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Technical Papers

MTM Portable Cold Welding

What is Cold Welding?

Cold welding is designed to joint two materials together under high pressure creating a molecular bond between the materials. The process allows for the welding of Al to Cu, Cu to Cu, and Al to Al. The process is fully integrated into the machine structure and control software. The software will prompt the operator with the necessary step for welding.

The cold-welding process is:

- ✓ Allows for the welding of Al to Cu, Cu to Cu, and Al to Al.
- ✓ Clean, quick, with no cooling time needed
- ✓ Easily repeatable by ordinary winding personnel
- ✓ Can be integrated with any existing machine. Contact MTM for more details on portable cold-welding solutions.

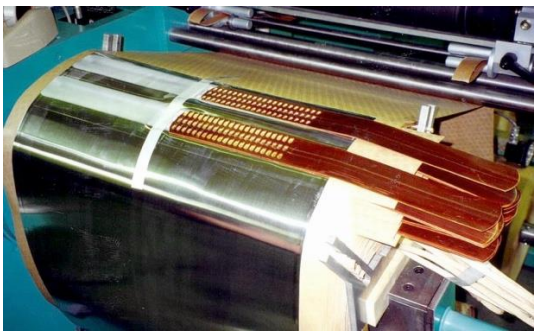
Background

MTM has found these procedures to be the best practice to follow when cold-welding. There are several factors associated with a successful weld and it is necessary for the end user to standardize process to develop repeatable results. MTM has supplied this technology to companies who have been using it successfully for the past 25 years and have been using this cold-welding practice for leads on foil windings up to 1,000 mm (40 in.) in width. Some testing will be needed to determine variables such as welding pressure, dwell time, and material preparation procedures to determine your ideal operational procedures for your application.

The following materials can be welded together by the cold weld process:

- Aluminium to Aluminium
- Aluminium to Copper
- Copper to Copper

Note: the grade of material plays a role a significant role in the quality of the weld. Typically, in electrical applications such as transformers, aluminium is AL1350 type and copper is C110 / ECU58 annealed type.



Micro Tool & Machine Ltd.
1166 Sanford Street
Winnipeg, Canada R3E2Z9

www.mtmmachines.ca
info@mtmmachines.ca
ph +1(204) 774-1641

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The cold weld process involves the application of pressure as high as 180,000psi (12,250atm) for a short time period to the area being welded. This is accomplished by a press equipped with heat-treated steel or special carbide indent dies. The components to be cold-welded are placed one over the other on a hardened anvil beneath the indent dies. Weld pressure and holding time are variables for which there are no set rules, although an initial setting of 0.3 to 0.5 seconds would be reasonable for dwell time after full stroke to cold weld. The materials will be bonded at the bottom of the indent and also to varying degrees around the indent areas.

Electrical Path

As current takes the path of least resistance, not only does it pass via the bottom of the indent, but can pass via the side (slopes) of the indent.

Weld Dies & Material Thickness

Each indent die is normally intended for a particular range in material thicknesses, and the dies are in the form of cartridges that can be quickly interchanged. The number of indents per die, their stripper depths, configurations and arrangement will vary according to the types and thickness of materials to be welded. Extrusion of the material is a factor that needs to be controlled by the die.

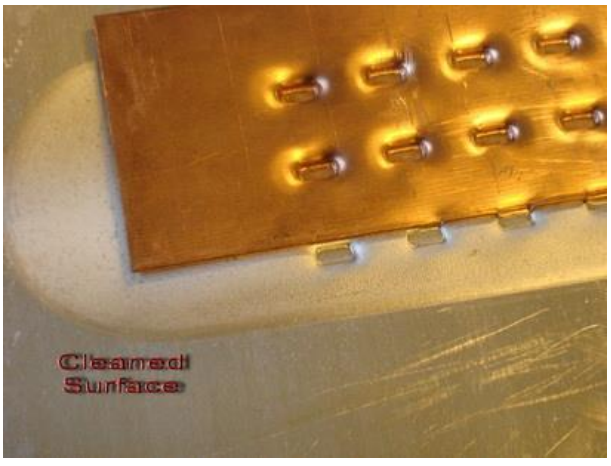
In the MTM systems an overhead die is pressed downward against an anvil below. The thickness of the upper piece of material to be welded typically should not exceed 4-5mm. The thickness of the piece of material underneath can be up to approximately 12mm or more, especially if it is a harder metal.

Tools Required

- Angle grinder for preparing weld surface on lead
- 40-80 grit disc
- A vacuum unit, enclosure, or other device that protects the operator from metallic dust while grinding.

Operation – General Guidelines

1. De-oxidize both lead and foil surfaces by lightly grinding with a 40-80 grit disc. You may have to level the surfaces by tapping with a mallet in order to prevent low and high spots. Wipe or brush these surfaces clean and free of debris, oils (including fingerprints) and dust. Within as little as 5 minutes oxidation my form again, so perform the weld immediately.
2. Assemble lead and foil as desired and place into position.
3. Follow the prompts onscreen or instructions provided by MTM with your particular equipment.



