

SEMI-FINISHED PRODUCTS

Modern, flexible materials



LICHARZ engineering plastics –
EXACTLY YOUR SOLUTION

Licharz
engineering plastics





LICHARZ

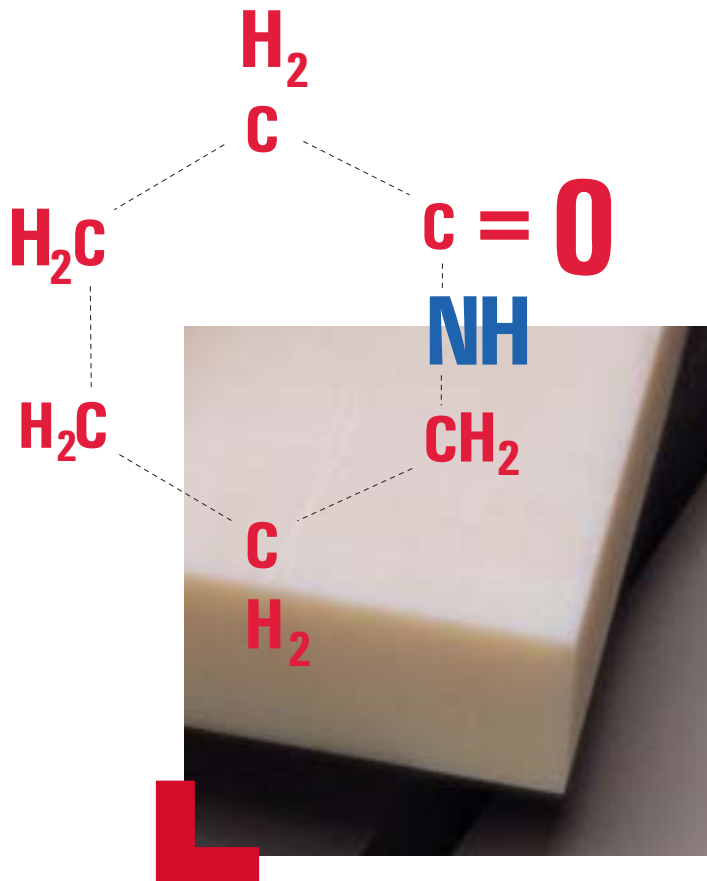
WE PUT PLASTICS ON TARGET:

Semi-finished products!

PA, POM and PET engineering plastics are modern and flexible materials for which the greatest variation of engineered components for machines and equipment can be manufactured. Licharz develops particularly wear-resistant and smooth-sliding polyamides and manufactures wide spectrums of semi-finished products which can be machined quickly and easily processed further.

With a broad, accessible stock of standard products, as well as customised offers and cut to size services, we provide flexibly and quickly a wide variety of requirements from different industries.

0,08^{kg/m³}



Chemical formula for Caprolactam

LICHARZ

LONG-LIVED AND INNOVATIVE:

Performance in plastics!

1145

Our semi-finished products are available as rods, sheets and tubes in various dimensions and a variety of colours. They are also available in customised cut to size pieces. We have developed high-grade polyamide grades which are highly resistant to wear even where the loads are high.

- PA 6 G is a very solid, long life and low stress cast polyamide which can be easily machined.
- Oilamid® is particularly smooth sliding and thus particularly suited for applications such as conveyor technology
- Lubramid® 600 T is a specialty material for friction bearings and for highly loaded slide and wear components due to solid lubricant additives
- Calamid® is extraordinarily impact resistant and highly elastic. It is therefore ideally suited for applications with higher impact and vibration stress, e.g. sprockets and gears.

