MIC6 SPECIFICATIONS

TYPICAL PROPERTIES

Tensile Strength:	Typical 24 ksi / 166 MPa
Yield Strength:	Typical 15 ksi / 105 MPa
Percent of Elongation:	3%
Brinell:	65
Coefficient of Thermal Expansion (average)	
68 to 212 °F (20 to 100 °C):	13.1 x 10-6 in/in ·°F
	23.6 x 10-6 m/m · K
68 to 392 °F (20 to 200 °C):	13.6 x 10-6 in/in ·°F
	24.5 x 10-6 m/m · K
Thermal Conductivity:	0.34 cal/cm · s · °C
	142 W/m · K
	82 Btu/ft · h · °F
Electrical Conductivity, IACS:	36%
Modulus of Elasticity:	10.3 x 106 psi / 71,000 MPa

MILL SIZES

Standard Thicknesses:	1/4″ - 4″ 6 – 100mm
Standard Widths:	48.5″ & 60.5″ 1232 & 1537mm
Standard Lengths:	96.5″, 120.5″ & 144.5″ 2451, 3061 & 3670mm

Non-standard thicknesses, widths and lengths may be available on inquiry.

TOLERANCES

Surface
Each side is machined to a maximum 20 microinch or 0.50 micron smoothness.

Edge Condition

Width:	milled or saw cut
Length:	saw cut

Mill Plate

Length tolerance:	+1/2″ -0. / +13mm -0.
Width tolerance:	+1/4″ -0. / +7mm -0.

Thickness tolerance
The tolerance for any thickness is ±.005″ /±.127mm.

Maximum deviation from flat:
Specified plate thickness maximum variation:
3/4″ and over: .005″ / 19mm and over: .127mm
1/4″ to 5/8″: .015″ / 6mm and over: .381mm

Flatness tolerances at the mill are measured using a laser system and/or granite flatness table. The tolerances apply to both standard mill origin plate and cut blanks when proper cutting techniques and equipment are used and to measurements obtained on a flatness table when using a straight edge with an eight foot (2.45m) maximum length.

Alcoa North America Rolled Products
Plate Facility
1530 Apollo Drive
Lancaster, PA 17601 USA
800-854-4762
Fax: 717-293-3381
www.alcoamic6.com

ALCOA

mic 6®

PRECISION MACHINED
Cast Aluminum Plate

Stability is the defining characteristic of MIC6® Precision Machined Cast Aluminum Plate.

Only MIC6 is cast to near net thickness with a stress-relieved, granular structure to virtually eliminate distortion from machining and end use temperature fluctuations.

Manufacture of MIC6, the most advanced process in the cast plate industry, promotes consistency between plates and reduces the risk of disrupting material stability by entrapped stress. In addition, the optimum in molten metal cleanliness has been achieved by the continuous application of SNIF degassing and impurity removal technology to every MIC6 plate that is cast.

The unique combination of MIC6 product characteristics allows for down-stream processing with precise control of tolerances and dimensionality. Fully stress-relieved, MIC6 is a free cutting aluminum alloy with excellent machining characteristics, producing small, uniform chips in a variety of high speed operations.

When critical applications demand superior performance, plates claiming to be "good enough" just aren't. MIC6 customers can perform extensive machining routines involving extensive metal removal with a minimal risk of distortion, often exceeding the product accuracy requirements of the most demanding end uses.

To support the industry's best casting process, MIC6 plates are thermally stress-relieved at an elevated temperature as a separate furnace treatment. This helps insure a stress-free and stable plate.

MIC6 plates are milled to exacting tolerances and smoothness, .005" for 3/4" (.127mm for 19mm) thickness and over, .015" (.381mm) for plates between 1/4" and 5/8" (6mm and 16 mm) thickness. Surface smoothness is normally maintained at 10 to 12 microinches, well below the 20 microinch (0.50 micron) product maximum.

Laser equipment installed on this granite table checks MIC6 plates for flatness.

