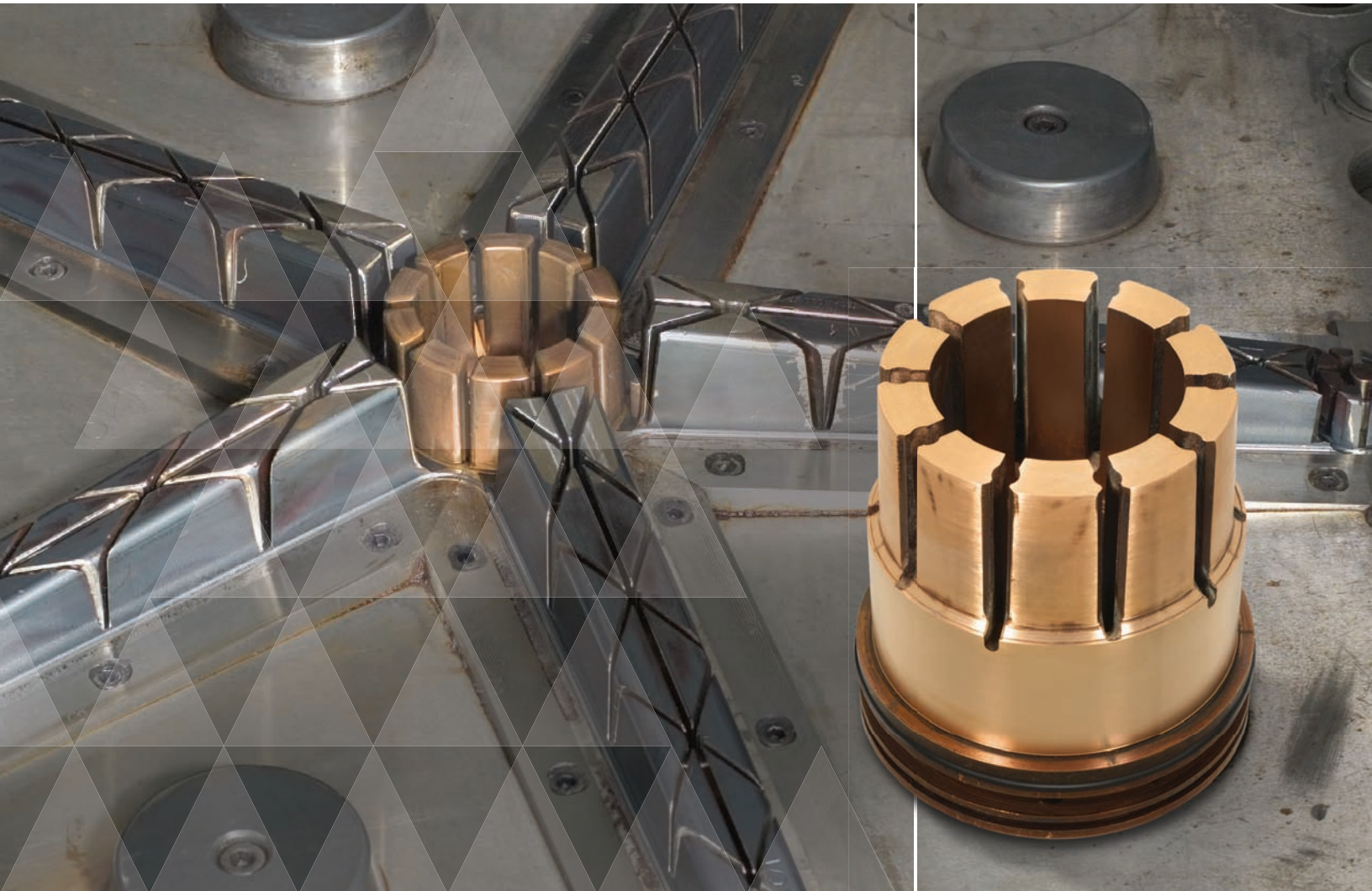




MATERION



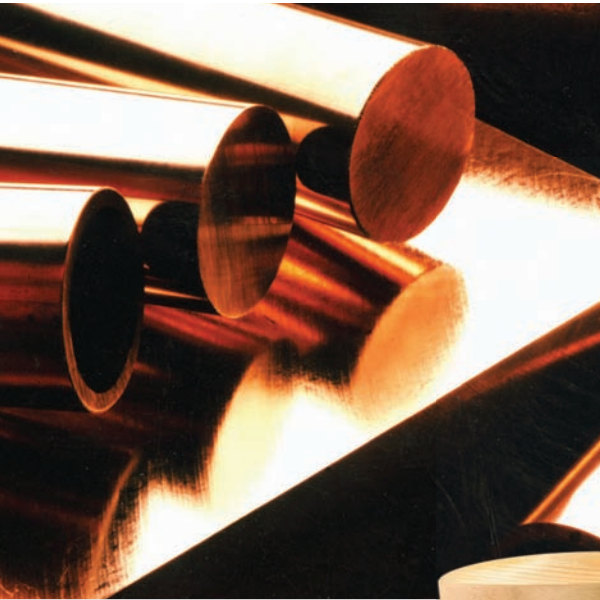
BRUSH PERFORMANCE ALLOYS

**THERMAL MANAGEMENT
SOLUTIONS**

MOLDMAX[®]

MOLDMAX

THERMAL MANAGEMENT SOLUTIONS



HIGH CONDUCTIVITY ALLOYS FOR THE PLASTICS MOLD INDUSTRY

As the world's leading supplier of high performance alloys, Materion Brush Performance Alloys offers customers more than just superior manufacturing materials. Driven by our customers' complete satisfaction, Materion provides a total product support system giving them a unique advantage.



PEOPLE. Materion Brush Performance Alloys' strength lies in our team of exceptional technical, manufacturing and customer support members. From assistance with product design and development to superior manufacturing practices as well as courteous and accommodating customer service, our team members work with customers to provide material solutions that best meet their individual needs.

PROMISE. Our commitment to the highest quality products and service is evident throughout our entire material development and manufacturing process. All material solutions begin with individual product development based on the unique needs of the customer; then manufactured to exact specifications. Our promise to all our customers is continued superior customer service, on-time delivery and customized design solutions.