(For an exact description of the products see page 08)

COLOURS

available in the following materials:
PA 6 G, Oilamid®, Lubramid® 600 T, Calaumid® 612, Calaumid® 1200,
Calaumid® 612-Fe, Calaumid® 1200-Fe, PA 6, PA 6.6, PA 12 E, POM-C, PET, PEEK

in

NATURAL

PA 6 G, Oilamid®, Lubramid® 600 T,
Calaumid® 612, Calaumid® 1200,
Calaumid® 612-Fe, Calaumid® 1200-Fe,
PA 6, PA 6.6, PA 12 E, POM-C, PET, PEEK

BLACK

PA 6 G, Oilamid®, Calaumid® 612,
Calaumid® 1200, Calaumid® 612-Fe,
Calaumid® 1200-Fe, PA 6, PA 6.6,
PA 12 E, POM-C, PET, PEEK

ANTHRACITE

PA 6 G, Oilamid®, Lubramid® 600 T

BLUE

PA 6 G

RED

PA 6 G, Oilamid®, Lubramid® 600 T

GREEN

PA 6 G, Oilamid®, Lubramid® 600 T

YELLOW

PA 6 G, Oilamid®

GREY

Lubramid® 600 T

1,04 kg/m³

13⁴⁵

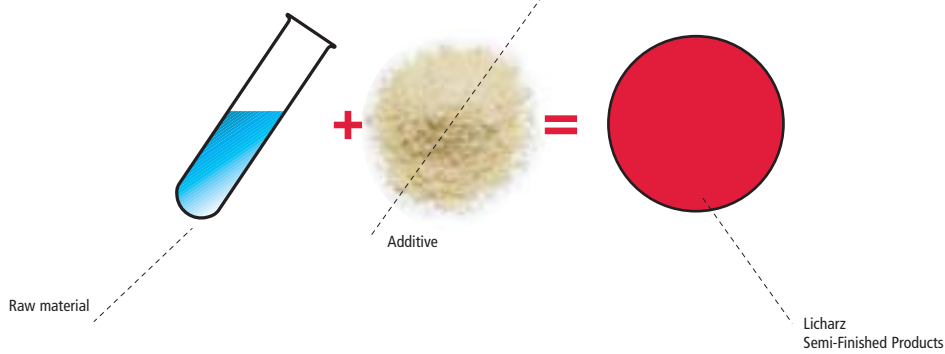
1,5 kg/m³



Whether its a
standard product or
customised production:
We simplify your
fabrication process!

0,9 kg/m

1,02 kg/m



2,08^{kg/m}

LICHARZ INDIVIDUAL AND FLEXIBLE:

We make your work easier!

You need semi-finished products with special dimensions? You need small or large quantities? You need a material which can be produced quickly and without complications? We will provide your semi-finished product exactly how you want it:

- In a wide variety and available from stock
- Custom cut to size pieces
- With customised formulae
- In various colours
- With no minimum order from stock
- Very durable
- Easily machined
- No tempering necessary
- For various application environments
(impact resistant, good sliding properties, antistatic)



LICHARZ

PERFECTLY FITTED AND PRECISE:

We bring your product to the front!

3,7^{kg/m}

The art of producing cast polyamide and semi-finished products is in the good formulae and production equipment which is perfectly matched. With our equipment we manufacture batches of very different sizes: Always quickly, accurately, cost-effectively – and with consistent quality. Our volume of engineering plastics is over 7000 tonnes a year. We are among the top manufacturers worldwide.



“
We ensure a smooth transaction process – from fast order processing to on time delivery. As a mid-sized-company we emphasise unbureaucratic processes and are whole-heartedly dedicated to you with all our heart. Our processes are certified to DIN EN ISO 9001:2000
”

3,73 kg/m

4,02 kg/m

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LICHARZ **ENGINEERING PLASTICS:**

Polyamides, POM and PET



Polyamides are subdivided into various basic types. The most important for technical applications are PA 6, PA 66, PA 6 G and PA 12 and these have established themselves as the most important representatives of the polyamide materials. Apart from the standard versions there are a large number of polyamides from which the basic types are treated with additives for the demands of special applications.

