\$17.00	\$18.00	30212	30312	30682	30683	\$20.00	\$21.00		
.013	33247	33347	30584	30614	\$14.00	\$15.00	30012	30051	30585	30615	\$17.00	\$18.00	30213	30313	30684	30685	\$20.00	\$21.00		
.014	33298	33398	30586	30616	\$14.00	\$15.00	30013	30052	30587	30617	\$17.00	\$18.00	30214	30314	30686	30687	\$20.00	\$21.00		
.015	33249	33349	30588	30618	\$14.00	\$15.00	30014	30053	30589	30619	\$17.00	\$18.00	30215	30315	30688	30689	\$20.00	\$21.00		
.016	33250	33350	30590	30620	\$14.00	\$15.00	30015	30054	30591	30621	\$17.00	\$18.00	30216	30316	30690	30691	\$20.00	\$21.00		
.017	33251	33351	30592	30622	\$14.00	\$15.00	30016	30055	30593	30623	\$17.00	\$18.00	30217	30317	30692	30693	\$20.00	\$21.00		
.018	33252	33352	30594	30624	\$14.00	\$15.00	30017	30056	30595	30625	\$17.00	\$18.00	30218	30318	30694	30695	\$20.00	\$21.00		
.019	33253	33353	30596	30626	\$14.00	\$15.00	30018	30057	30597	30627	\$17.00	\$18.00	30219	30319	30696	30697	\$20.00	\$21.00		
.020	33254	33354	30598	30628	\$14.00	\$15.00	30019	30040	30599	30629	\$17.00	\$18.00	30220	30320	30698	30699	\$20.00	\$21.00		
.021	33255	33355	30600	30630	\$13.50	\$14.50	30020	30058	30601	30631	\$16.50	\$17.50	30221	30321	30698	30699	\$19.50	\$20.50		
.022	33256	33356	30602	30632	\$13.50	\$14.50	30021	30059	30603	30633	\$16.50	\$17.50	30222	30322	30700	30701	\$19.50	\$20.50		
.023	33257	33357	30604	30634	\$13.50	\$14.50	30022	30060	30605	30635	\$16.50	\$17.50	30223	30323	30702	30703	\$19.50	\$20.50		
.024	33258	33358	30606	30636	\$13.50	\$14.50	30023	30061	30607	30637	\$16.50	\$17.50	30224	30324	30704	30705	\$19.50	\$20.50		
.025	33259	33359	32259	32359	\$13.50	\$14.50	30024	30041	30073	30090	\$16.50	\$17.50	30225	30325	30264	30364	\$19.50	\$20.50		
.026	33260	33360	32260	32360	\$13.50	\$14.50	30025	30062	30074	30091	\$16.50	\$17.50	30226	30326	30265	30365	\$19.50	\$20.50		
.027	33261	33361	32261	32361	\$13.50	\$14.50	30026	30063	30075	30092	\$16.50	\$17.50	30227	30327	30266	30366	\$19.50	\$20.50		
.028	33262	33362	32262	32362	\$13.50	\$14.50	30027	30064	30076	30093	\$16.50	\$17.50	30228	30328	30267	30367	\$19.50	\$20.50		
.029	33263	33363	32263	32363	\$13.50	\$14.50	30028	30065	30077	30094	\$16.50	\$17.50	30229	30329	30268	30368	\$19.50	\$20.50		
.030	33264	33364	32264	32364	\$13.00	\$14.00	30029	30042	30078	30095	\$16.00	\$17.00	30230	30330	30269	30369	\$19.00	\$20.00		
.031	33265	33365	32265	32365	\$13.00	\$14.00	30030	30043	30079	30096	\$16.00	\$17.00	30231	30331	30270	30370	\$19.00	\$20.00		
.032	30005	30574	30470	30570	\$13.00	\$14.00	30031	30066	30080	30097	\$16.00	\$17.00	30232	30332	30271	30371	\$19.00	\$20.00		
.033	30706	30796	30748	30838	\$13.00	\$14.00	30707	30797	30749	30839	\$16.00	\$17.00	30233	30333	30272	30372	\$19.00	\$20.00		