PERFORMANCE. Whether its construction and heavy equipment, Motocross racing, portable communication devices, or aerospace applications, materials from Materion Brush Performance Alloys exhibit the highest performance attributes in the industry. Strength, durability, reliability, miniaturization and electrical conductivity are all examples of superior material performance advantages that can only be found with Materion Brush Performance Alloys.

Your only source for the people, promise and performance advantage, Materion Brush Performance Alloys is your partner for unmatched customer support and material selection. Supplying the world with materials that matter; Materion Brush Performance Alloys.

MATERION BRUSH PERFORMANCE ALLOYS

All MoldMAX® products are high performance alloys specifically designed for the plastic processing industry. These alloys offer a unique combination of thermal conductivity and strength that provides important benefits for the molding process.

Grade	Alloy	Hardness	Applications
MoldMAX HH®	CuBe	40 Rc	Injection Molds - longest life Blow mold components
MoldMAX LH®	CuBe	30 Rc	Injection Molds - fastest cycle Blow mold components
PROtherm™	CuBe	20 Rc	Blow molds, Hot runner tips
MoldMAX XL®	CuNiSn	30 Rc	Injection Molds requiring good polishability, large sizes
MoldMAX® V	CuNiSiCr	28 Rc	Injection Molds - fastest cycle

MoldMAX® and PROtherm™ are registered trademarks of Materion Brush Inc.

MOLDMAX OFFERS A VARIETY OF MOLD ALLOYS TO FIT YOUR EVERY NEED.

COPPER BERYLLIUM ALLOYS INCLUDE:

- ▲ MoldMAX HH®
(High Hardness)
- ▲ MoldMAX LH®
(Low Hardness)
- ▲ PROtherm™
(High Conductivity)
- ▲ MoldMAX XL®
(Non-Beryllium Alloy)
- ▲ MoldMAX® V
(Non-Beryllium Alloy)