In the production of semi-finished products, a distinction is made between the manufacturing processes of extrusion and casting. The performance of extruded polyamide semi-finished products, however, has various disadvantages. The limits of manufacturing size are quickly reached. Also the properties of the extruded materials are negatively affected, since this process deforms the materials under temperature and pressure. The extrusion screw and tooling also leads to shearing stress and thus to breaks in the polymer matrix.

Polyamides manufactured in monomer casting show a higher degree of crystallinity and thus have much better material properties than the extruded types.

But apart from the type specific properties, all polyamides share, independently of their manufacturing process, a great number of basic properties specific to the material.

These are:

- High mechanical strength, hardness, stiffness and toughness
- High mechanical damping characteristics
- Good fatigue resistance
- Very high wear resistance
- Good slide and emergency running properties
- Good machining properties

Extruded polyamides

Polyamide 6 (PA 6) is the best known extruded polyamide and offers a combination of all typical polyamide material properties.

Compared to the cast varieties however, this variety displays higher water absorption, is less wear resistant and has less dimensional stability. Furthermore, because of the manufacturing process, only a limited size range and unit weight can be produced. This restricts the design possibilities of the user.

The main properties of PA 6 are:

- Good mechanical stability
- High impact resistance
- Good damping properties

Typical application examples are:

- Gears and sprockets
- Hammer heads
- Impact and shock resistant components

PA 66

Polyamide 66

PA 66 is used in smaller dimensioned applications and offers higher rigidity and wear resistance compared to PA 6. Compared to the cast varieties, this material also has higher water absorption. Regarding the other properties, PA 66 is comparable to the standard cast type PA 6 G, however it is much more costly. As in the case of PA 6, the manufacturing process limits the size and unit weight which can be produced, and this restricts the design possibilities of the user. Therefore PA 66 in practical application is replaced to a large extent by the more economical PA 6 G, which can also be produced in almost unlimited sizes.

The main properties of PA 66 are:

- Good mechanical stability
- High impact resistance
- Good damping properties
- Good wear resistance

Typical application examples are:

- Friction bearings
- Slide plates
- Gears and sprockets

PA 66 GF 30

Polyamide 66 + 30 % glass fibre

Compared to unreinforced PA 66, the combination with glass fibre produces an improved pressure and tension resistance, rigidity and dimensional stability as well as low water absorption. Glass fibre reinforced Polyamide 66 is therefore particularly suitable for components which are subjected to high stress and/or high demands on the dimensional stability.

PA 12 E

Polyamide 12 E

PA 12 E has very good impact resistance, it is tough and, because of its very low water absorption, it remains dimensionally stable. As a semi-finished product it has only a limited availability, but because of its high price (3 – 4 times more expensive than PA 6) it is usually not considered in design options.

Cast polyamides

Cast polyamide is a partially crystalline thermoplastic which is produced by means of anionic polymerisation of the raw material Caprolactam. In a pressureless casting process the liquid monomer is polymerised via a controlled chemical reaction directly to a semi-finished product. As already described, cast polyamides show a number of advantageous qualities when compared to those of extrusion manufacture.

Polyamides produced by means of this process:

- Have low internal stress
- Display a high degree of crystallinity
- Can be manufactured as semi-finished product or custom cast part
- Can be machined to almost any form
- Can be manufactured in almost unlimited weights and dimensions.

By means of additives, e. g. solid lubricants or heat stabilisers, and modifications to the polymer matrix, the typical properties of cast polyamide can be adjusted for specific applications. Thus a tailor-made material can be offered for a wide range of applications.