.034	30708	30798	30750	30840	\$13.00	\$14.00	30709	30799	30751	30841	\$16.00	\$17.00	30234	30334	30273	30373	\$19.00	\$20.00		
.035	33266	33366	32266	32366	\$13.00	\$14.00	30047	30067	30081	30098	\$16.00	\$17.00	30235	30335	30274	30374	\$19.00	\$20.00		
.036	30710	30800	30752	30842	\$13.00	\$14.00	30711	30801	30753	30843	\$16.00	\$17.00	30236	30336	30275	30375	\$19.00	\$20.00		
.037	30006	30575	30471	30571	\$13.00	\$14.00	30032	30068	30082	30099	\$16.00	\$17.00	30237	30337	30276	30376	\$19.00	\$20.00		
.038	30712	30802	30754	30844	\$13.00	\$14.00	30713	30803	30755	30845	\$16.00	\$17.00	30238	30338	30277	30377	\$19.00	\$20.00		
.039	30714	30804	30756	30846	\$13.00	\$14.00	30715	30805	30757	30847	\$16.00	\$17.00	30239	30339	30278	30378	\$19.00	\$20.00		
.040	33267	33367	32267	32367	\$13.00	\$14.00	30033	30044	30083	30100	\$16.00	\$17.00	30240	30340	30279	30379	\$19.00	\$20.00		
.041	30716	30806	30758	30848	\$13.00	\$14.00	30717	30807	30759	30849	\$16.00	\$17.00	30241	30341	30280	30380	\$19.00	\$20.00		
.042	30718	30808	30760	30850	\$13.00	\$14.00	30719	30809	30761	30851	\$16.00	\$17.00	30242	30342	30281	30381	\$19.00	\$20.00		
.043	30720	30810	30762	30852	\$13.00	\$14.00	30721	30811	30763	30853	\$16.00	\$17.00	30243	30343	30282	30382	\$19.00	\$20.00		
.044	30722	30812	30764	30854	\$13.00	\$14.00	30723	30813	30765	30855	\$16.00	\$17.00	30244	30344	30283	30383	\$19.00	\$20.00		
.045	30724	30814	30766	30856	\$13.00	\$14.00	30725	30815	30767	30857	\$16.00	\$17.00	30245	30345	30284	30384	\$19.00	\$20.00		
.046	30007	30576	30472	30572	\$13.00	\$14.00	30034	30069	30084	30101	\$16.00	\$17.00	30246	30346	30285	30385	\$19.00	\$20.00		
.047	33268	33368	32268	32368	\$13.00	\$14.00	30035	30045	30085	30108	\$16.00	\$17.00	30247	30347	30286	30386	\$19.00	\$20.00		
.048	30726	30816	30768	30858	\$13.00	\$14.00	30727	30817	30769	30859	\$16.00	\$17.00	30248	30348	30287	30387	\$19.00	\$20.00		
.049	30728	30818	30770	30860	\$13.00	\$14.00	30729	30819	30771	30861	\$16.00	\$17.00	30249	30349	30288	30388	\$19.00	\$20.00		
.050	33269	33369	32269	32369	\$12.00	\$13.00	30036	30070	30086	30109	\$15.00	\$16.00	30250	30350	30289	30389	\$18.00	\$19.00		
.051	30730	30820	30778	30862	\$12.00	\$13.00	30731	30821	30779	30863	\$15.00	\$16.00	30251	30351	30290	30390	\$18.00	\$19.00		
.052	30732	30822	30780	30864	\$12.00	\$13.00	30733	30823	30781	30865	\$15.00	\$16.00	30252	30352	30291	30391	\$18.00	\$19.00		
.053	30734	30824	30782	30866	\$12.00	\$13.00	30735	30825	30783	30867	\$15.00	\$16.00	30253	30353	30292	30392	\$18.00	\$19.00		
.054	30736	30826	30784	30868	\$12.00	\$13.00	30737	30827	30785	30869	\$15.00	\$16.00	30254	30354	30293	30393	\$18.00	\$19.00		
.055																				