MACHINING **MIC6**

General Recommendations

- Use machines capable of operating at high speeds with a minimum of vibration or backlash.
- Use high speeds and feeds for rough cuts, high speeds with lower feeds for better finish cuts.
- Use the following cutting fluids to prevent aluminum from sticking to tool surfaces and for heat removal:
  - water-soluble oils for most machining routines
  - cutting oil with additives for horizontal milling, turning and tapping requirements

  Commercial wax sticks and paraffin have been used for some sawing and other special situations.
- Water used with any recommended coolants should be of neutral pH, with minimum chlorides. Coolant should be wiped clean from the plate when machining is finished – do not leave coolant on the plate for extended periods or overnight.
- Use sharp tools with larger or positive rake angles. The tool surfaces should be smooth and free of marks or scratches. Allow ample clearance.

Horizontal Milling

Grooving, straddle-milling, edging and single tooth fly-cutting can be done efficiently with this method if proper cutting tools are employed. Climb-cutting gives a smoother finish with better tolerance control provided backlash is minimal. Employ high peripheral speeds to reduce any tendency toward gumming and loading.

Vertical Milling

When large surfaces are to be milled, this method is preferred due to greater chip clearance and accessibility to the work piece. Facing and fly-cutters are used for surfacing, while end and shell mills are used to contour and create cavities. Fly-cutting angles for top and side tools are similar to those used in lathe turning. Facing, circular, spiral and helical cutters should have undercut teeth to provide essential top rake.

Shaping and Planing

This method produces a rough torn surface due to the slow speed on tool travel over the work piece. A fair finish can be achieved with an extreme rake angle to give sufficient shearing action to the tool edge.

Circular Sawing

Peripheral blade speeds of approximately 15,000 feet per minute (4575 m/min) are recommended. Blades should have carbide teeth with up to a 45 degree rake angle. Such blades are usually manufactured with chip breaker teeth or alternating slide rake teeth – one tooth cuts one side and the next tooth cuts the other side.

Band Sawing
High speed saws with a blade speed of 3,000 to 6,000 feet per minute (915 to 1830 m/min) are recommended. They should be of tempered steel with a 15 degree minimum top rake and 4 to 8 teeth per inch (6 to 3 mm per tooth). Proper support for the plate being cut is mandatory and will help maintain flatness tolerances during sawing.

Drilling
The recommended drills for cast plate should have more twists per inch than ordinary drills. The flutes of these drills should be highly polished. Cutting compound should be used.

Turning
Lathes capable of turning the stock at 5,000 to 9,000 surface feet per minute (1525 to 2745 m/min) should be used. Use carbide tipped tools with a 40 degree top rake and 18 degree side rake angle. Feed should not exceed .020 inches (0.5mm) per revolution.