The material selection of cast polyamides includes the following products:

Polyamide 6 G (PA 6 G)

Standard quality for high wear demands on engineered components for machines and equipment. Colours: natural, black, black with MoS₂, anthracite with MoS₂, blue, red, green, yellow, grey

Oilamid® (PA 6 G + oil)

PA 6 G with integrated lubrication, self-lubricating effect, improved wear resistance. Colours: black, yellow, green, natural, red

Lubramid® 600 T (PA 6 G + solid lubricants)

PA 6 G with solid lubricant additives, self lubricating effect, very low friction. Colours: grey, red, green, natural

Polyamide + heat stabiliser (PA 6 G + HS)

Basically comparable with standard quality but with heat stabiliser to protect better against thermal oxidative degeneration. Colours: natural, black

Polyamide 6 G + molybdenum disulphide (PA 6 G + MoS₂)

Basically comparable to standard quality but with higher degree of crystallinity due to molybdenum disulphide additive. Colour: black with MoS₂

Calaumid® 612 (PA 6/12 G)

Polyamide mix on the basis of PA 6/12 G with greater impact resistance, less water absorption and improved creep resistance compared to pure PA 6 G. As Calaumid® 612-Fe also with steel core available (see special material description). Colours: natural, black

Calaumid® 1200 (PA 12 G)

Cast polyamide based on Laurinlactam. Very good impact resistance, toughness, excellent dimensional stability, lowest water absorption, very good creep resistance, hydrolysis resistance, good chemical resistance. PA 12 G is far superior to extruded PA 12 in every respect. Also available as Calaumid® 1200-Fe with a steel core (see separate material description). Colours: natural, black, yellow

Further special versions can be manufactured and supplied on request.

PA 6 G

Polyamide

This standard quality manufactured in monomer casting process is, due to its balanced mechanical properties and its excellent mechanical features is the ideal construction material for a wide range of applications.

Cast Polyamide 6 is superior to extruded Polyamide 6 in its:

- Better mechanical stability
- Lower water absorption
- Better creep resistance
- Better dimensional stability
- Higher wear resistance

Very good sliding properties

mean that PA 6 G is the classical slider material for highly loaded machine components. Among these are bearing bushes, slider pads, guide pads as well as gears and sprockets. Because of the low coefficient of friction only an initial lubrication is generally needed. Often lubrication can be dispensed with altogether.

High wear resistance

at low and medium speeds, in particular under rough conditions (e.g. dust or sand contamination in the bearings) are further characteristics of PA 6 G as a sliding material for bearings. Contrary to conventional bearing materials such as cast iron, steel or bronze a much longer running life can be achieved under rough conditions.

Good damping properties

for the reduction of vibration and noise, particularly in the case of wire rope and conveyor rollers are of particular interest. PA 6 G reduces vibration which is transferred from metallic rollers to shafts, bearings and machine frames. In the same way, use of friction bearings of PA 6 G allows reduction of the vibration affecting the machine frame. This way the life of machines and their parts can be extended. Furthermore a contribution is made to lowering machine noise.

Low specific weight

reduces component weight compared to that of metallic materials. This is of particular interest where parts rotate and centrifugal force is generated. This is

considerably reduced due to the lower weight, and also reduces the associated unbalances and vibrations. The greatly reduced weight often reduces even the required drive power. Furthermore, handling and assembly of large parts is made much easier.

Good machining, dimensional stability, low residual stress

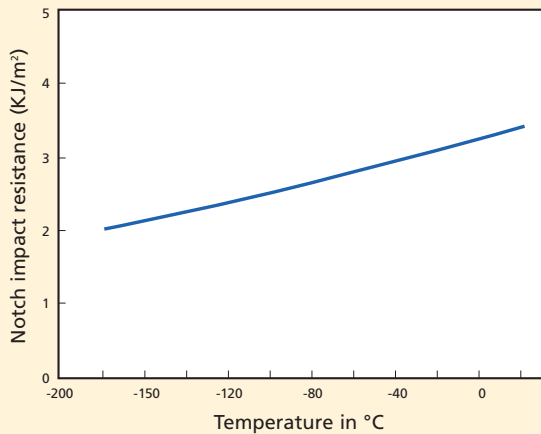
allow production of complex engineered components and application in all design areas. Machining can be performed with standard tools and conventional machines for wood and metal working. High feed and cutting speeds promote cost-effective production.

