

## Machining Recommendations for ToughMet® Rod, Tube, and Plate

ToughMet is a trademark of Materion Performance Alloys' high performance spinodally hardened alloy system. These copper-based alloys are cast using the Materion Performance Alloys EquaCast®, or flow control, casting technology which creates refined microstructures, uniform composition, and high strength through tailored nickel and tin additions.

ToughMet 2, a Cu-9%Ni-6%Sn alloy, exhibits tensile strength in the cast and hardened (CX) condition in excess of 105 ksi (725 MPa), hardness exceeding HRC 26, and excellent machinability. ToughMet 3, a Cu-15%Ni-8%Sn alloy, exhibits tensile strength in the cast and hardened (CX) and wrought and hardened (AT) conditions up to 130 ksi (895 MPa) and hardness as high as HRC 36. These non-magnetic alloys combine low coefficient of friction with excellent wear resistance. Other property combinations can be tailored to fit your needs.

ToughMet alloys are typical short chip copper alloys. They machine very well, especially when aided with chip breakers. ToughMet 2 can be machined at extremely high surface speeds with carbide tools. Shops equipped with high speed machines with sufficient horsepower can remove large amounts of material in short periods of time. Copious amounts of coolant are required to achieve these high speeds. ToughMet 3 does not have the thermal conductivity of ToughMet 2 and, consequently, high speed roughing is not recommended.

ToughMet 2 can be turned with C2 grade carbides. This choice of carbide is recommended in high speed machining applications where heat generation may lead to fracture and premature deterioration of the insert. ToughMet 3 should be machined with a harder grade of

carbide to minimize wear. Grade C5 is recommended for most applications. Chip breakers incorporated into the insert aid in producing a very short, manageable chip. Surface finishes better than 100 micro-inches (2.5 microns) Ra are possible with feeds as large as 0.004 inch (0.1 mm) per revolution. Liquid coolant is recommended. **Positive rake angles are strongly recommended.**

Milling is best performed with a carbide inserted milling cutter. The same cutters used for P20 tool steels can be employed; however, a **positive rake angle is advantageous.**

ToughMet alloys should be machined in the "as-received" condition. Chips can be mixed and sold with other copper alloy scrap.

The tables on the reverse side of this TechBrief suggest recommended machining parameters for ToughMet materials. These parameters are conservative values based on simple machining studies. Variations of these may be necessary depending on part geometry and available machine tools. Consult with Materion Brush Performance Alloys Technical Service for assistance developing custom parameters.

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## Turning

	Tool Material	Surface Speed † (sfm)	Surface Speed † (m/min)	Roughing Feed @ Depth (mil/rev)	Roughing Feed @ Depth (mm/rev)	Finishing Feed (mil/rev)	Finishing Feed (mm/rev)
ToughMet 2 CX	HSS	200 – 500	60 – 150	6-10 @ 0.050"	0.15 – 0.25 @ 1.3 mm	2-5 @ 0.025"	0.05 – 0.15 @ 0.6 mm
	C2 (K20) carbide	300 - 3000	90 - 900	6-20 @ 0.100"	0.15 – 0.5 @ 2.5 mm	2-5 @ 0.030"	0.05 – 0.15 @ 0.75 mm
ToughMet 3 All Tempers	HSS	50	15	1-2 @ 0.050"	0.025 – 0.05 @ 1.3 mm	1-2 @ 0.010"	0.025 – 0.05 @ 0.25 mm
	C5 (P40) carbide	400 - 800	120 - 240	5-12 @ 0.100"	0.13 – 0.3 @ 2.5 mm	2-4 @ 0.010"	0.05 – 0.1 @ 0.25 mm

## Milling

	Tool Material	Surface Speed † (sfm)	Surface Speed † (m/min)	Roughing Feed (mil/tooth)	Roughing Feed (mm/tooth)	Finishing Feed (mil/tooth)	Finishing Feed (mm/tooth)
ToughMet 2 CX	HSS	200 – 500	60 – 150	3-5 @ 0.050"	0.075 – 0.13 @ 0.05 mm	2-5 @ 0.010"	0.05 – 0.13 @ 0.25 mm
	C2 (K20) carbide	300 - 3000	90 - 900	6-20 @ 0.100"	0.15 – 0.5 @ 2.5 mm	2-5 @ 0.025"	0.05 – 0.13 @ 0.65 mm
ToughMet 3 All Tempers	HSS	100	30	1-3 @ 0.050"	0.025 – 0.075 @ 1.3 mm	1-2 @ 0.015"	0.025 – 0.05 @ 0.4 mm
	C5 (P40) carbide	300 - 500	90 - 150	5-15 @ 0.125"	0.13 – 0.4 @ 3 mm	2-4 @ 0.010"	0.05 – 0.1 @ 0.25 mm

## Drilling and Tapping

	Tool Material	Surface Speed † (sfm)	Surface Speed † (m/min)	Feed (mil/rev)	Feed (mm/rev)	Tapping Speed (sfm)	Tapping Speed (m/min)
ToughMet 2 CX	HSS	100 – 300	30 – 90	10-20	0.25 – 0.5	15	4.5
	C2 (K20) carbide	300 - 3000	90 - 900	6-20	0.15 – 0.5	15	4.5
ToughMet 3 All Tempers	Cobalt Steel	50	15	2-10	0.05 – 0.25	10	3
	C5 (P40) carbide	150 - 500	45 - 150	5-20	0.13 – 0.5	10	3

## Grinding

## Sawing

	Grinding Wheel (type)	Wheel Speed (sfm)	Wheel Speed (m/min)	Saw Blade (tpi)	Saw Blade (mm/tooth)	Blade Type	Blade Speed (fpm)	Blade Speed (m/min)
ToughMet 2 CX	A54LV	5500-6500	1700 - 2000	1.4 / 2	18 – 12.5	Variable Pitch Ground Tooth Bi-Metal Blade	100	30
ToughMet 3 All Tempers	A54LV	5500-6500	1700 - 2000	1.4 / 2	18 – 12.5	Variable Pitch Ground Tooth Bi-Metal Blade	100	30

† The speeds presented are for ToughMet 2 CX 90, ToughMet 3 CX 110, and ToughMet 3 AT 110 tempers. The speeds for softer tempers can be increased in proportion to the reduction of yield strength. It is recommended to hold feeds to the same value.