HIGH CONDUCTIVITY ALLOYS FOR THE **PLASTICS MOLD INDUSTRY**



THE MOLDMAX® ADVANTAGE

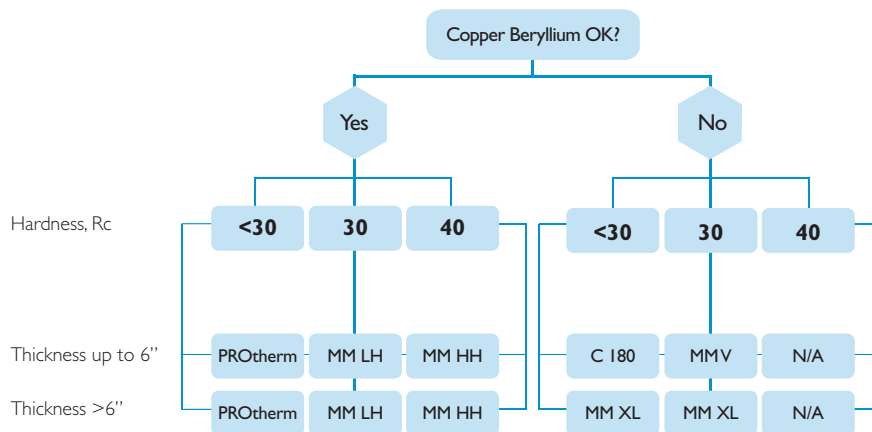
Through the unique combination of thermal conductivity and strength available in the MoldMAX product line, these copper mold alloys provide:

- Shorter cycle time
- Improved plastic part dimensional control
- Better parting line maintenance
- Excellent corrosion resistance

WHY USE MOLDMAX®

A Mold Must	Materion Brush Performance Alloys Mold Alloys Provide	Benefits
Transfer heat rapidly	The highest thermal conductivity available	<ul style="list-style-type: none"> • Rapid heat transfer • Faster cycle times • Lower processing costs
Transfer heat uniformly	Uniform cooling	<ul style="list-style-type: none"> • Dimensionally correct parts • Minimized warpage • Reduced scrap rates
Provide long life	Better wear properties than tool steels	<ul style="list-style-type: none"> • Higher cycle life with lower maintenance costs • Less downtime
Be easily fabricated	Faster machining rates than tool steels	<ul style="list-style-type: none"> • Lower mold fabrication costs

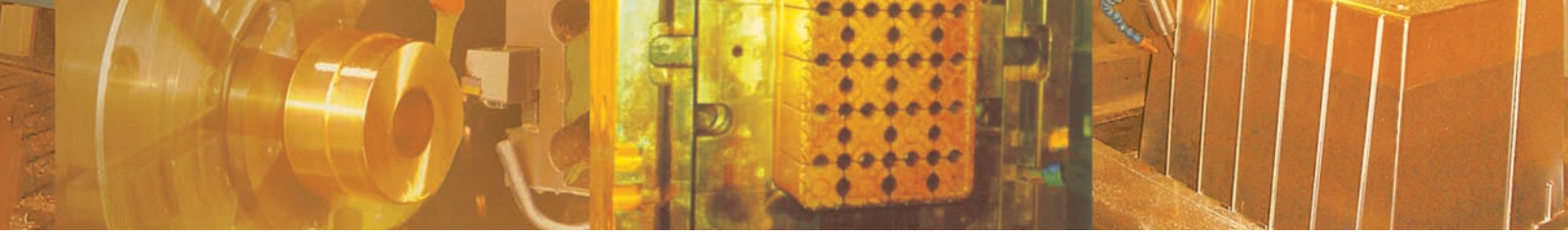
MOLDMAX® SELECTION BY SIZE AND HARDNESS



MoldMAX provides strength and wear resistance similar to that of many tool steels. In addition, MoldMAX offers a thermal conductivity up to ten times greater than steel, and is typically specified for:

- Injection mold components and core / cavity inserts
- Blow mold pinch offs, neck rings and handle inserts
- Hot runner system injection nozzles and manifolds

PROtherm™ provides the highest thermal conductivity available in a mold material... ten times greater than steel and twice that of aluminum.