Changes in material properties

due to temperature, environmental influences and dampness must be taken into account. At increased temperatures and humidity the material becomes more elastic. Tension and pressure resistance, Young's modulus and hardness are reduced. Simultaneously impact resistance and elongation increases. The material adopts a strong elasticity. Furthermore, in case of increase in temperature or humidity, a change in length must be taken into account. The following graphs show the relations:

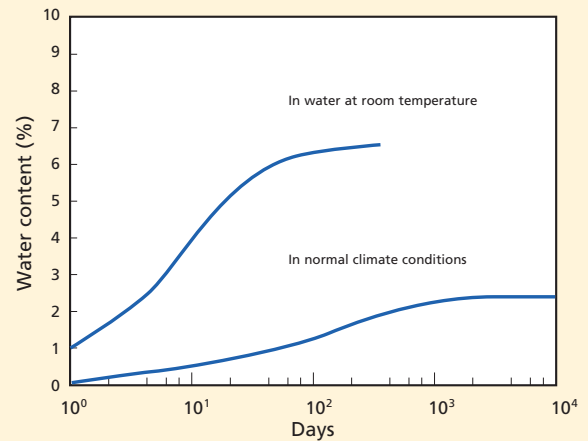
Notch impact resistance

Of polyamide 6 G at low temperatures



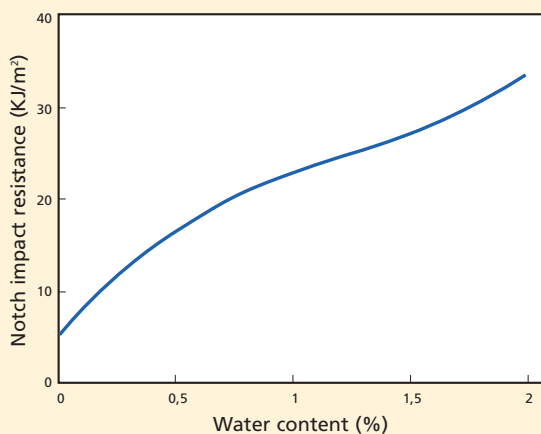
Water absorption

at room temperature and at normal climate conditions (inspection tool: norm short rod)



Notch impact resistance

Of polyamide 6 G at different water contents



PA 6 G + Oil

Oilamid®

Oilamid® is a high crystalline modification of PA 6 G, manufactured in the monomer casting process which, through the addition of oil and stabilisers, is specially designed for sliding applications. Contrary to the standard quality PA 6 G, Oilamid® features a good combination of properties.

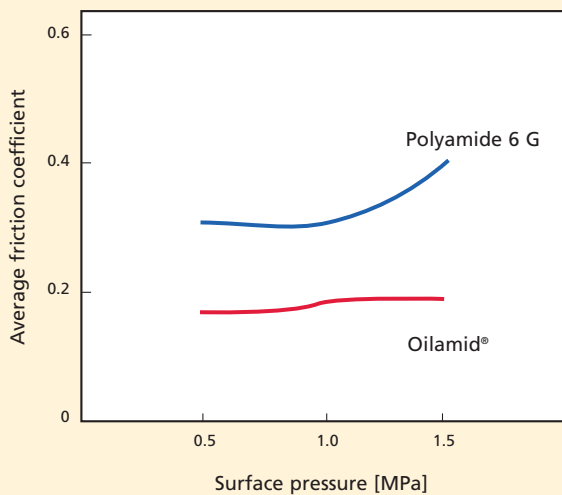
Excellent sliding properties

make Oilamid® a special friction bearing material for highly loaded slide and wear parts in machines and equipment. Due to the lubrication and additives in the material, a sustainable lubricating effect is achieved given for the whole life cycle. Compared to the standard quality, a 50 % reduction in friction is achieved, thus producing less frictional heat and considerably higher peak load capacity. Also the undesirable stick-slip tendency is reduced.



