DOTMAR

ENGINEERING PLASTIC PRODUCTS

QUADRANT

ENGINEERING PLASTIC PRODUCTS

MACHINING INSTRUCTIONS

DOTMAR
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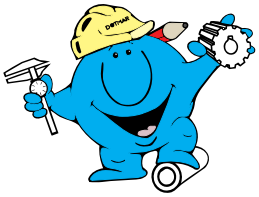
ABN 82 714 271 936

Application solutions, custom engineering.

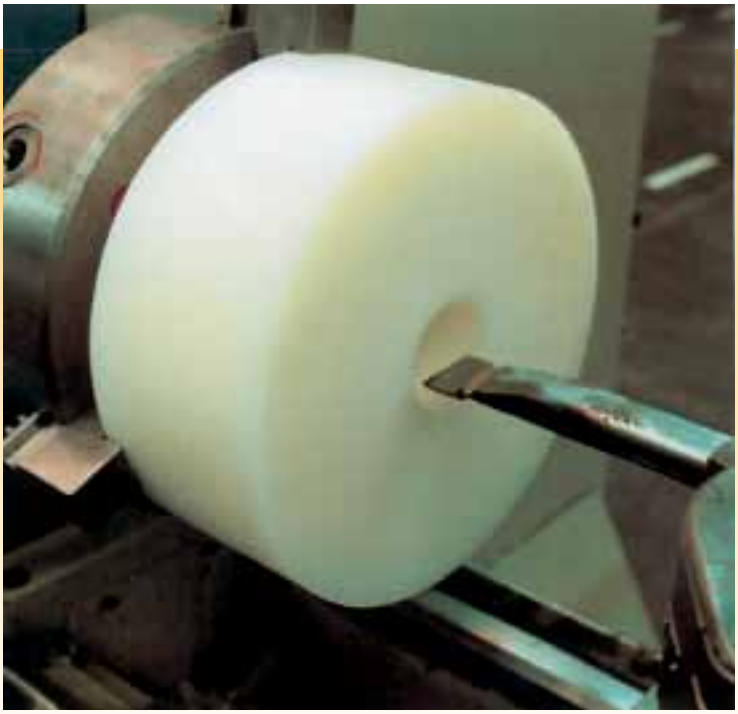


The Quadrant stock shapes can easily be machined on ordinary metal-working and, in some instances, wood-working machines. However, there are a few points which are worth noting to obtain the best results.

In view of the poor thermal conductivity and the relatively low melting points of thermoplastics, the generated heat must be kept to a minimum and heat build-up in the plastics part avoided. This is in order to avoid colour changes or even melting.

Therefore:

- tools must be kept sharp and smooth at all times;
- tools must have sufficient clearance so that only the cutting edge contacts the material;
- a good swarf removal from the tool must be assured;
- coolants should be applied for operations where plenty of heat is generated (eg. drilling)



Flat, rigid boring tool to "bore" holes on a lathe.

Machining Forces

Machining forces are lower for engineering plastics than for metals, therefore clamping pressures may be reduced. But as these materials are not as rigid as metals, it is essential to support the work adequately during machining in order to prevent deflection, eg. thin walled bushings often require an internal plug for accurate machining of the outside diameter.

Tools

Carbon steel, high speed steel and hard metal tools can be used. However, tungsten carbide tipped tools or diamond bit tools are preferred for long production runs and are a must when machining glass or carbon fibre reinforced materials.

Coolants

When the use of coolants is required, cooling liquids of the soluble oil type do generally very well. They should, however, not be used when machining thermoplastics which are susceptible to environmental stress-cracking such as PC, PEI and PSU. For these materials the most suitable coolants are pure water or compressed air.

Machining Tolerances

The machining tolerances required for thermoplastics parts are generally considerably larger than those normally applied to metal parts. This is because of the higher coefficient of thermal expansion, plus swelling due to moisture absorption and possible deformations caused by internal stress-relieving during machining. The later phenomenon mainly occurs on parts where machining causes asymmetric and/or heavy section changes. In these cases, a thermal treatment (stress-relieving) after pre-machining and prior to final machining of the part might prove necessary.