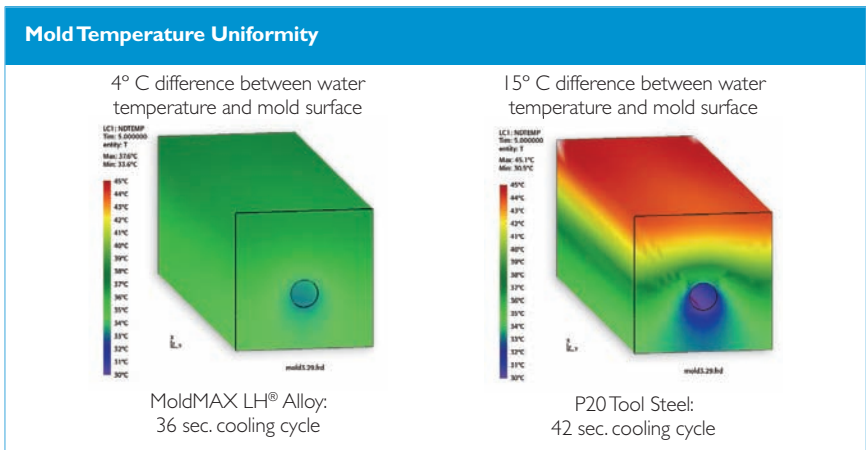
PROtherm™ also offers a hardness and strength exceeding aluminum. PROtherm™ is specifically designed for foam processing, hot runner systems, blow molds and other applications where maximum heat removal or control is required.

Attributes:

- Heat treated and ready to machine
- Resistant to corrosion
- Fully machinable
- Easy to polish
- Can be welded to copper and other alloys
- Available in large block sizes
- High levels of strength and conductivity

WHERE MOLDMAX® ALLOYS HAVE PROVEN SUCCESS

Market	Product
Automotive (injection mold)	<ul style="list-style-type: none"> • Air Intake Manifolds • Engine Covers • Radiator End Tanks • Bumper Beams • Grills • Interior/Exterior Parts
Appliance (injection mold)	<ul style="list-style-type: none"> • Refrigerators • Vacuum Cleaners • Washers • Kitchen Tools
Consumer Products (injection mold)	<ul style="list-style-type: none"> • Plastic Household Products • Luggage • Infant Products • Toys
Electronics (injection mold)	<ul style="list-style-type: none"> • Computers • Connectors • Printers/Copiers • Televisions
Medical (injection mold)	<ul style="list-style-type: none"> • Hospital Equipment • Testing Equipment • Personal Lab Equipment • Eyeglass Lenses
Containers/Caps (injection/blow mold)	<ul style="list-style-type: none"> • Trash Can • Storage Unit • Buckets • Cups • Bottles



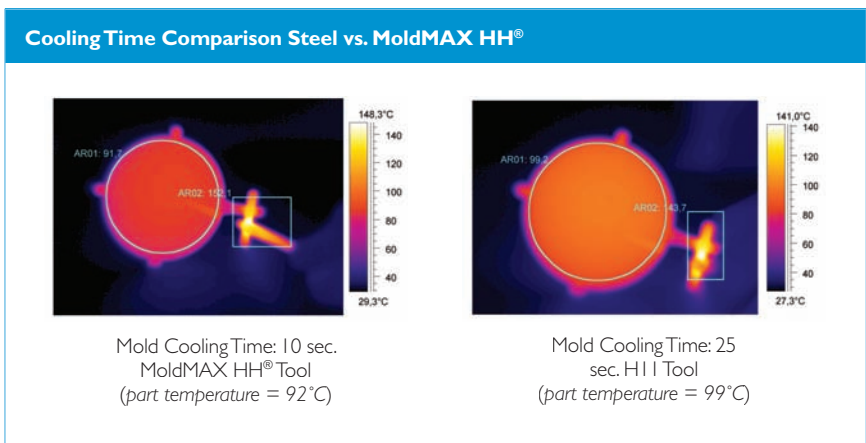
Compliments of Dr. Robert Kusner - Materion Brush Performance Alloys

THERMAL CONDUCTIVITY ADVANTAGE

Mold designs which optimize the superior combination of thermal conductivity and strength of these alloys will result in rapid, uniform and controlled heat removal from the plastic part.

The immediate benefit is less in-mold and post-mold warpage. Once molding parameters have been optimized, shorter cycle time and better dimensional control will be achieved.

Also, hot-runner and manifold design with MoldMAX results in more uniform temperature control of the plastic melt. Delivery of a more uniform and predictable plastic melt to the mold cavity results in higher quality plastic parts.



THE MOLDMAX ADVANTAGE

WEAR RESISTANCE ADVANTAGE

Mold life is primarily a function of a mold material's ability to withstand abrasive wear and galling. MoldMAX has exhibited excellent wear resistance as injection mold components and cavity inserts in direct contact with the plastic part. Many molds have been used with glass-reinforced polymers and achieved in excess of one million cycles. Strategic location of MoldMAX components and inserts in aluminum blow molds improves parting line maintenance and provides longer service life.