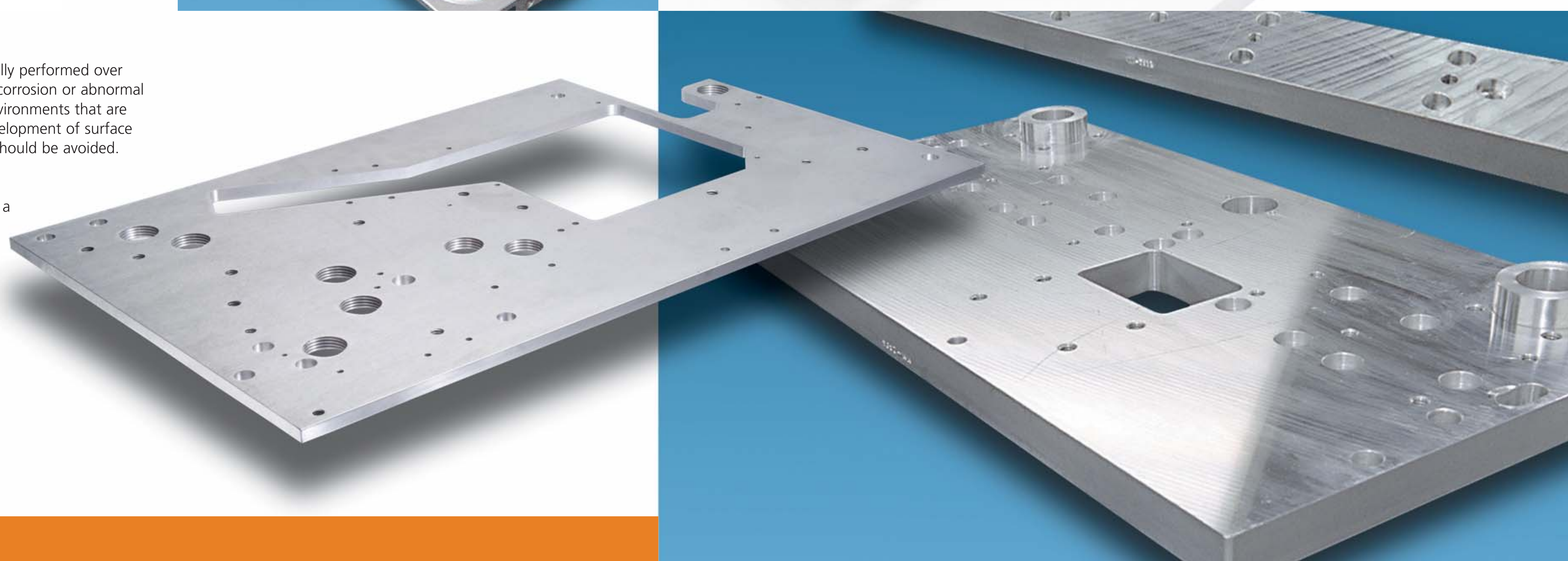
Tapping
Hand or machine taps will produce smooth and accurate threads in MIC6 cast plate. For a full thread, the tap drill should be of slightly less diameter than that used for steel. Rounded or trapezoidal threads are recommended – thread length should be 20% longer than for steel. Inserts will prolong the thread life.

Surface Exposure
As-machined MIC6 parts have successfully performed over decades of service without evidence of corrosion or abnormal surface oxidation. Exterior and other environments that are high in moisture tend to induce the development of surface staining and pitting. Marine exposures should be avoided.

Thermal Cycles
MIC6 can be repetitively cycled through a thermal exposure without affecting or altering the physical properties of the plate. Thermal treatments during each cycle can range from 250 to 600 °F (120 to 315 °C). Full support under the plate during the thermal cycle is recommended – the thinner the plate, the more important this consideration becomes.

When parts must work every time, **demand no less than MIC6 for these critical applications:**

- Aircraft Tooling
- Automotive Tooling
- Base Plates, Side Plates and Indexing Tables
- CNC Routing Tables
- Checking Fixtures, Gauges and Templates
- Chip Printers
- Circuit Printers
- Dielectrics
- Document Sorting Equipment
- Electronics
- Food Machinery: Side Frames and Functional Components
- Foundry Patterns
- Heating and Cooling Platens
- Medical Instrumentation: Internal Functional Components
- Packaging Machinery and Molds
- Pharmaceutical Machinery
- Plastic Components Manufacturing: Temperature Control Manifolds
- Printing Machinery
- Robotics
- Vacuum Chambers for Computer Chips
- Vacuum Chucks



WORKING WITH **MIC6**

Anodizing

MIC6 has been satisfactorily anodized for thousands of end uses, providing good performance and a uniform coating depth across the entire surface with either conventional or hard coat anodizing treatments. Both are applied after the machining routine for improved corrosion protection, wear resistance and/or as a color enhancement.

A non-etching type cleaner is recommended. Strong caustic-based or aggressive cleaners that etch tend to preferentially attack the cast grain structure and thereby overly roughen the surface. With a non-etching cleaner, the smooth machined surface is better maintained for the subsequent anodize.