Solid Carbide Micro End Mills by ULTRATOOL

Series 330MS / 330MB 2-flute 1.5X
Series 320MS / 320MB 4-flute 1.5X

1.5X



Series 330MLS / 330MLB 2-flute 3X
Series 320MLS / 320MLB 4-flute 3X

3.0X



Series 330MXLS / 330MXLB 2-flute 5X
Series 320MXLS / 320MXLB 4-flute 5X

5.0X



Diam	2 sq	2 ball	4 sq	4 ball	price	coated	2 sq	2 ball	4 sq	4 ball	price	coated	2 sq	2 ball	4 sq	4 ball	price	coated
.059	30742	30832	30790	30880	\$12.00	\$13.00	30743	30833	30791	30881	\$15.00	\$16.00	30259	30359	30298	30398	\$18.00	\$19.00
.060	33271	33371	32271	32371	\$12.00	\$13.00	30039	30072	30089	30112	\$15.00	\$16.00	30260	30360	30299	30399	\$18.00	\$19.00
.061	30744	30834	30792	30882	\$12.00	\$13.00	30745	30835	30793	30883	\$15.00	\$16.00	30261	30361	30300	30400	\$18.00	\$19.00
.062	30746	30836	30794	30884	\$12.00	\$13.00	30747	30837	30795	30885	\$15.00	\$16.00	30262	30362	30308	30408	\$18.00	\$19.00
.065	30900	30915	30930	30945	\$12.00	\$13.00	30960	31600	31615	31630	\$15.00	\$16.00						
.070	30901	30916	30931	30946	\$12.00	\$13.00	30961	31601	31616	31631	\$15.00	\$16.00						
.075	30902	30917	30932	30947	\$12.00	\$13.00	30962	31602	31617	31632	\$15.00	\$16.00						
.078	30903	30918	30933	30948	\$12.00	\$13.00	30963	31603	31618	31633	\$15.00	\$16.00						
.080	30904	30919	30934	30949	\$12.00	\$13.00	30964	31604	31619	31634	\$15.00	\$16.00						
.085	30905	30920	30935	30950	\$12.00	\$13.00	30965	31605	31620	31635	\$15.00	\$16.00						
.090	30906	30921	30936	30951	\$12.00	\$13.00	30966	31606	31621	31636	\$15.00	\$16.00						
.093	30907	30922	30937	30952	\$12.00	\$13.00	30967	31607	31622	31637	\$15.00	\$16.00						
.095	30908	30923	30938	30953	\$12.00	\$13.00	30968	31608	31623	31638	\$15.00	\$16.00						
.100	30909	30924	30939	30954	\$12.00	\$13.00	30969	31609	31624	31639	\$15.00	\$16.00						
.105	30910	30925	30940	30955	\$12.00	\$13.00	30970	31610	31625	31640	\$15.00	\$16.00						
.110	30911	30926	30941	30956	\$12.00	\$13.00	30971	31611	31626	31641	\$15.00	\$16.00						
.115	30912	30927	30942	30957	\$12.00	\$13.00	30895	31612	31627	31642	\$15.00	\$16.00						
.118	30913	30928	30943	30958	\$12.00	\$13.00	30896	31613	31628	31643	\$15.00	\$16.00						
.120	30914	30929	30944	30959	\$12.00	\$13.00	30897	31614	31629	31644	\$15.00	\$16.00						



Specs (micro end mills
cutting diameter < 1/8"):
Cutting Diam +.0003 / -.0003
Shank Diam +.0000 / -.0002
Radius ± .00015
SFR = Shrink Fit Ready



Specs (MM micro end mills
cutting diameter < 3.0mm):
Cutting Diam +0.008 / -0.008mm
Shank Diam +0.000 / -0.005mm
Radius ± 0.004mm
SFR = Shrink Fit Ready