CORROSION RESISTANCE ADVANTAGE

The copper base in the entire MoldMAX family provides excellent resistance to hydrochloric acid, carbonic acid and similar decomposition products, which may result from plastics processing. As a result, these materials are ideal for applications involving potentially corrosive plastics, such as PVC.

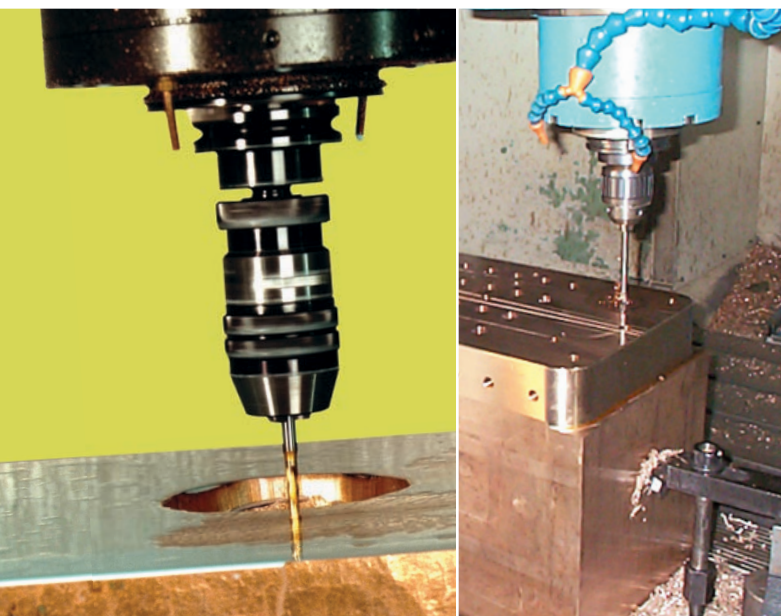
MACHINABILITY ADVANTAGES

All MoldMAX grades are readily machinable. In conventional machining operations, MoldMAX provides a 10-25% reduction in machining time over the tool steels. While the high thermal conductivity of MoldMAX makes it slower to electrical discharge machine (EDM) than steel, set up can be optimized to minimize this difference.

WELDABILITY ADVANTAGES

Unlike steel and aluminum, MoldMAX molds are readily weld repaired without significant loss of strength to the mold body. Both TIG (GTAW) and MIG (GMAW) welding processes are advocated.

Weldpak® from Materion Brush Performance Alloys is recommended as a filler rod. Weldpak is MoldMAX rod conveniently packaged in three foot lengths and stocked in 3/32", 1/16", 1/8" or a combination of these diameters. Also, stainless steels and nickel filler rod have been used successfully.



Product	Rockwell Hardness HRC (HBW)	Thermal Conductivity BTU/ft-hr-°F (W/m-°C)	Charpy V-Notch Impact Strength Ft-lb (J)	Yield Strength ksi (MPa)	Tensile Strength ksi (MPa)	Thermal Expansion Coefficient 10-6 / °F (10-6 / °C)
MoldMAX HH®	40 (370)	75 (130)	4 (5)	145 (1000)	170 (1175)	9.7 (17.5)
MoldMAX LH®	30 (285)	90 (155)	12 (16)	110 (760)	140 (965)	9.7 (17.5)
MoldMAX XL®	30 (285)	40 (70)	15 (20)	105 (725)	115 (795)	9.3 (16.7)
MoldMAX®V	28 (270)	92 (160)	4 (5)	105 (725)	125 (860)	9.7 (17.5)
PROtherm™	20 (225)	145 (250)	40 (54)	90 (620)	105 (725)	9.8 (17.6)
C18000	16 (210)	135 (235)	35 (48)	75 (515)	95 (655)	9.7 (17.5)
AISI P-20	32 (302)	17 (29)	18 (24)	130 (900)	155 (1070)	7.0 (12.6)
420 Stainless	50 (480)	14 (24)	5 (7)	200 (1380)	250 (1725)	6.1 (11.0)
H-13 Tool Steel	45 (420)	15 (26)	14 (19)	200 (1380)	250 (1725)	7.1 (12.8)
QC7 Aluminum	B88 (175)	90 (155)	30 (41)	75 (515)	78 (540)	12.9 (23.2)