As a rule of thumb, for turned or milled parts, a machining tolerance of 0.1 to 0.2% of the nominal size can be applied without taking special precautions (min. tolerance for small sizes being 0.05mm). In this respect, the ISO 2768, the DIN 7168 as well as the Swiss VKI-Recommendation "Toleranzen spanend hergestellter Kunststoff-Fertigteile" ("Tolerances for machined plastic parts") can be used.

Turning

See table for tool geometry, speeds and feeds.

Milling

Milling cutters for light metals can be used but fly cutters are preferred because of the much better swarf removal.

Drilling

High speed steel twist drills work well but plenty of heat is generated so a cooling liquid should be applied. In order to improve heat and swarf removal, frequent pull-outs ("peck drilling") are necessary, especially for deep holes. For large diameter holes, it is advised to use drills with a thinned web in order to reduce friction and consequently heat generation. It is also recommended for large holes to drill step wise; eg. a bore diameter of 50mm should be made by drilling successively with ø 12 and ø 25mm, then expanding the hole further with larger diameter drills or with a single point boring tool.

For KETRON® PEEK-HPV, KETRON® PEEK-GF30 and TECHTRON® HPV PPS rods over 50mm diameter, for ERTALON® 66-GF30, ERTALYTE® and KETRON® PEEK 1000 rods over 100mm diameter as well as for ERTALON® 6 rods over 200mm diameter, it is even recommended in order to avoid cracks, not to use high speed twist drills at all but to "bore" the holes on a lathe using a rigid, flat boring tool with its cutting edge perfectly set on centre-height (see photo).

When drilling or boring through-holes, feed should be reduced at the bottom of the cut to prevent the drill or flat boring tool from pulling through at the exit side, causing chipping or breaking out. Hand feeding the drill is not recommended since this may cause the drill to "grab" and stress the material.

Sawing

Band saws, circular saws or reciprocating saws that have widely spaced teeth in order to assure good chip removal can be used. They should also have enough set to minimise the friction between the saw and the work and to avoid close-in behind the cutting edge causing excessive heat build-up and even blocking of the saw. Proper clamping of the work table is required to avoid vibrations and consequent rough cutting, or even rupture.

IMPORTANT: Reinforced materials (ERTALON® 66-GF30, KETRON® PEEK-HPV, KETRON® PEEK GF30, KETRON® PEEK-CA30 and TECHTRON® HPV PPS) are preferably cut with a band saw that has a tooth pitch of 4 - 6mm. Do not use circular saws as this often results in cracks.

Safety

To avoid any risks the general industrial safety recommendations should be followed as well as the eventual specific ones you can find in the material safety data sheets.

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With respect to their hardness and moderate toughness, it has to be noted that next to what already has been said earlier, some additional machining / design rules should be observed in order to avoid premature material failure. In design and assembly, stress concentrations should be avoided and, particularly during sawing and drilling operations, a gentle machining approach is required.

Figure 1: 1mm minimum radius.

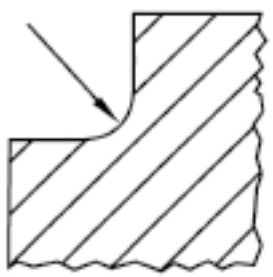
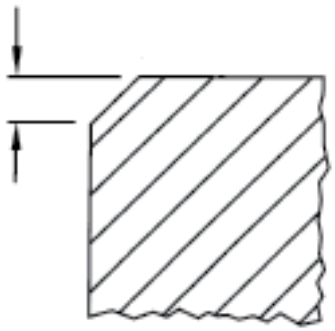


Figure 2: 1 x 45° minimum chamfer.



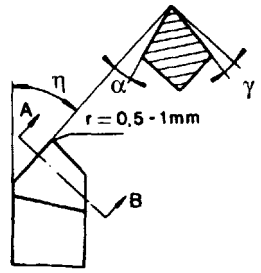
Some tips:

- Use light to moderate clamping forces. Never try to force the plastics part.
- Avoid sharp "internal corners". The radius of curvature should be at least 1mm. Refer to figure 1.
- For drilling and sawing operations (pre-machining), one can also preheat the stock shapes up to 100 - 120°C. This procedure drastically cuts back the risk of cracking during machining.
- To avoid chipping the edges during turning, boring or milling, chamfered edges are advantageous, providing a smoother transition between the cutting tool and the plastics work. Refer to figure 2.
- Sharp V-threads should be avoided (plenty of notch-sensitive areas); threads with a rounded root should be applied whenever possible.
- The use of thread cutting and thread forming screws is not recommended. Particularly the latter create tremendous stresses around the hole and are most likely to cause cracking at that point.
- When tapping threads or assembling bolts in blind holes, care should be taken not to force the bottom of the holes by the tap- or bolt-tip since this is likely to induce cracking.

