Hard Milling Guidelines for Miniature End Mills

Machining centers with rigid workholding (minimizing vibration) and balanced toolholders (providing T.I.R.) will optimize tool performance along with air/coolant for materials over 45 Rc.

To avoid chipping and/or breakage, slow the feedrate into the workpiece by ramping or helical interpolation. By utilizing the "Climb Milling" method, extended tool life and improved surface finish can be expected.

Machine RPM formula: RPM = 3.82 x SFM ÷ Cutter Diameter

Material Hardness: 44-55 Rc / Reach: 1.5x to 5x

Cutter Diameter	SFM	IPT	ADOC
.010	140	.0002	.0006
.015	140	.0002	.0006
.020	140	.0002	.0006
.025	140	.0002	.0006
.030	250	.0005	.0012
.031	250	.0005	.0012
.035	250	.0005	.0012
.040	250	.0005	.0012
.045	360	.0008	.0019
.047	360	.0008	.0019
.050	360	.0008	.0019
.060	450	.0010	.0025
.062	450	.0010	.0025
.075	530	.0013	.0031
.078	530	.0013	.0031
.090	580	.0015	.0037
.093	580	.0015	.0037
.125	750	.0018	.0050
.187	750	.0028	.0075
.250	750	.0038	.0100

Material Hardness: 44-55 Rc / Reach: 8x to 12x

Cutter Diameter	SFM	IPT	ADOC
.010	120	.0001	.0002
.015	120	.0001	.0002
.020	120	.0001	.0002
.025	120	.0004	.0002
.030	220	.0004	.0005
.031	220	.0004	.0005
.035	220	.0004	.0005
.040	220	.0004	.0005
.045	320	.0005	.0007
.047	320	.0005	.0007
.050	320	.0005	.0007
.060	420	.0006	.0009
.062	420	.0006	.0009
.075	490	.0009	.0012
.078	490	.0009	.0012
.090	540	.0011	.0014
.093	540	.0011	.0014
.125	650	.0014	.0019
.187	650	.0023	.0028
.250	650	.0032	.0032

Material Hardness: 55-68 Rc / Reach: 1.5x to 5x

Cutter Diameter	SFM	IPT	ADOC
.010	140	.0002	.0006
.015	140	.0002	.0006
.020	140	.0002	.0006
.025	140	.0002	.0006
.030	250	.0004	.0012
.031	250	.0004	.0012
.035	250	.0004	.0012
.040	250	.0004	.0012
.045	360	.0006	.0019
.047	360	.0006	.0019
.050	360	.0006	.0019
.060	450	.0008	.0025
.062	450	.0008	.0025
.075	530	.0010	.0031
.078	530	.0010	.0031
.090	580	.0011	.0037
.093	580	.0011	.0037
.125	600	.0014	.0050
.187	600	.0021	.0075
.250	600	.0028	.0100

Material Hardness: 55-68 Rc / Reach: 8x to 12x

Cutter Diameter	SFM	IPT	ADOC
.010	120	.0001	.0002
.015	120	.0001	.0002
.020	120	.0001	.0002
.025	120	.0001	.0002
.030	220	.0003	.0005
.031	220	.0003	.0005
.035	220	.0003	.0005
.040	220	.0003	.0005
.045	320	.0004	.0007
.047	320	.0004	.0007
.050	320	.0004	.0007
.060	420	.0005	.0009
.062	420	.0005	.0009
.075	490	.0007	.0012
.078	490	.0007	.0012
.090	540	.0008	.0014
.093	540	.0008	.0014
.125	580	.0011	.0019
.187	580	.0016	.0028
.250	580	.0022	.0038

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Machine RPM formula: M/Min = RPM x .00312 x D (Cutter Diameter)

Material Hardness: 44-55 Rc / Reach: 1.5x to 5x			
Cutter Diameter	M/Min	MMPT	ADOC
0.2	42	.0051	.0006
0.3	42	.0051	.0006
0.4	42	.0051	.0006
0.5	76	.0127	.0305
0.6	76	.0127	.0305
0.8	76	.0127	.0305
1.0	109	.0203	.0483
1.2	109	.0203	.0483
1.5	133	.0254	.0635
2.0	161	.0330	.0787
2.5	176	.0381	.0940
3.0	227	.0457	.1270
4.0	227	.0711	.1905
5.0	227	.0965	.2540

Material Hardness: 44-55 Rc / Reach: 1.5x to 5x			
Cutter Diameter	M/Min	MMPT	ADOC
0.2	36	.0025	.0051
0.3	36	.0025	.0051
0.4	36	.0025	.0051
0.5	61	.0102	.0127
0.6	61	.0102	.0127
0.8	61	.0102	.0127
1.0	97	.0127	.0178
1.2	97	.0127	.0178
1.5	127	.0152	.0229
2.0	148	.0229	.0305
2.5	167	.0279	.0356
3.0	197	.0356	.0483
4.0	197	.0584	.0711
5.0	197	.0813	.0813

Material Hardness: 56-68 Rc / Reach: 1.5x to 5x			
Cutter Diameter	M/Min	MMPT	ADOC
0.2	42	.0051	.0127
0.3	42	.0051	.0127
0.4	42	.0051	.0127
0.5	76	.0102	.0305
0.6	76	.0102	.0305
0.8	76	.0102	.0305
1.0	109	.0152	.0483
1.2	109	.0152	.0483
1.5	133	.0203	.0635
2.0	161	.0254	.0787
2.5	176	.0279	.0940
3.0	182	.0356	.1270
4.0	182	.0534	.1905
5.0	182	.0711	.2540

Material Hardness: 56-68 Rc / Reach: 8x to 12x			
Cutter Diameter	M/Min	MMPT	ADOC
0.2	36	.0025	.0051
0.3	36	.0025	.0051
0.4	36	.0025	.0051
0.5	61	.0076	.0127
0.6	61	.0076	.0127
0.8	61	.0076	.0127
1.0	99	.0102	.0178
1.2	99	.0102	.0178
1.5	127	.0127	.0229
2.0	148	.0178	.0305
2.5	164	.0203	.0356
3.0	176	.0279	.0483
4.0	176	.0381	.0711
5.0	176	.0559	.0965

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