Metric Diameters: 1.5X



Metric Diameters: 3.0X



Metric Diameters: 5.0X



Diam	2 sq	2 ball	4 sq	4 ball	price	coated	2 sq	2 ball	4 sq	4 ball	price	coated	2 sq	2 ball	4 sq	4 ball	price	coated
0.10mm	30477	30480			\$22.00	\$23.00	30201	30204			\$25.00	\$26.00						
0.15mm	30478	30481			\$16.00	\$17.00	30202	30205			\$19.00	\$20.00						
0.20mm	30479	30482			\$16.00	\$17.00	30203	30206			\$19.00	\$20.00						
0.25mm	33272	33372	30483	30492	\$14.00	\$15.00	30113	30139	30501	30886	\$17.00	\$18.00	30417	30517			\$20.00	\$21.00
0.30mm	33273	33373	30484	30493	\$14.00	\$15.00	30114	30140	30502	30887	\$17.00	\$18.00	30418	30518			\$20.00	\$21.00
0.35mm	33274	33374	30485	30494	\$14.00	\$15.00	30115	30141	30503	30888	\$17.00	\$18.00						
0.40mm	33275	33375	30486	30495	\$14.00	\$15.00	30116	30142	30504	30889	\$17.00	\$18.00	30419	30519			\$20.00	\$21.00
0.45mm	33276	33376	30487	30496	\$14.00	\$15.00	30117	30143	30505	30890	\$17.00	\$18.00						
0.50mm	33277	33377	30488	30497	\$14.00	\$15.00	30118	30144	30506	30891	\$17.00	\$18.00	30420	30520	30445	30545	\$20.00	\$21.00
0.55mm	33278	33378	30489	30498	\$13.50	\$14.50	30119	30145	30507	30892	\$16.50	\$17.50						
0.60mm	33279	33379	30490	30499	\$13.50	\$14.50	30120	30146	30508	30893	\$16.50	\$17.50	30421	30521	30446	30546	\$19.50	\$20.50
0.65mm	33280	33380	30491	30500	\$13.50	\$14.50	30121	30147	30509	30894	\$16.50	\$17.50						
0.70mm	33281	33381	32281	32381	\$13.50	\$14.50	30122	30148	30165	30182	\$16.50	\$17.50	30422	30522	30447	30547	\$19.50	\$20.50
0.75mm	33282	33382	32282	32382	\$13.50	\$14.50	30123	30149	30166	30183	\$16.50	\$17.50						
0.80mm	33283	33383	32283	32383	\$13.00	\$14.00	30124	30150	30167	30184	\$16.00	\$17.00	30423	30523	30448	30548	\$19.00	\$20.00
0.85mm	33284	33384	32284	32384	\$13.00	\$14.00	30125	30151	30168	30185	\$16.00	\$17.00						
0.90mm	33285	33385	32285	32385	\$13.00	\$14.00	30126	30152	30169	30186	\$16.00	\$17.00	30424	30524	30449	30549	\$19.00	\$20.00
0.95mm	33286	33386	32286	32386	\$13.00	\$14.00	30127	30153	30170	30187	\$16.00	\$17.00						
1.00mm	33287	33387	32287	32387	\$13.00	\$14.00	30128	30154	30171	30188	\$16.00	\$17.00	30425	30525	30450	30550	\$19.00	\$20.00
1.05mm	33288	33388	32288	32388	\$13.00	\$14.00	30129	30155	30172	30189	\$16.00	\$17.00						
1.10mm	33289	33389	32289	32389	\$13.00	\$14.00	30130	30156	30173	30190	\$16.00	\$17.00	30426	30526	30451	30551	\$19.00	\$20.00
1.15mm	33290	33390	32290	32390	\$13.00	\$14.00	30131	30157	30174	30191	\$16.00	\$17.00						
1.20mm	33291	33391	32291	32391	\$13.00	\$14.00	30132	30158	30175	30192	\$16.00	\$17.00	30427	30527	30452	30552	\$19.00	\$20.00
1.25mm	33292	33392	32292	32392	\$13.00	\$14.00	30133	30159	30176	30193	\$16.00	\$17.00						
1.30mm	33293	33393	32293	32393	\$12.00	\$13.00	30134	30160	30177	30194	\$15.00	\$16.00	30428	30528	30453	30553	\$18.00	\$19.00
1.35mm	33294	33394	32294	32394	\$12.00	\$13.00	30135	30161	30178	30195	\$15.00	\$16.00						
1.40mm	33295	33395	32295	32395	\$12.00	\$13.00	30136	30162	30179	30196	\$15.00	\$16.00	30429	30529	30454	30554	\$18.00	\$19.00
1.45mm	33296	33396	32296	32396	\$12.00	\$13.00	30137	30163	30180	30197	\$15.00	\$16.00						
1.50mm	33297	33397	32297	32397	\$12.00	\$13.00	30138	30164	30181	30198	\$15.00	\$16.00	30430	30530	30455	30555	\$18.00	\$19.00

