Pittsburgh Plastics Manufacturing, Inc.

# **Machining Metapor:** Properties, Conditions and Results

## Material Properties:

Metapor is an air permeable, aluminum composite material. It is used for thermoform and open cast molding applications. It has a porosity range of 15 to 16%, an operating temperature of 212° F (100° C) to 410° F (210° C) and impact strength ranging from 5.2 ft-lb/$in^2$ to 6.7 ft-lb/$in^2$

## Advantages:

**Machining environment:**
Because Metapor has to be machined in a completely dry environment; the cost, health risks and environmental issues that come with the use of cutting fluids are absent from the process.

**Feed rate:**
Depending on the type of machining being performed the feed rate (IPM) used to machine Metapor can be increased up to 400% over that of regular aluminum. Using a 1/2" diameter flat end mill, at 7750 RPM and a .125" depth of cut (DOC), the feed rate can be increased from 31.16 to 124.62 IPM, without compromising finish quality. Machining with small end mills (1/16" diameter and below), the feed can be safely increased by %200 without sacrificing the quality of detailed part features or tool life.

**Stepover:**
Metapor gives a much better surface finish using larger stepover gaps than traditional aluminum. Perform a 3-D milling process with a 1/4" diameter ball end mill, at 7750 RPM, a .105" DOC, using a feed rate of 69.75 IPM and a stepover of .010". The result is a production quality finished surface that is completely free of burs and scallops. Using that feed, speed, DOC and stepover this machining process would be a roughing or semi finishing step using aluminum.

**Tool wear:**
Using carbide end mills and high speed steel twist drills, tool wear is nearly nonexistent. After a year of machining various prototype and production tools, none of the tool offsets needed to be adjusted to compensate for tool wear. We have quite a few molds that require machining with end mills as small as .010" in diameter with no loss in part quality.

## Disadvantages:

**RPM limitation:**
Machining Metapor limits the cutting tool to 7750 RPM. Any cutting speed above that causes the material to break down and burn. This causes the material to stick to the surface of the cutting tool and ruins the part.

**Reaction to moisture:**
Machining Metapor creates a powder and any contact with fluid causes it to break down. The material begins to clump together and stick to the cutting tool; this also causes the material to burn. Part cavities and small details become inconsistent and are sometimes lost completely. If it is suspected that the Metapor has become wet or saturated with liquid, it should be dried in a vacuum oven between 100-120°F.

**Waste:**
The powder left behind from machining Metapor is easy to clean assuming it is run on a dedicated machine. A concern is the use of multiple material types in a single machine. Since most tooling metals are best cut with the use of coolant, care must be taken to clean all surfaces of moisture prior to cutting Metapor. Conversely, Metapor

powder from machining can easily clog coolant filters and wreak havoc on machine bearings without the proper care to pre and post machine cleaning.

## Solutions:

**RPM limitation:**
With a wide range of feed rate control, a programmer and/or operator can make up for the RPM limitation through feed percentage adjustments.

**Reaction to moisture:**
Make sure that all surfaces, tools and the surrounding areas are completely dry before machining Metapor. If the material does get wet wait until it is completely dry before using it or use a vacuum over to assist with drying.

**Waste:**
If it is possible, having a CNC dedicated to machining Metapor could be a viable solution for handling the residual material. If this is not possible, the best solution is to machine all Metapor jobs first and completely remove all the waste before switching to materials that require cutting fluids.

## Conclusion:

Metapor is easy to process with virtually no tool wear. Because it machines quickly and cleanly it is perfect for rapid prototyping as well as production tools in thermoforming and open cast molding applications. The waste material left behind from machining is easy to clean and the scrap can be sold with Aluminum scrap. If it is cost effective, having one or more machines designated to Metapor is desirable. On the other hand, with proper planning, using a single machine for multiple materials is feasible provided that the proper care is taken with each job.