MATERION

TECH BRIEFS

MoldMAX® and PROtherm® Mold Alloy Machining Guide

Copper alloy molds used in plastic injection molding provide significant improvements in cycle time and molded part quality. Materion's MoldMAX mold alloys are the premier choice of copper mold alloy. The popularity of these high reliability engineered mold materials stems from their combination of high conductivity, mechanical strength, hardness and fatigue strength, excellent wear and corrosion resistance, and nonmagnetic characteristics. These mold alloys, while as hard as many mold steels, machine with ease and can provide optical quality surface finishes. These recommendations summarize current machinability data as developed by Materion and verified by a number of users with extensive experience in the machining of these materials.

INTRODUCTION TO THE RECOMMENDATIONS

These recommendations provide a starting point for each machining operation. Advances in machine tools, tooling materials, tool coatings and cutting fluids may require some changes in these machining parameters. Machining methods also may need to be adjusted for individual part geometry. Optimizing the machining parameter for one's particular situation is recommended.

While as hard as many mold steels, MoldMAX alloys machine differently from steel because of higher resilience (i. e. springiness) and higher thermal conductivity. Because of the higher thermal conductivity one can machine at higher speed without overheating the tooling. Since these material are as hard as many mold steels, achieving higher metal removal rates will require more power. Copper mold materials will not heat up and expand during machining as can happen with steel. One consequence of this is that drilled holes will closely match the drill bit diameter, leading to a stuck drill bit as the bit heats up and expands. Using an offset point and/or pecking at the hole may help prevent this. The higher conductivity will adversely affect EDM burn rates, but employing the recommended settings will produce acceptable metal removal. Finally, the higher springiness of copper may make machining thin sections more difficult. Sharp, positive rake tooling and high cutting speeds can aid in these situations.

Additional information on machining copper alloys, including reaming, tapping, and grinding, can be found in Materion's publication "Machining Copper Beryllium." Use the 25AT tables for MoldMAX HH, LH, XL and V alloys and the 3AT tables for PROtherm alloy and C180.

ADDITIONAL FABRICATION PROCESSES

In addition to standard metal remove processes, Materion provides information on other fabrication procedures used on injection mold tooling. This include polishing, cleaning, EDM, and welding. These documents can be found on the MoldMAX page, www.moldmax.com.

SAFE HANDLING OF BERYLLIUM CONTAINING MOLD ALLOYS MOLDMAX HH, LH AND PROTHERM ALLOYS

Please refer to the Materion Corporation publications "*Safety Facts 101-Safety Practices for Machining Copper Beryllium Alloys*" "*Safety Facts 5-Safety Practices for Electrical discharge Machining Copper Beryllium,*" and "*Safety Facts 105-Processing Copper Beryllium Alloys*." These can be found on the Materion Performance Alloys' resource pages at www.materion.com.

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Safety Data Sheet (SDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Materion Performance Alloys, Technical Service Department at 1-800-375-4205.

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MoldMAX Machining (English Units)

Milling (roughing)

MoldMAX	Tool Material	Cutting Speed (sfm)	FEED RATE (in./tooth)	Depth of Cut (in.)
HH	C-2 Carbide	375-800	0.004-0.015	0.1-0.2
LH	C-2 Carbide	500-1000	0.004-0.015	0.1-0.2
V	C-2 Carbide	350-500	0.003-0.006	0.1-0.2
XL	C-2 Carbide	800-2400	0.005-0.015	0.1-0.15
PROtherm	C-2 Carbide	800-2000	0.005-0.008	0.1-0.15

Milling (finish)

MoldMAX	Tool Material	Cutting Speed (sfm)	FEED RATE (in./tooth)	Depth of Cut (in.)
HH	C-2 Carbide	400-1500	0.001-0.003	0.01-0.10
LH	C-2 Carbide	500-1500	0.001-0.003	0.01-0.10
V	C-2 Carbide	400-1500	0.001-0.004	0.01-0.10
XL	C-2 Carbide	800-2400	0.001-0.005	0.01-0.10
PROtherm	C-2 Carbide	800-2000	0.001-0.005	0.01-0.10