SURFACE TREATMENT

Wear resistance, corrosion resistance and surface release of MoldMAX can be extended with standard treatments. MoldMAX can be coated with chromium, electroless nickel, titanium nitride and tungsten disulfide. Further information can be obtained by contacting our technical service department by calling:
1-888-MoldMAX

DESIGN GUIDELINES

MoldMAX core inserts must be properly water cooled in order to provide maximum benefit. MoldMAX does not make heat energy disappear, but rather transfers it efficiently to the water line for removal. Water cooling circuits should be located similar to steel cores but will be more effective, because the insulating effect of tool steel between the plastic and the water has been removed. Because of the high efficiency, it is a good idea to cool MoldMAX cores with a separate water circuit to allow maximum flexibility in mold temperature control. Closed loop mold temperature systems are very effective with MoldMAX. Ensure that inserts of MoldMAX are large enough to contain adequate water cooling. Larger inserts give better control over more of the mold surface.

Good tool design practices should be followed with MoldMAX, such as ensuring generous radii, where possible, and allowing for thermal expansion of mold components. Keep height to thickness ratios at or below 4:1 if possible. MoldMAX will expand more than tool steel at the same temperature, and less than a tool grade aluminum. (Refer to the datasheets for actual thermal expansion data). Design for the equilibrium

temperature of the mold component and remember that the MoldMAX component may be at a lower temperature than steel, offsetting some or all of the additional thermal expansion. MoldMAX can be used on the parting line just like prehardened tool steels, and has excellent wear resistance and a low coefficient of friction. MoldMAX should be used in cores where there are ribs, bosses or other structural features, such as intersecting walls. These features not only concentrate thermal energy and overwhelm typical tool steels, but tend to be farther away from the cooling channels. MoldMAX will dissipate this heat energy throughout the tool, eliminating hot spots and increasing the rate of heat transfer to the cooling medium.

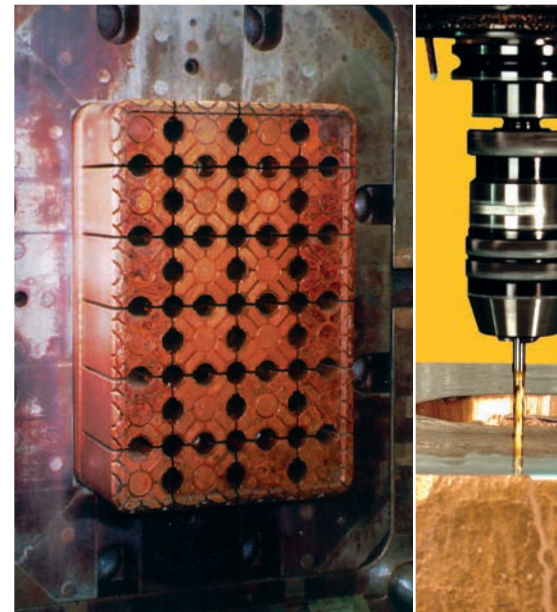
ECONOMIC JUSTIFICATION

MoldMAX combines high levels of strength and thermal conductivity tailored to all types of plastic injection molds. Additional benefits are the ease of machinability and high impact strength, resulting in a mold which is easily fabricated and stands up to a production environment.

MoldMAX is designed to be used as the core material in concert with steel mold bases and steel cavities. Perhaps the most important function of an injection mold is to act as a heat exchanger. The core performs the majority of the heat removal in the typical mold. MoldMAX, with up to 10x the conductivity of tool steel, provides cycle time reductions of 15-50%. The cost savings from these reductions can be substantial, especially when the life of the tooling program is considered. These savings provide a significant and untapped competitive advantage to the molder.

CYCLE TIME REDUCTION

A 28% reduction in cycle time for an auto fascia resulted in a savings of \$200,000 annually, or \$1 million over the life of the mold. These savings exceed the total cost of the tool. Numerous other examples from customers show a payback of less than 30 days in most cases.



CAPITAL AVOIDANCE

One customer who retrofitted an all steel trash can tool with a MoldMAX insert, improved their cycle time by 42%, and avoided the purchase of a new injection

WASTE ELIMINATION

Some tools produce a high scrap rate due to warpage or dimensional variation. MoldMAX reduces warpage and also produces plastic parts with more consistent dimensions especially in multi-cavity tools where cavity-to-cavity variation is an important concern.