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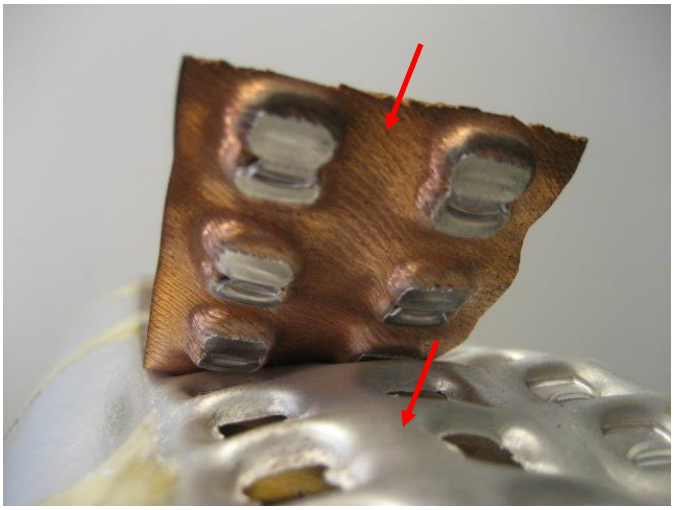
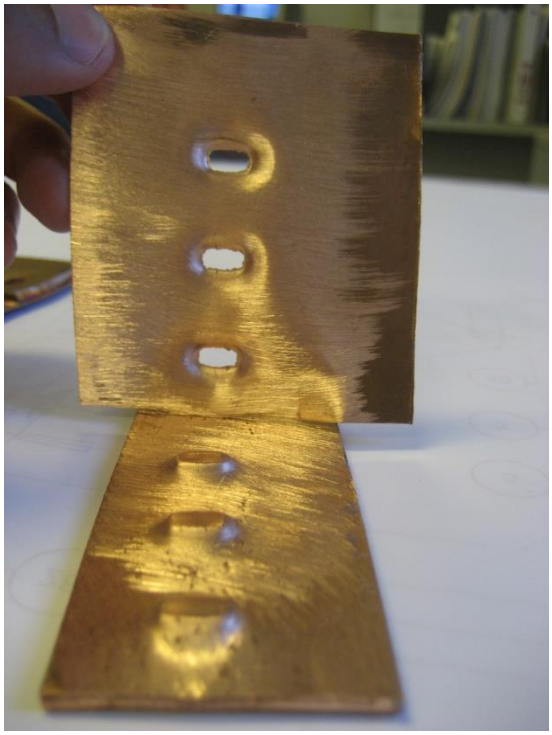
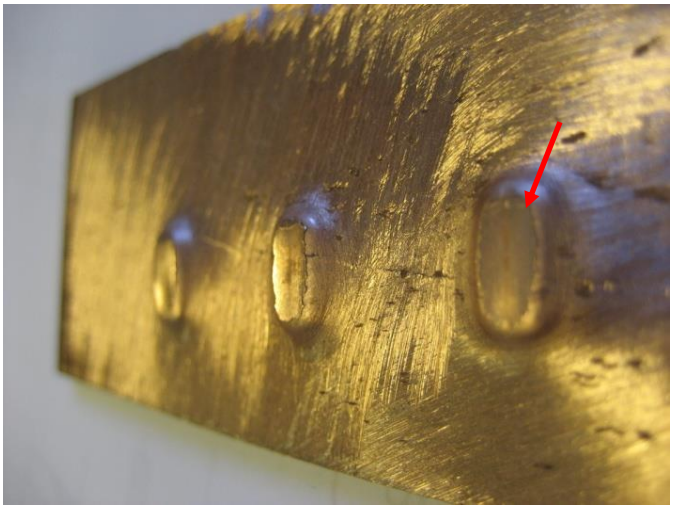
Weld Quality Test

A practical test of the cold weld area is to peel the lead from the foil. A good cold weld will show tearing completely around each of the cold weld indents such that one piece has holes and the other has the hole pieces still firmly welded on (see photos showing this material transfer – marked by red arrows). The cold weld has failed if the materials come apart without any tearing at the welds.



You will need to experiment with weld preparation procedures, pressure, and dwell time (in this order) to determine your ideal operational procedures for your materials. The most common type of weld failure is inadequate preparation of surfaces. Increase pressure gradually in 5% increments. Too much pressure will damage the indenters. Generally, it is best not to use more pressure than what is required to produce a good weld.





Photos show example of a successful weld. Note the material transfer of copper (red arrow) and the grinding marks from the de-oxidation process.

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Important Notes

Several factors influence the quality of the welds; the most critical is the surface condition of the material in the areas to be welded.

1. Aluminium must be clean and free of oil, grease, oxides or other contaminants. A stainless-steel bristle wire brushing of the areas to be cold-welded just prior to welding will provide added assurance of good welds. Burnishing using a 40-80 grit sanding disk is also a good alternative, but the surface must be flat and care must be taken not to remove too much material.

2. Copper must be clean free of oil, grease, oxides or other contaminants, and the surface to be cold-welded must be burnished by a 40-80 grit sanding disk not more than 15 minutes prior to cold welding.

3. When cold-welding copper to copper a more superior weld is achieved by placing a heat insulator such as mylar to prevent heat discharge into the tool steel anvil.

4. Ideally the thickness of foil and leads should be the same, but if there is a difference the thicker material (up to 4-5mm), usually the lead, can be placed on top for cold welding. If the lead exceeds 5mm thickness, it should be placed on the bottom provided its hardness is not less than the material above. (i.e. Al or Cu can be welded to Cu, but it is difficult to weld (press) Cu to Al).

5. The relationship of indent depth to total material thickness is also important; as allowance must be made for the spreading of material as the cold weld process takes place. MTM uses different ratios of indent depth to total thickness of material depending on the combination of materials being welded.

Sometimes it may be mandated by design that the lead be above the foil, where the lead cross-section is thicker than the cold weld process will allow. To overcome this, the lead can be made up of multiple layers, with the bottom layer covering only a portion of the foil width and being cold-welded on. The next layer is laid on top of the first but a little longer to allow layering over the first cold weld area and then the end portion cold welding to the foil. This is carried on until the all the layers are cold welded onto the foil.

This application also allows for a more flexible lead, which is sometimes desirable.

For Further Information Contact:

Micro Tool & Machine Ltd. (MTM)
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Email: sales@mtmmachines.ca
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