Turning

MoldMAX	Tool Material	Cutting Speed (sfm)	FEED RATE (ipr)
HH	C-2 Carbide	900-1200	0.01-0.02
LH	C-2 Carbide	1200-1500	0.01-0.02
V	C-2 Carbide	900-1400	0.003-0.010
XL	C-2 Carbide	1200-3000	0.01-0.02
PROtherm	C-2 Carbide	1500-2000	0.01-0.025

Drilling

MoldMAX	Tool Material*	Cutting Speed (sfm)	FEED RATE (ipr)
HH	Cobalt Steel	100-300	0.002-0.009
LH	Cobalt Steel	100-400	0.002-0.009
V	Cobalt Steel	125-200	0.002-0.007
XL	Cobalt Steel	150-500	0.002-0.005
PROtherm	Cobalt Steel	125-500	0.002-0.005

*The high conductivity of MoldMAX alloys may result in the drill bit binding. Grinding the point slightly off-center may alleviate this problem.

Sink EDM

MoldMAX	Electrode*	Polarity	Current	Voltage	Duty Factor	Estimated Burn Rate
HH	Copper	Negative	50	220	50%	2 cm./hr.
LH	Copper	Negative	50	220	50%	1.8 cm./hr.
V	Copper	Negative	60	220	50%	1.8 cm./hr.
XL	Copper	Positive	40	110	90%	2.5 cm./hr.
PROtherm	Copper	Negative	50	220	50%	1.3 cm./hr.

*Graphite electrodes can be used, but wear rates may be up to 2-4 times greater.

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MoldMAX Machining (SI Units)

Milling (roughing)

MoldMAX	ISO Tool Grade	Cutting Speed (m/min)	FEED RATE (mm/tooth)	Depth of Cut (mm)
HH	K20	115-250	0.1-0.4	2.5-5.0
LH	K20	150-300	0.1-0.4	2.5-5.0
V	K20	110-150	0.08-0.15	2.5-5.0
XL	K20	250-740	0.13-0.4	2.5-4.0
PROtherm	K20	250-600	0.13-0.2	2.5-4.0

Milling (finish)

MoldMAX	ISO Tool Grade	Cutting Speed (m/min)	FEED RATE (mm/tooth)	Depth of Cut (mm)
HH	K20	125-460	0.025-0.075	0.25-2.5
LH	K20	150-460	0.025-0.075	0.25-2.5
V	K20	125-460	0.025-0.10	0.25-2.5
XL	K20	250-740	0.025-0.125	0.25-2.5
PROtherm	K20	250-600	0.025-0.125	0.25-2.5

Turning

MoldMAX	ISO Tool Grade	Cutting Speed (m/min)	FEED RATE (mm/rev)
HH	K20	275-365	0.25-0.50
LH	K20	365-450	0.25-0.50
V	K20	275-425	0.08-0.25
XL	K20	365-900	0.25-0.50
PROtherm	K20	450-600	0.25-0.65

Drilling

MoldMAX	Tool Material*	Cutting Speed (m/min)	FEED RATE (mm/rev)
HH	Cobalt Steel	30-90	0.05-0.23
LH	Cobalt Steel	30-125	0.05-0.23
V	Cobalt Steel	40-60	0.05-0.18
XL	Cobalt Steel	45-150	0.05-0.13
PROtherm	Cobalt Steel	40-150	0.05-0.13

*The high conductivity of MoldMAX alloys may result in the drill bit binding. Grinding the point slightly off-center may alleviate this problem.

Sink EDM

MoldMAX	Electrode*	Polarity	Current	Voltage	Duty Factor	Estimated Burn Rate
HH	Copper	Negative	50	220	50%	2 cm./hr.
LH	Copper	Negative	50	220	50%	1.8 cm./hr.
V	Copper	Negative	60	220	50%	1.8 cm./hr.
XL	Copper	Positive	40	110	90%	2.5 cm./hr.
PROtherm	Copper	Negative	50	220	50%	1.3 cm./hr.

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