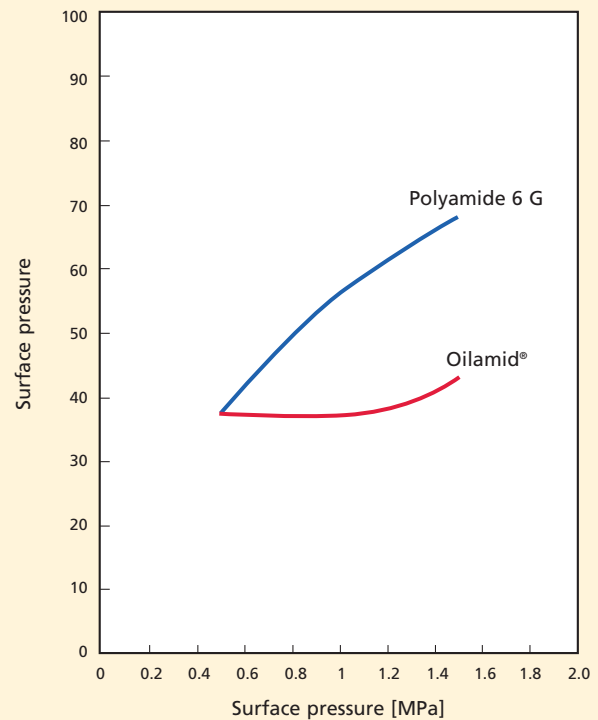
Coefficient of sliding friction of polyamide 6 G and Oilamid®

Friction ring ST 50 K ($v = 1\text{m/s}$)



Surface temperature after 1 hour

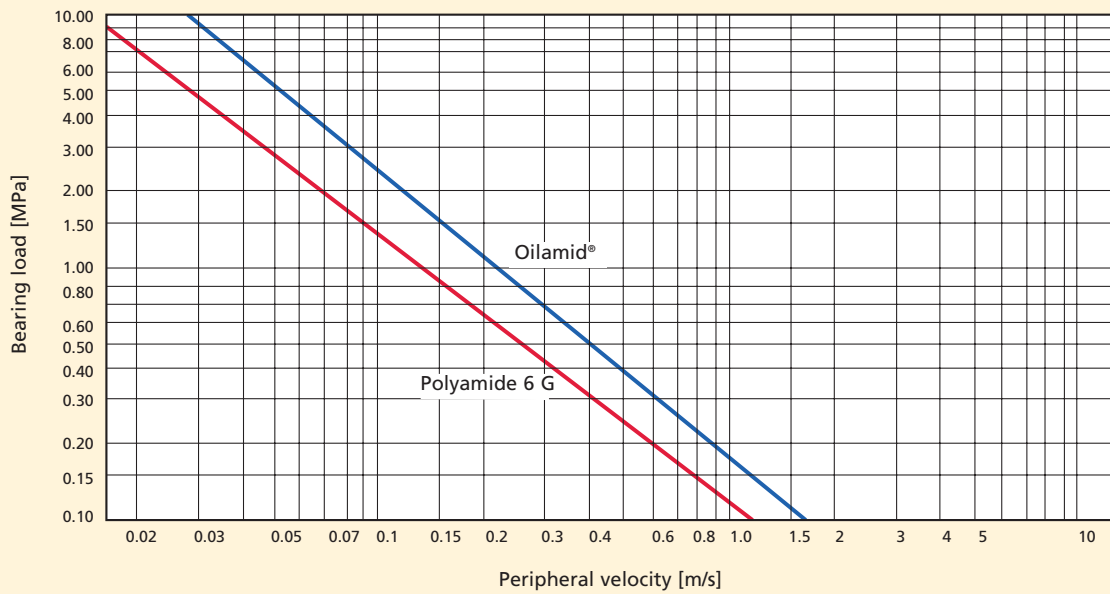
Sliding friction of polyamide 6 G and Oilamid® friction ring ST 50 K ($v = 1\text{m/s}$)