Tool Geometry, Speeds and Feeds for Sawing, Turning, Milling and Drilling

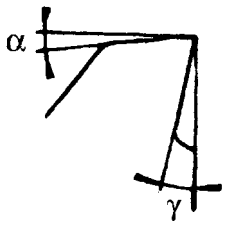
TURNING

Section AB



α Side relief angle (°)
γ Rake angle (°)
η Side cutting edge angle (°)
v Cutting speed (m/min.)
s Feed (mm/rev.)

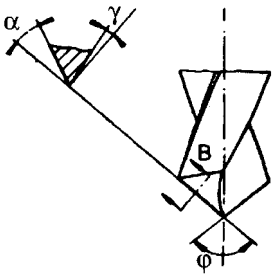
MILLING



α Relief angle (°)
γ Rake angle (°)
v Cutting speed (m/min.)
s Feed (mm/tooth)

DRILLING

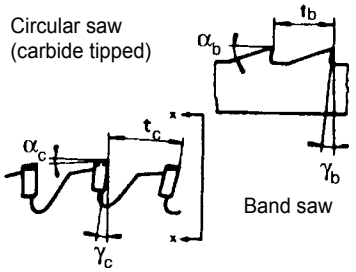
Section AB

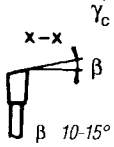


α Relief angle (°)
γ Rake angle (°)
φ Top angle (°)
v Cutting speed (m/min.)
s Feed (mm/rev.)

SAWING

Circular saw (carbide tipped)





α Relief angle (°)
γ Rake angle (°)
t Pitch (mm)
v Cutting speed (m/min.)

	TURNING					MILLING				DRILLING					SAWING							
	α	γ	η	s	v	α	γ	s	v	α	γ	φ	s	v	α_c	γ_c	t_c	v_c	α_b	γ_b	t_b	v_b
ERTALON® PVDF 1000	5-15	0-10	0-45	0,05-0,5	200-500	5-15	0-15	≤0, 05	200-500	10-15	3-5	90-120	0,1-0,3	50-100	10-15	0-15	8-45	1000-3000	25-40	0-8	4-10	50-500
ERTACETAL®	5-15	0-10	0-45	0,05-0,5	200-500	5-15	0-15	≤0, 05	200-400	5-10	3-5	90-120	0,1-0,3	50-100	10-15	0-15	8-45		25-40	0-8	4-10	50-500
ERTALYTE® KETRON® PEEK 1000	5-15	0-10	0-45	0,05-0,5	200-400	5-15	0-15	≤0, 05	150-300	5-10	3-5	90-120	0,1-0,3	50-80	10-15	0-15	8-25		25-40	0-8	4-10	50-400
PC 1000 PSU 1000 PEI 1000	5-15	0-10	0-45	0,05-0,4	200-400	5-15	0-15	≤0, 05	200-400	5-10	3-5	90-120	0,1-0,3	50-100	10-15	0-15	8-25	1000-3000	25-40	0-8	4-10	50-400
ERTALON® 66-GF30 KETRON® PEEK-HPV KETRON® PEEK-GF30 KETRON® PEEK-CA30 TECHTRON®HPV PPS	5-15	0-10	0-45	0,05-0,3	100-200	5-15	0-15	≤0, 05	50-150	5-10	3-5	90-120	0,1-0,3	50-80	10-15	0-15	8-25		25-40	0-8	4-6	50-200

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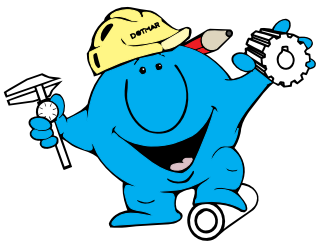

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