MATERION

TECH BRIEF

Weld Repair of MoldMAX V Mold Material

MoldMAX® V Alloy is a high-conductivity, moderately high-strength, copper-nickel-silicon-chromium alloy that is commonly used for injection mold cores and cavities. Unlike copper-beryllium, the MoldMAX V alloy system does not weld readily or easily. To repair minor defects, WeldPAK® V filler metal is available, but it should not be used for larger repairs. To build up the surface, copper-beryllium filler metal is required. This brief details how to prepare and carry out welding repairs on MoldMAX components in order to avoid using costly additional materials.

Safety Notes

It is important to follow all necessary safety precautions when welding, heat treating or cleaning with solvents. Use the proper personal protective equipment and follow all guidance on Materion's Safety Data Sheets for all substances involved.

Surface Preparation

Before welding, a clean surface is necessary. Remove tenacious oxides or other surface contaminants, such as any plastic residue, by wire brushing the mold. Use a suitable, nonflammable solvent to remove organic contaminants. Grind out cracks or unsound metal completely, making sure that the machined grooves have rounded bottoms and sloping side walls. Perform welding immediately after surface cleaning.

Preheating

If the section size of the piece to be welded is larger than 0.25 inches (6 mm), a preheating of the workpiece is necessary. Preheat the mold to a uniform temperature of 400°F (200°C) maximum.

Figure 1: MoldMAX V Block Laser Welded with WeldPAK V Filler Metal.

Welding with Copper-Beryllium Filler Metal

Gas tungsten arc welding (GTAW), also known as TIG welding, is best suited for sections up to 0.25 inches (6 mm) thick. Gas metal arc welding (GMAW), also known as MIG welding, is suggested for heavier sections.

TIG Welding

TIG welding is widely used for rebuilding worn mold surfaces and for minor cosmetic repairs. In this process, an electric arc is struck between a non-consumable tungsten electrode and the workpiece. A filler metal is used which is consumed during welding. The electrode should be a sharply pointed tungsten rod containing 2% thoria. Use low oxygen grade argon or helium gas as a shielding gas. Argon provides good control of arc, while helium permits deeper penetration. Pure argon is normally used for sections up to 0.0625 inches (1.5875 mm) thick. Helium, or a helium and argon mixture, is typically used when hotter arcs are needed for larger section sizes. Maintain gas flow rate between 15 and 40 ft^3/hr (0.4 and 1.1 m^3/hr).

If your welding shop has established procedures for welding C18000 or similar copper-nickel-silicon-chromium alloys, use those welding parameters as a starting point for repair of MoldMAX V alloy. Otherwise, a recommended starting point is 180-250 Amps for manual TIG welding and around 50-100 Amps for automatic TIG welding processes.

WeldPAK copper-beryllium should be used as a filler rod. Available diameters include 1/16", 3/32", and 1/8" (1.57, 2.36, and 3.175 mm). The power source should be high frequency AC for manual welding, and DC, electrode negative for automatic welding.

MIG Welding

In MIG welding, the electrode from which the arc is struck is consumed during welding. MIG welding is typically used for heavier sections and larger repair jobs. The power source is reverse polarity DC, electrode positive. An argon and helium gas mixture is preferred for welding thicker sections. Suggested welding parameters are 24-32 volts, 250 450 amps, and a 0.5-1.0 in^3/min (8-16 mm^3/min) wire feed rate.

Welding with WeldPAK V Filler Metal

WeldPAK V filler metal should only be used for repairing small cracks. It cannot be used to build up the surface. If the surface needs to be built up, copper-beryllium filler metal should be used. Otherwise, the mold or mold insert would need to be freshly machined from a new piece of MoldMAX V material.

TIG Welding

TIG welding using WeldPAK V metal is suitable for repairing small, thin cracks only. The electrode should be a sharply pointed tungsten rod containing 2% thoria. Use low oxygen grade argon or helium gas as a shielding gas. Argon provides good control of arc, while helium permits deeper penetration. Pure argon is normally used for sections up to 0.0625 inches (1.5875 mm) thick. Helium, or a helium and argon mixture, is typically used when hotter arcs are needed for larger section sizes. Maintain gas flow rate between 40 and 55 ft^3/hr (1.1 and 1.6 m^3/hr). Use direct current negative polarity on the electrode.

Laser Welding

MoldMAX V material readily laser welds with WeldPAK V filler metal, as shown in Figure 1. Laser welding is more precise than TIG welding and does not result in a heat affected zone around the weld.

Post Weld Heat Treatment

MoldMAX V alloy is not heat treatable to higher hardness after welding. However, if a weld repair was done with copper-beryllium filler metal, heat treat at 650°F (315°C) for three hours after welding to increase the hardness of the weld bead. Please be aware that there will still be a heat affected zone of softer metal around the weld. The post weld heat treatment does not, however, restore the full hardness of the base metal.

Ventilation

Provide adequate ventilation during welding copper-beryllium since fumes are generated which may contain hazardous compounds.

Health and Safety

Please refer to the Materion Corporation publications "Safety Facts 1 - Safety Practices for Welding Copper Beryllium", "Safety Facts 6 - Safety Practices for Heat Treating Copper Beryllium Parts", "Safety Facts 9 - Ventilation of Beryllium Dust-Generating Operations" and "Safety Facts 105 - Processing Copper Beryllium Alloys."

Processing beryllium-containing alloys poses a health risk if safe practices are not followed. Inhalation of airborne beryllium can cause serious lung diseases in some individuals. Occupational safety and health regulatory agencies worldwide have set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Safety Data Sheet (SDS) before working with this material. The SDS and additional important beryllium health and safety information and guidance can be found at berylliumsafety.com, berylliumsafety.eu and Materion.com. For questions on safe practices for beryllium-containing alloys, contact the Materion Product Stewardship Group at +1.800.862.4118 or contact us by email at Materion-PS@Materion.com.

References

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2. Welding, Brazing, Soldering, Brazing and Surfacing of Copper and Copper Alloys, Copper Development Association Inc., 1972.
3. Welding Copper Beryllium, Materion Corporation
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