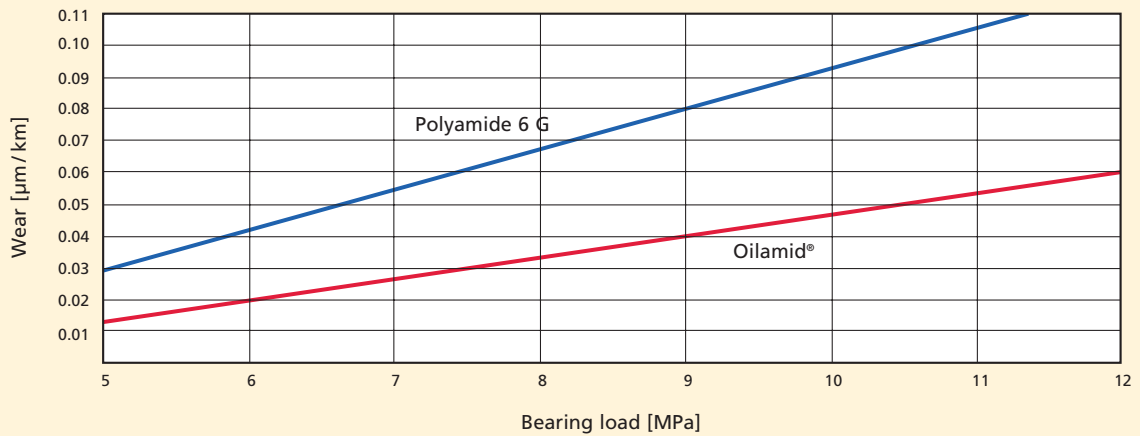
Extraordinary wear resistance

Is achieved by the fine crystal microstructure of Oilamid® generated by the additives. Compared with standard quality, the reduced frictional heat as well as the reduced friction coefficient makes application possible at higher speeds and surface pressures. This applies not only for dry running but also for running under emergency conditions.

Load limit of Oilamid®/PA 6 G

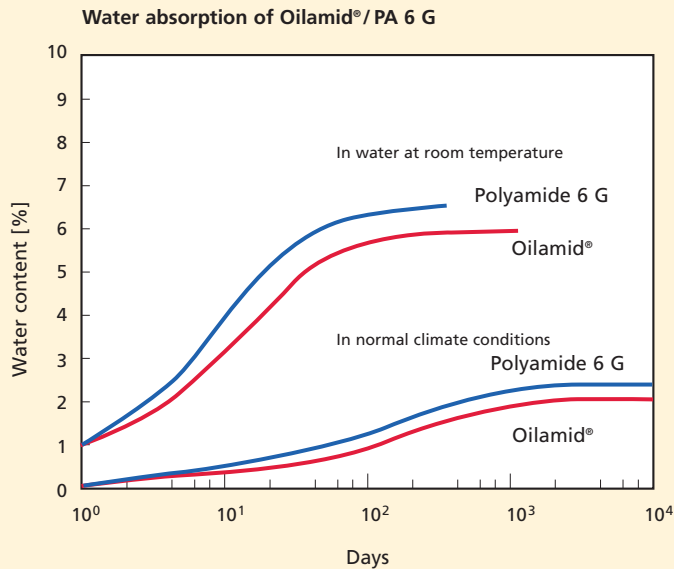


Wear rate of Oilamid®/PA 6 G



Lower moisture absorption and dimensional stability

are the result of the high crystalline molecular structure and the special additives. The low moisture absorption leads better dimensional stability and less of a reduction in the mechanical values due to moisture.



Applications and examples

The main applications of Oilamid® are in conveyor and transport technology as well as in machine engineering, plant construction and the automotive industry. Particularly in filling, labelling and packaging machines, Oilamid® components are used to advantage.

Typical applications are:

- Bearings
- Guide rails
- Sprockets and chain guides
- Slide rails
- Feeder wheels
- Actuators
- Curve guides
- Gears

Sliding specialist

Lubramid® 600 T is the latest self-lubricating polyamide material from the Licharz line of bearing materials. Lubramid® 600 T is a cast polyamide with special additives and solid lubricants. The carefully selected integrated additives with focus on sliding properties. Their balanced combination allows for a friction coefficient of 0.15 μ which is extraordinarily low. Furthermore, the tendency for stick-slip is reliably reduced to a minimum.