MOLDMAX MACHINABILITY ADVANTAGES

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.



MACHINING (METRIC 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

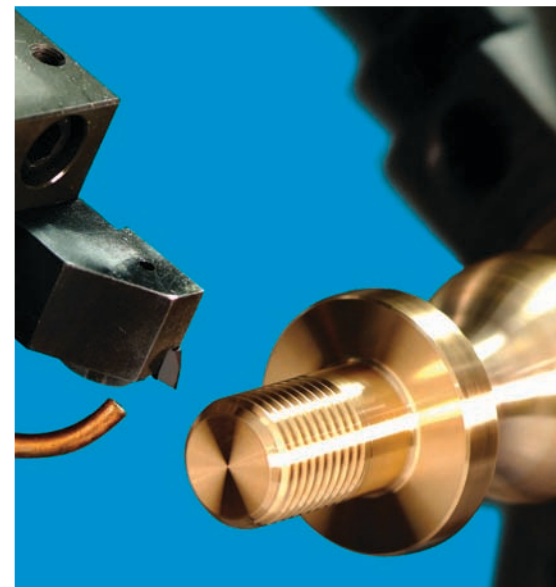
MoldMAX	Tool Material*	Cutting Speed (m/min)	Feed Rate (mm/rev)
HH	Cobalt Steel	30-90	0.05-0.23
LH	Cobalt Steel	30-125	0.05-0.23
V	Cobalt Steel	40-60	0.05-0.18
XL	Cobalt Steel	45-150	0.05-0.13
PROtherm™	Cobalt Steel	40-150	0.05-0.13

*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.

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



MOLDMAX SUPERIOR MOLD ALLOYS

PROPERTIES (ENGLISH UNITS)

Product	Rockwell Hardness HRC	Thermal Conductivity BTU/ft-hr°-F	Charpy V-Notch Impact Strength Ft-lb	Yield Strength ksi	Tensile Strength ksi	Thermal Expansion Coefficient 10-6 / °F
MoldMAX HH®	40	75	4	145	170	9.7
MoldMAX LH®	30	90	12	110	140	9.7
MoldMAX XL®	30	40	15	105	115	9.3
MoldMAX®V	28	92	4	105	125	9.7
PROtherm™	20	145	40	90	105	9.8
CI8000	16	135	35	75	95	9.7
AISI P-20	32	17	18	130	155	7.0
420 Stainless	50	14	5	200	250	6.1
H-13 Tool Steel	45	15	14	200	250	7.1
QC7 Aluminum	B88	90	30	75	78	12.9

PROPERTIES (METRIC UNITS)

Product	Rockwell Hardness HBW	Thermal Conductivity W/m-°C	Charpy V-Notch Impact Strength J	Yield Strength MPa	Tensile Strength MPa	Thermal Expansion Coefficient 10-6 / °C
MoldMAX HH®	370	130	5	1000	1175	17.5
MoldMAX LH®	285	155	16	760	965	17.5
MoldMAX XL®	285	70	20	725	795	16.7
MoldMAX®V	270	160	5	725	860	17.5
PROtherm™	225	250	54	620	725	17.6
CI8000	210	235	48	515	655	17.5
AISI P-20	302	29	24	900	1070	12.6
420 Stainless	480	24	7	1380	1725	11.0
H-13 Tool Steel	420	26	19	1380	1725	12.8
QC7 Aluminum	175	155	41	515	540	23.2



Health & Safety – 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 Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact **Materion Brush Performance Alloys, Technical Service Department at 800.375.4205.**





MATERION

ABOUT MATERION

Materion is the new name for Brush Engineered Materials Inc., its Brush Wellman Inc. subsidiary, and all of the company's businesses worldwide. Materion is among the world's premier providers of advanced materials solutions and services. Now under the one Materion brand, we are better aligned to deliver a broader scope of products, services and expertise needed to drive our customers' growth and profitability and become their first choice in a partner. Materion Corporation common stock trades on the New York Stock Exchange under the symbol MTRN.

MATERION BUSINESSES

Advanced Chemicals	Electrofusion
Barr Precision Optics & Thin Film Coatings	Large Area Coatings
Brush Beryllium & Composites	Microelectronics & Services
Brush Performance Alloys	Natural Resources
Ceramics	Technical Materials

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