

## SHAPAL™ Hi-M SOFT MACHINABLE ALUMINIUM NITRIDE CERAMIC

### MACHINING INSTRUCTIONS

Shapal™ Hi-M soft can be machined to make precision™ components, but its machining characteristics are different to metals and plastics.

Shapal™ Hi-M soft has a special crystal structure which makes it strong and hard - yet machinable. It is the crystals which prevent the microscopic fractures at the tool tip from spreading throughout the material so making it machinable in a controlled way. During machining, the tool pulverizes and tears the Shapal™ Hi-M soft surface producing a fine powder. The crystals are so small that, when machined, Shapal™ Hi-M soft has a good surface finish. When finished, the component is cleaned and used; no further treatment (e.g. firing) is required. Do not use acids or alkalis to clean components.

#### Setting Up

Shapal™ Hi-M soft is not resilient so, when small or delicate pieces are being machined, make sure the clamping load is uniformly distributed. Use soft jaws, if possible.

#### Machining

It is well worthwhile taking sometime to learn how the material behaves during machining. Try some simple tasks such as drilling, turning and milling and you will see how the material machines. This information gives a basis for good machining practice, but do not be afraid to experiment with tools and speeds to obtain your optimum machining performance.

Shapal™ Hi-M soft must be machined with carbide tools, do not use high speed steel tools. Ceramic tip tools are not advised. Always keep tools sharp and check regularly throughout the machining process. If the tool squeaks or too much force is needed - then stop and sharpen the tool.

As a general rule, machine with slower speeds (keeping the work piece cool) and take smaller depths of cut until you become more confident in machining the material. Always machine from the edge to the center to avoid edge chipping. Remember, you are machining a brittle material so always avoid physical shock. It is normally the requirement to maintain a surface finish which controls machining speeds.

#### Use coolant generously

Although Shapal™ Hi-M soft is a high-temperature material, the best machining results are obtained when both the material and tool are kept cool. Water soluble cutting fluids improve the cutting action, trap and wash away the powder during machining and protect machine tools. If the fluid is to be recirculated, the use of a Settling pot is recommended. The powder generated during machining is somewhat abrasive so attention must be given to cleanliness and machine maintenance.

#### Turning

Suggested turning speeds are up to 320 rpm for 5 and 10mm diameter rod, reducing to around 150 rpm for 25mm diameter rod. Feed rates are 0.1mm/rev with a 0.1-0.5mm depth of cut.

Side and back rack angle, end and side relief angles are to be around 5°.

The recommended side cutting edge angle is 15 - 45° and the nose radius is to be larger than 0.8mm.

Thread cutting can also be done at low spindle speeds; a typical cutting depth is 0.025 - 0.040mm per path.

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### MACHINING INSTRUCTIONS continued....

#### Milling

Typical head speeds are around 1000 rpm for end mill diameters up to 5mm, reducing to as low as 100 rpm for larger tool diameters. Feed rates are 50-20mm/min with a 0.1-0.5mm depth of cut. Mill top faces first before side faces and climb mill to minimise chipping.

#### Drilling

For holes up to about 5mm diameter a spindle speed of 1000-1500 rpm and a feed rate of 10-15mm/min has been found to be effective. Relieve the drill flutes constantly, especially for small diameter holes. Check the sharpness of the drill every few holes.

Slow feed is recommended at the start and the finishing of holes. To prevent breakout, use a backing plate or bevel the hole entrance and exit before drilling. It is possible to ultrasonically drill Shapal™ Hi-M soft.

#### Sawing

Use a carbide grit blade with a 30m/min band speed, or a diamond or silicon carbide cut off wheel.

#### Tapping

Make the clearance hole one size larger than recommended for metal (typically 0.1 - 0.2mm larger). Chamfer both ends of the hole to prevent chipping. Carbide or titanium nitride coated taps can be used for sizes up to M4.

For larger sizes, better results are obtained by machine cutting the thread using carbide tips. Wire thread inserts, e.g. Helicoil can be used with Shapal™ Hi-M soft.

#### Grinding and Polishing

Diamond grinding wheels are best although silicon carbide and alumina can be used. Always use water cooling. Polishing is started with a 400 grit silicon carbide prior to using alumina powders for the final finish.

#### Design considerations

Shapal™ Hi-M soft is a brittle material and, as such, certain design considerations will help achieve the best performance of the material.

If possible and practical:

Avoid sudden changes in section or thickness.

Avoid sharp edges, if possible chamfer or round any changes in direction.

If possible, ensure that the distance between a hole and an edge or second hole is twice the diameter of the hole.

For thermal applications, try to ensure that wall thicknesses are uniform to reduce thermal expansion strains during heating and cooling.

*SHAPAL™ Hi-M soft is a trademark of Tokuyama Corp.*

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