35% tighter shank
tolerance than h6!

Micro End Mills have a
1/8" (3.0mm for metric)
shank diameter.



In addition to UnCoated
(UC) our micro end mills are
available with these standard
coatings.

Application Data for Standard ULTRATOOL® End Mills

The milling data presented below is for all "standard" Series of Ultra end mills (data is presented separately on each respective product page for our application-specific high performance designs). Note: When using SmoothCoat & SmoothEdge surface treatments, Surface Feet or Meters Per Minute can be increased from the stated levels by at least 25%.



Peripheral Milling data based on axial depth ≤ 100% of tool diameter & radial depth of ≤ 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: ± .060
Helix: ± 2°

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	150 to 350	150 to 300	.0005	.0010	.0015	.0018	.0020	.0025	.0030	.0035	.0040	.0045
4140 / 4340 / P20	150 to 300	125 to 225	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0025	.0030	.0040
Stainless Steel												
303 / 304 / 316	150 to 300	125 to 250	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0030	.0040	.0040
410 / 420 / 440C	150 to 300	125 to 250	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0025	.0035	.0038
15-5/17-4 ≤ 32HRc	125 to 250	100 to 225	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0025	.0030	.0038
15-5/17-4 ≥ 32HRc	100 to 150	100 to 150	.0003	.0005	.0010	.0012	.0015	.0015	.0015	.0020	.0030	.0038
13-8 / 316L	125 to 300	125 to 250	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0030	.0040	.0040
Tool Steel												
A2/D2/H13 ≤ 32HRc	125 to 250	100 to 200	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0025	.0030	.0035
A2/D2/H13 ≥ 32HRc	100 to 150	100 to 125	.0003	.0005	.0010	.0012	.0015	.0015	.0015	.0020	.0030	.0035
Titanium												
6Al-4V	120 to 250	100 to 175	.0005	.0007	.0010	.0012	.0012	.0018	.0020	.0020	.0030	.0040
High Temp Alloys												
Inconel 625	50 to 150	50 to 125	.0005	.0007	.0010	.0012	.0012	.0018	.0020	.0020	.0025	.0030
Inconel 718	50 to 150	50 to 125	.0003	.0005	.0010	.0012	.0012	.0015	.0015	.0020	.0025	.0025
Cast Iron												
Gray Iron ≤ 32HRc	150 to 350	125 to 300	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0030	.0040	.0045
Ductile Iron	150 to 300	125 to 250	.0005	.0007	.0010	.0012	.0015	.0018	.0020	.0025	.0035	.0045
Non-Ferrous												
6061 T6 Aluminum	up to 2000	up to 1500	.0010	.0020	.0020	.0025	.0030	.0035	.0040	.0050	.0060	.0070
Copper, Brass, Bronze	up to 1200	up to 1000	.0010	.0010	.0020	.0022	.0025	.0028	.0030	.0040	.0040	.0050
Plastic	up to 2000	up to 1500	.0010	.0020	.0030	.0035	.0040	.0050	.0060	.0080	.0100	.0120

Metric End Mill Specifications:

Diameter (mm): +.000 / -.051mm
Shank Diameter (mm): +.000 / -.007mm
LOC: +1.52 / -0.00mm
OAL: ±1.52mm