A natural, darker gray color occurs as a result of anodizing. Since MIC6 is a casting, variations in the shade and texture of the gray appearance can occur within a given plate or from plate to plate. However, when typical applications involve only one piece of MIC6, any piece to piece variation is not of concern.

When a black dye treatment has been used, the color developed has been a deep black tone, satisfying the requirements of most end users. This color tone has proven consistent from piece to piece and lot to lot.

For conventional anodizing, a 15% by weight sulfuric acid solution, current density of 12 amps per square foot (1.2 A/dm2) and a bath temperature of 70 to 90 °F (20 to 32 °C) is suggested. Once the anodizing has been completed, the surfaces should be rinsed - when organic dyes are used, good rinsing practices become critical. If all the sulfuric acid from the anodizing bath is not rinsed prior to the dye treatment, white spots can occur. Although these occurrences are rare, a neutralizing solution of 5% ammonium oxalate or sodium bicarbonate applied for 5 to 10 minutes has proven effective in their elimination. If sulfuric acid from the anodizing bath becomes entrapped in any voids, it can bleed after the dye treatment and oxidize the dye, causing a lighter color spot.

For hard coat anodizing, a variety of proprietary processes are in use. In general, the bath operating temperatures are 32 to 50 °F (0 to 10 °C), and the current densities are 20 to 36 amps per square foot (2.0 to 3.6 A/dm2). The combination of the lower bath temperature and the higher current density produces a thicker coating that has improved wear resistance. Excessive operating temperatures should be avoided when conducting these hard coat anodize treatments as they can affect the quality and thickness of the coating. It is suggested that a test piece be evaluated when considering a given hard coat process.

Welding

MIC6 components can be successfully welded utilizing the fusion based Gas Metal Arc Welding (GMAW or Mig), Gas Tungsten Arc Welding (GTAW or Tig) and solid state based Friction Stir Welding (FSW) processes. GMAW is used most often and GTAW has some limited applications. Argon, Helium or a mixture of the two are the only recommended shielding gases for welding MIC6.

Because MIC6 has a high thermal conductivity, it is recommended to be welded "hot and fast", meaning the welding current should be set at a level that provides adequate heat input while maintaining a moderate welding speed. Specific parameters can be found in welding handbooks such as "Welding Aluminum – Theory and Practice" from The Aluminum Association.

Aluminum filler alloys 4043, 4145 and 5356 are all acceptable for use when welding MIC6. Filler alloy 4145 (10% Si, 4% Cu) offers the best weld ability and freedom from cracking with 4043 (5% Si) being a good second choice – both would be recommended if the service temperature of the welded assembly is above 150 °F (66 °C). Under some conditions (e.g. high parts restraint), filler alloy 5356 may cause some cracking in the Fusion Zone and Heat Affected Zone (HAZ) of MIC6 parts. In addition, the welds deposited with this filler alloy can be sensitized to stress corrosion cracking at high temperatures and should be used only in service applications below 150 °F (66 °C). When testing under tension traverse to the welds, 0.5 in. thick weldments, produced with the 4145 and 5356 filler wires, generally break in the HAZ with joint efficiencies that can be as high as 96%.

In general, it is recommended to weld the MIC6 at interpass temperatures not exceeding 150 °F (66 °C). If a pre-heat is required, the temperature should be limited to 250 °F (120 °C).

Pre-weld cleaning and oxide removal are important to the successful welding of MIC6. Residual machining lubricants and moisture will produce porosity in welds.

Prior to welding, solvent clean and dry the areas to be welded of surface contaminants. Aluminum's natural oxide melts at 3700 °F (2035 °C) while aluminum melts at approximately 1200 °F (650 °C). This oxide can act as a barrier to adequate fusion between the weld and base metal. Usually a light brushing with a clean stainless steel brush, after the surface has been cleaned of contaminants, will remove the oxide film.

