



# Magnesium Elektron

SERVICE & INNOVATION IN MAGNESIUM

# Machining of Magnesium

## Datasheet 254 Web

The information contained within is meant as a guideline only. †

More detailed information is available on request.

† Disclaimer: The information provided within this document is aimed to assist manufacturers and other interested parties in the machining and use of magnesium alloys. Magnesium Elektron accepts no liability in whole or in part from use and interpretation of the data herein.



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## MACHINING OF MAGNESIUM

Magnesium is the lightest structural metal and exhibits excellent machinability. Some of the advantages of machining magnesium compared to other commonly used metals include:

- Low power required – approximately 55% of that required for Al.
- Fast machining – employing the use of high cutting speeds, large feed rates and greater depths of cut.
- Excellent surface finish – extremely fine & smooth surface achieved.
- Well broken chips – due to the free-cutting qualities of magnesium.
- Reduced tool wear – leading to increased tool life.

Table 1 – RELATIVE POWER & COMPARATIVE MACHINABILITY OF METALS

Metal	Relative Power	AISI - B1112 Machinability Index (%)
Magnesium alloys	1.0	500
Aluminium alloys	1.8	300
Mild steel	6.3	50
Titanium alloys	7.6	20

## TOOL MATERIAL

Although HSS tooling can be used and is often employed in twist drills, taps and broaches, carbide is the preferred tooling material for most machining operations on magnesium alloys. Carbide gives a balance of economics and the ability to perform high volume production runs. It also gives a good surface finish, however, if a superior surface quality is required with long series at high production volumes, polycrystalline diamond (PCD) should be considered. PCD tools are extremely wear resistant and their use eliminates the occurrence of built-up edge (BUE) on the tool. This is due to the low adhesion tendency of PCD.

## TOOL GEOMETRY

In order to take advantage of the machining characteristics of magnesium it is useful to consider recommended tool design and angles. The geometry of the tool can have a large influence on the machining process. Tool geometry can be used to aid with chip flow and clearance, reduce excessive heat generation, reduce tool build up, enable greater feed rates to be employed and improve tool life.

It is vital that tools are kept extremely sharp. This helps to avoid overheating. Dull tools can lead to problems with dimensional accuracy and tolerance, the generation of excess heat, the formation of long burnished chips, and sparking or flashing at the tool edge. It is worth checking the sharpness of the tool and sharpening if necessary if any of these phenomena start to occur.

## DRY MACHINING

In the past, machining operations performed on magnesium parts were carried out safely without the use of coolants or cutting fluids. Magnesium is an excellent material for machining dry. This is because of the low cutting pressures, free machining characteristics and the high thermal conductivity which allows heat to dissipate quickly through the part.

## COOLING

However, there may be times when further cooling of the workpiece is required, for example to;

- minimise the possibility of distortion
- reduce the chance of fine chips igniting during very high speed machining
- prolong the life of machine tools in high volume production settings
- control and remove chips
- or just for peace of mind when using expensive modern CNC machining centres

## OILS

The type of oil should always be mineral oil rather than animal or vegetable oils. Using oil rather than an emulsion type coolant has been shown to improve both dimensional accuracy and surface quality in certain machining operations.

## WATER-MISCIBLE CUTTING FLUIDS

Traditionally, the use of water soluble oils and oil-water emulsions was not advised due to the risk of hydrogen gas development and the increased fire hazard should the chips ignite. However, developments in coolant technology have led to a number of emulsions that now specify that they are designed to deal with any hydrogen generation, residue and splitting issues encountered when machining magnesium alloys.

## MACHINING OPERATIONS

When using carbide tools the machining speed is usually only limited by the stability of the component, chip extraction, or the rotation speed and accuracy of the machine.

### Turning & Boring

Turning operations present little difficulty with swarf clearance and should be carried out at the highest available speed depending on the machine tool, and the clamping and stability of the component.

Although HSS tools can be employed at normal speeds, carbide tooling is the preferred choice, especially for high speed machining. If cost is not an issue, the use of PCD tooling has been shown to result in the greatest dimensional accuracy and the highest cutting speeds.

### MILLING

Extremely high speeds and large feed rates are possible and are encouraged during the milling of magnesium alloys; these still produce excellent surface finishes. Using coarse feed rates and high cutting speeds enables the full advantage of machining magnesium to be realised. As with turning and boring, HSS tools can be used at normal speeds, but, carbide is the tool material of choice for high speed milling operations.

## DRILLING

Although magnesium can be drilled with standard twist drills, the use of specifically designed or modified drills is of great benefit. Better dimensional accuracy is often achieved with the use of a mineral oil coolant.

### REAMING

Carbide inserts are the preferred tooling choice especially for high production runs, although steel reamers can be used, if carburised and case-hardened.

### TAPPING

Standard taps are suitable for small production quantities or if high tolerances are not required. For best results taps tailored to magnesium should be used.

### SAWING

Magnesium is easily cut with either a band or a circular saw with a power consumption of one tenth that required for steel.

### GRINDING & POLISHING

Magnesium dust is flammable and precautions must be taken both in its production and disposal.

## SWARF HANDLING

The most crucial factors for safe machining are to avoid excess heat generation, especially when machining dry, and to ensure proper collection and handling of chips.

Magnesium chips, raspings and turnings should never be mixed with chips from other types of materials. Segregation of swarf is crucial if any value is to be retained from recycling.

Magnesium Elektron are committed to recycling magnesium metal containing products arising from the metals industry. Chips, swarf and turnings may be accepted for recycling in the purpose built facility in Manchester, UK.

## FIRE PRECAUTIONS

Magnesium must be heated to its melting point before it can burn. Therefore, magnesium components will not ignite easily.

Magnesium swarf can be ignited, but simple precautions and good housekeeping can help to avoid the risk. The finer the particles of magnesium become the more easily they are ignited.

Should a fire occur, dry turnings will burn slowly and evenly but can flare up if disturbed. Fine swarf will burn more quickly and vigorously. The principle for dealing with burning magnesium swarf is to conduct the heat away and to exclude air. The way to tackle a magnesium fire is to cover and suppress rather than disturb the swarf.

The presence of water will greatly intensify and accelerate combustion as it will dissociate to form oxygen and hydrogen. Hydrogen is explosive therefore water should not be used to extinguish magnesium swarf fires.