Metric

Material	SMPM	SMPM	2 mm	3 mm	4 mm	6 mm	8 mm	10 mm	12 mm	16 mm	20 mm	25 mm
Steel	Peripheral	Slotting					Feed Per Tooth (FPT)					
1018 / 1020	45 to 110	45 to 90	0.010	0.012	0.025	0.038	0.045	0.050	0.080	0.090	0.100	0.120
4140 / 4340 / P20	45 to 90	40 to 70	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.065	0.080	0.100
Stainless Steel												
303 / 304 / 316	45 to 90	40 to 75	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.080	0.100	0.100
410 / 420 / 440C	45 to 90	40 to 75	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.065	0.080	0.100
15-5/17-4 ≤ 32HRc	38 to 75	30 to 70	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.065	0.080	0.100
15-5/17-4 ≥ 32HRc	30 to 45	30 to 45	0.005	0.007	0.012	0.025	0.030	0.038	0.038	0.050	0.080	0.100
13-8 / 316L	38 to 90	40 to 75	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.080	0.100	0.100
Tool Steel												
A2/D2/H13 ≤ 32HRc	38 to 75	30 to 60	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.065	0.080	0.090
A2/D2/H13 ≥ 32HRc	30 to 45	30 to 40	0.005	0.007	0.012	0.025	0.030	0.038	0.038	0.050	0.080	0.090
Titanium												
6Al-4V	35 to 75	30 to 53	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.065	0.080	0.100
High Temp Alloys												
Inconel 625	15 to 45	15 to 38	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.050	0.065	0.070
Inconel 718	15 to 45	15 to 38	0.005	0.007	0.012	0.025	0.030	0.038	0.038	0.050	0.065	0.065
Cast Iron												
Gray Iron ≤ 32HRc	45 to 110	40 to 90	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.080	0.100	0.120
Ductile Iron	45 to 90	40 to 75	0.010	0.012	0.018	0.025	0.030	0.038	0.050	0.065	0.090	0.120
Non-Ferrous												
6061 T6 Aluminum	up to 600	up to 450	0.020	0.025	0.050	0.050	0.064	0.080	0.100	0.130	0.150	0.180
Copper, Brass, Bronze	up to 365	up to 300	0.020	0.025	0.025	0.050	0.056	0.065	0.080	0.100	0.100	0.130
Plastic	up to 600	up to 450	0.020	0.025	0.050	0.080	0.089	0.100	0.150	0.200	0.250	0.300

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®



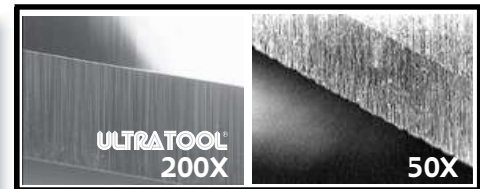
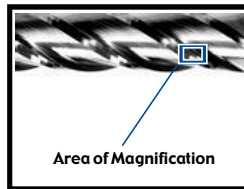
Ultra-Grain® 1
Cobalt Percentage: 10%
Grain Size (µm): ≤ 0.7
Hardness: 92.7 HRA
Fracture Toughness (K1c): 7.9
TRS (GPa): 4.1
Density (gm/cc): 14.30

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®

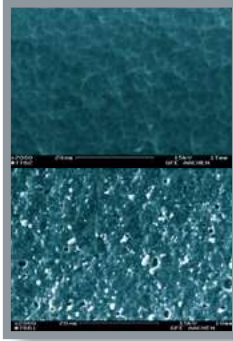


.0001 SmoothEdge atop cylindrical margin atop primary relief.



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.