For applications where fillet welds are used, no weld joint edge preparation is necessary. For butt joint applications, weld joint edge preparation is required, such as a single V or double V bevel (depending on the thickness being welded).

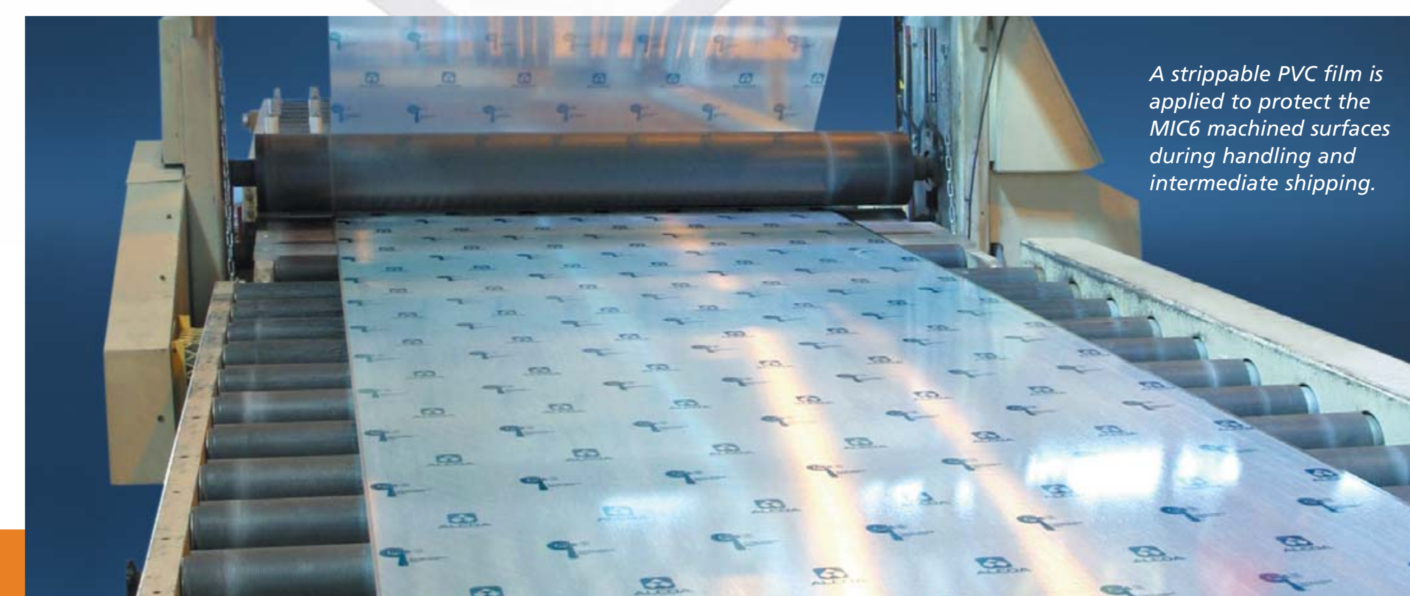
As with all welded assemblies, it is strongly recommended that the welding procedure used be tested and qualified on joint mockup(s) prior to introduction and in-service use.

Painting

MIC6 can be either painted or powder coated. The plate surfaces should be cleaned to remove any residual machining lubricant or oil – both water-based and solvent-based cleaners have proven effective. Once cleaned, there are several different approaches to further surface preparation.

A chemical conversion coating in combination with a primer coat has shown to provide the best surface protection and resistance to abrasion. In some applications, primer coats have been applied directly to the plate surface – in other cases, even the primer coat has been omitted. A light anodize has also been used on a limited basis for surface preparation prior to a coating application.

A surface that is free of moisture is the key to success with any coating method. Unless the surface is dry, entrapped moisture from micro shrinkage could contribute to flaws in the final coating.



A strippable PVC film is applied to protect the MIC6 machined surfaces during handling and intermediate shipping.