TechBriefs

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BRUSH WELLMAN ENGINEERED MATERIALS

Electrical Discharge Machining (EDM) Of Copper Beryllium Mold Materials (moldMAX® and PROtherm®)

by Technical Service Department
Brush Wellman Inc.

Electrical Discharge Machining (EDM) of copper beryllium (moldMAX® and PROtherm®) can be performed safely and effectively using conventional processes and equipment that are commonly used for EDM of steel. However, because copper beryllium has a much greater thermal conductivity (a significant advantage in molding plastics) than steel, the actual EDM operation requires more input energy. To obtain optimum results with copper beryllium, the EDM parameters will require processing adjustments from those used for steel. EDM of copper beryllium usually can be done at 80 - 100% of the penetration rate for steel while maintaining a smooth surface and acceptable electrode life.

Like steel, the EDM of copper beryllium produces a thin layer of recast metal on the worked surface. However, unlike steel, this layer is ductile and does not result in polishing problems or mold cracking. The thickness of the layer in copper beryllium can be controlled by adjusting the machining parameters. The layer is typically in the range of 1-10 μm, insignificant, and has no measurable effect on mold performance. In addition, thermal stress cracking during EDM of copper beryllium does not occur because of the material's unique ability to evenly dissipate the thermal energy of the EDM process.

Die Sinking

Following are recommended EDM parameters that provided the best combination of metal removal rate (MRR), tool wear ratio (TWR), and surface condition in a die sinking evaluation. These values will vary somewhat depending on your design, equipment and electrode selection; they should be used as a starting point for determining the parameters that are most suitable for you.
Many EDM references recommend "standard" polarity (electrode negative) for EDM of all copper alloys. Testing at Brush Wellman, however, exhibited better performance with the "inverted" (electrode positive) polarity. Recommended EDM parameters are summarized as follows:

Recommended EDM Parameters for CuBe

Voltage, V	220
Current, A	50
Pulse on-time, μsec	32
Duty factor	50%
Electrode gap, μm	305
Electrode polarity	positive
Electrode material	copper

The copper electrode was center flushed using Commonwealth EDM 244 dielectric fluid. Using the recommended parameters to EDM 19 mm diameter cavities into a 13 mm thick plate with a Mitsubishi M35KC7+G70 machine, the following results were obtained:

EDM Performance

	MRR*		TWR**
	g/min	in^3/hr	
moldMAX®	0.82	0.36	0.33
PROtherm®	0.54	0.22	0.87

*MRR is the Metal Removal Rate

**TWR is the volume ratio of electrode wear to workpiece removed by EDM.

Following are the effects of variations in the machining parameters on EDM performance:

	MRR	TWR	Roughness
On-time** + -	- -	- +	+ -
Current + -	+ -	- +	+ -
Duty factor + -	+ -	+ -	+ -
Polarity + -	+ -	- +	- +

Explanation: If the on-time is increased (+**), this results in a decrease (**-**) in MRR, a decrease in TWR, and an increase in the surface roughness.

The following observations were made during the machining trials using different electrode materials:

EDM Electrode Effects Compared to Copper	
Tungsten copper	Decreased TWR, no effect on MRR or surface
Graphite (POCO-EDM 3)	Increased TWR, increased MRR, unstable at high currents and low on-times, rougher surface

Pure copper electrodes generally provided the best combination of electrode durability and cost. Pure copper is used in most copper beryllium EDM applications. Tungsten copper provides better tool life, but it is more difficult to machine. The price of tungsten copper is significantly greater than pure copper. In general, tungsten copper electrodes provide better results in deep, narrow cavities that are difficult to flush.

Wire EDM

Testing done on a Charmilles Wire EDM machine with soft brass and brass-on-copper wires show the following:

For Maximum Machining Speed				
		moldMAX®	PROtherm®	
Capacitance	µF	3.3	3.3	
Current	A	48	48	
Pulse duration	µsec	1.6	1.6	
Frequency		kHz	25	29

For Best Finish				
		moldMAX®	PROtherm®	
Capacitance	µF	0.3	0.3	
Current	A	8	12	
Pulse duration	µsec	1.6	1.6	
Frequency		kHz	17	20

Safe Handling of Copper Beryllium

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.

Safety precautions always should be followed in EDM of any material to prevent worker exposure to hazardous materials. EDM of copper beryllium produces fine metallic particles that can if not handled properly, cause serious health problems if they become airborne and are inhaled. To prevent airborne exposure to these particles, the workplace should be fully immersed in dielectric fluid and adequate flow should be maintained to effectively flush the EDM swarf from the electrode area. The EDM equipment should be operated to minimize vaporization of the dielectric fluid. Local exhaust ventilation during EDM is recommended to control exposure to dielectric mist and metal particulate. During machine maintenance, the accumulated swarf must be handled in a manner to prevent workplace air contamination. Disposal of machining swarf should be done in compliance with local regulations. For additional information on safe handling practices or technical data on copper beryllium, contact Brush Wellman Inc. at 800-321-2076.

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