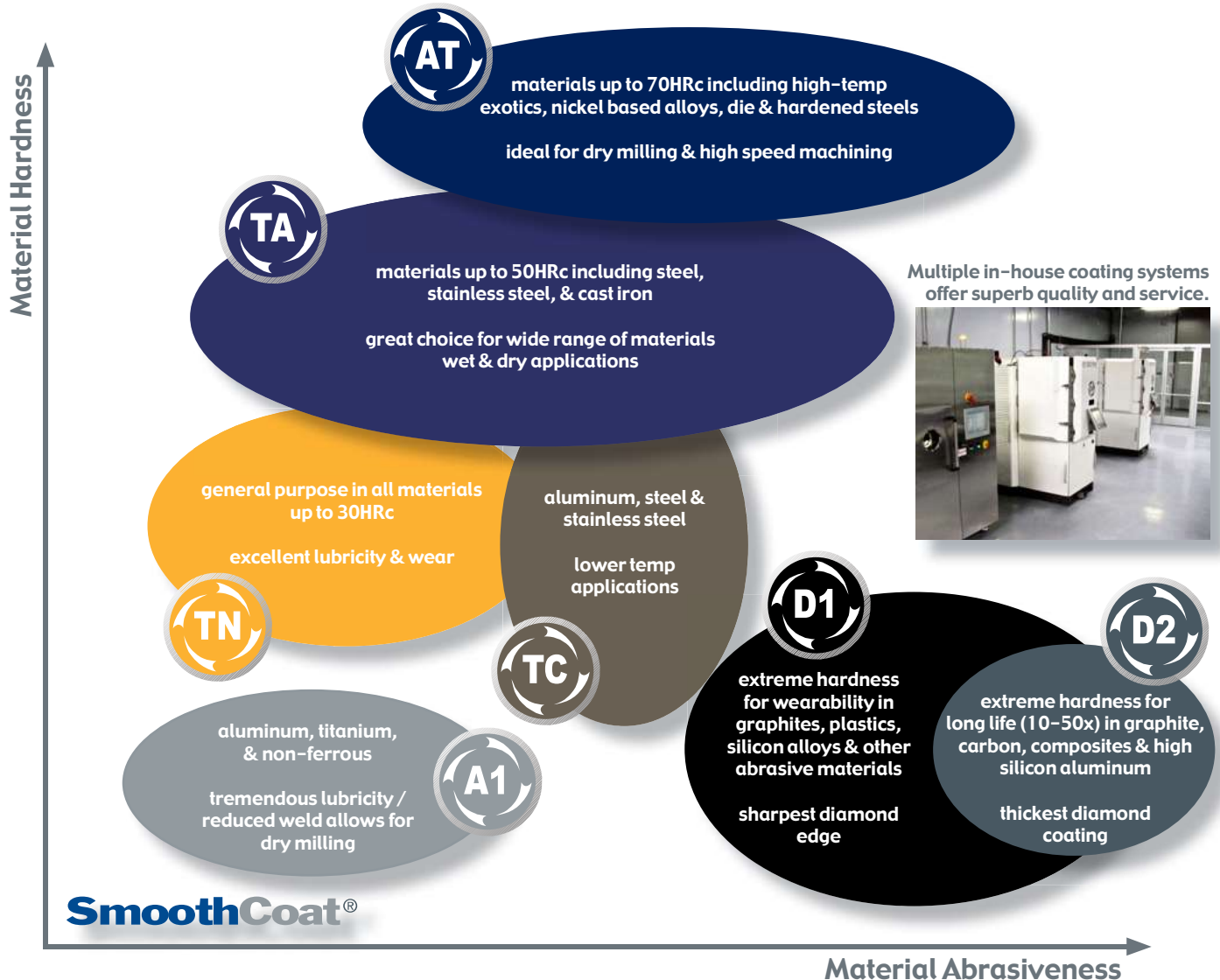


Our coating @ 2,000X (top).
Everybody else's (bottom).

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 #.

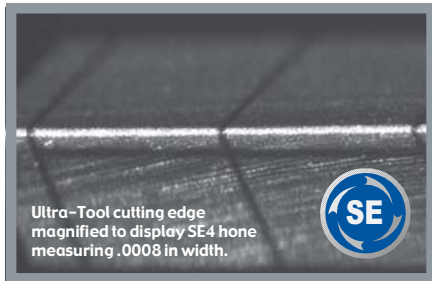


ULTRATOOL® Technical Data

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®

SmoothConcavity®

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.



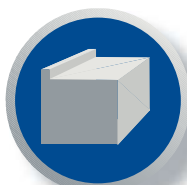
Commonly Used Formulas:

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

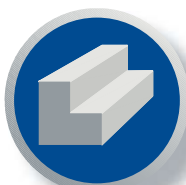
Tech Help Call, eMail us at technical@toolalliance.com, or copy / fax us this page for detailed assistance beyond what printed materials can provide. Please have the following information available to assure we can promptly process a response.

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



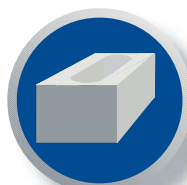
Face Milling



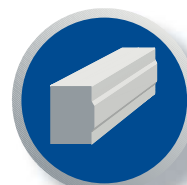
End Milling



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 Finish	• Tool wear	• Replace or regrind tool
	• Edge build up	• Increase RPM, switch to higher helix tool
Hole Tolerance	• Depth of cut too large	• Reduce depth of cut
	• Chip welding	• Increase volume of coolant

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
	• Incorrect speed & feed	• 1, 2
Long Chips	• Incorrect drill point	• 8, 21
	• Poor coolant conditions	• 5, 6
Solutions Key for Drills	• Tool wear	• 7, 8
	• Poor point grind	• 8
Poor Finish	• Incorrect speed & feed	• 1, 2
	• Insufficient stock removal	• Increase feed rate
Hole Tolerance	• Poor hole condition	• Use smaller diameter starter drill
	• Poor coolant	• Work-hardened hole; change drilling type
Tool Wear / Chipping	• Insufficient coolant	• Replace/correct coolant mixture
	• Workpiece alignment	• Increase coolant volume
Tool Breakage	• Incorrect tool size	• Use bushing, floating toolholder
	• Material shrinkage	• Check diameter of tool
Solutions Key for Drills	• Tool wear	• Adjust diameter for shrinkage; more coolant
	• Toolholder runoff	• Sharpen or replace tool
Poor Finish	• Increase feed rate	• Adjust or replace toolholder
	• Decrease speed	• Increase feed rate
Tool Wear / Chipping	• Tighten workpiece rigidity	• Tighten workpiece rigidity
	• Tighten toolholder or reduce float	• Tighten toolholder or reduce float
Tool Breakage	• Use shorter tool, place further up holder	• Use shorter tool, place further up holder
	• Increase feed rate (typically)	• Increase feed rate (typically)
Tool Wear / Chipping	• Reduce speed (typically)	• Reduce speed (typically)
	• Work-hardened hole; change drilling type	• Work-hardened hole; change drilling type
Tool Breakage	• Use proper coolant, coated reamer	• Use proper coolant, coated reamer
	• Use/increase coolant, use helical reamer	• Use/increase coolant, use helical reamer
Tool Wear / Chipping	• Replace coolant or correct mixture	• Replace coolant or correct mixture
	• Increase coolant volume	• Increase coolant volume
Tool Breakage	• Use bushing, floating holder, lead chamfer	• Use bushing, floating holder, lead chamfer
	• Use larger diameter starter drill	• Use larger diameter starter drill

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)
Tool Wear / Chipping	• Incorrect speed	• Reduce speed (typically)
	• Poor hole condition	• Work-hardened hole; change drilling type
Tool Breakage	• Abrasive material	• Use proper coolant, coated reamer
	• Poor chip evacuation	• Use/increase coolant, use helical reamer
Tool Breakage	• Poor coolant	• Replace coolant or correct mixture
	• Insufficient coolant	• Increase coolant volume
Tool Breakage	• Workpiece alignment	• Use bushing, floating holder, lead chamfer
	• Excessive stock removal	• Use larger diameter starter drill
Tool Breakage	• Incorrect feed rate	• Increase feed rate (typically)
	• Incorrect speed	• Reduce speed (typically)
Tool Breakage	• Tool wear	• Sharpen or replace reamer
	• Bottoming of hole	• Adjust stop depth, check preset
Tool Breakage	• Coolant conditions	• Increase, replace, or correct coolant
	• Insufficient stock removal	• Use smaller diameter starter drill
Tool Breakage	• Poor set up	• Use bushing, floating toolholder
	• Excessive stock removal	• Use larger diameter starter drill