Lifetime self-lubrication

The homogenous distribution of additives and lubricants and the complete saturation of the basic product with lubricant offer unique benefits compared to traditional bearing materials. They ensure that self-lubricating effects and sliding properties are maintained at a constant and stable level from the first moment of operation to the last. Lubricant which is forced out of the bearing area during operation can be replaced by fresh lubricant released from the material. Additionally, the base material PA 6 G guarantees excellent wear resistance and ensures the usual good and uncomplicated machining of the material.

Versatile in application

The properties combined in Lubramid® 600 T make this material the first choice in situations where it is difficult, impossible or undesirable to lubricate structural components. In addition, it is also always a good choice in situations where a combination of the sliding properties of PE 1000, good wear resistance and high mechanical stability are required. Furthermore, components which are subject to sliding and wear which have traditionally been manufactured from standard cast polyamide can also be made from Lubramid® 600 T. This prolongs the life of the components, decreases wear and thus lowers costs. Lubramid® 600 T can also be made FDA compliant.

Areas of application for Lubramid® 600 T are in machine and plant construction, drive and conveyor technology.

Typical applications of Lubramid® 600 T:

- curve guides
 - slider pads, strips, sheets
 - guide pads and strips
 - castors
 - gears, gear racks and sprockets
 - spindle nuts for threaded spindles
 - telescopic guides
- and other components.

This material is an alternative to the slide bearing materials used up to now for other applications where excellent slide and low-frictional behaviour is of the utmost importance.

PA 6/12 G and PA 12 G

Calaumid® 612 and Calaumid® 1200

Calaumid® 612 (PA 6/12 G) is a co-polyamide manufactured by static casting from the raw materials Caprolactam and Laurinlactam. Compared to pure PA 6 G, shock and impact resistance are higher in Calaumid® 612, moisture absorption is lower, creep resistance is better and elasticity is improved. Because of these material properties, Calaumid® 612 is especially suitable for use in areas where increased shock loads and vibration are expected or where higher fatigue resistance and elasticity are required. This is achieved through its tensile strength, making it an ideal design material.

Typical applications are:

- Gears
- Toothed racks
- Pinions
- Rollers with long idle times
- Crane support pads

Calaumid® 1200 (PA 12 G) is manufactured from the raw material Laurinlactam on the basis of anionic reaction in a pressureless monomer casting process. The process generates a high molecular highly crystalline material, largely stress-free, meaning that Calaumid® 1200 displays exceptional characteristics compared to other polyamides.

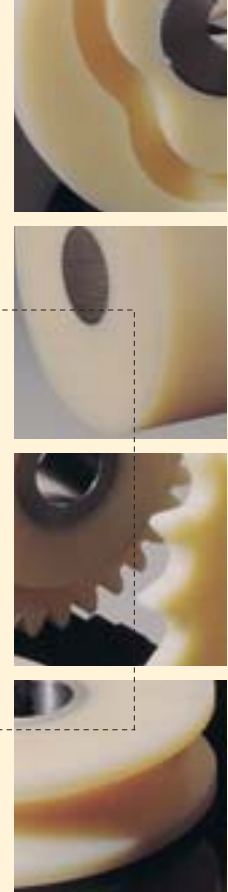
The main advantages of Calaumid® 1200:

- Extremely low water absorption
(max. 0.9 % in normal climate conditions 25/50)
- Extremely dimensionally stable
- Stable mechanical values
- Excellent damping behaviour in mechanical vibrations
- Great durability even at temperatures to – 50 °C
- Very good wear resistance
- Very good slide and emergency running properties
- Low specific weight
- Good chemical and hydrolysis resistance
- Not susceptible to tension cracks

The combination of these properties makes Calaumid® 1200 the ideal partner for applications in conveyor and drive technology.

Material characteristics

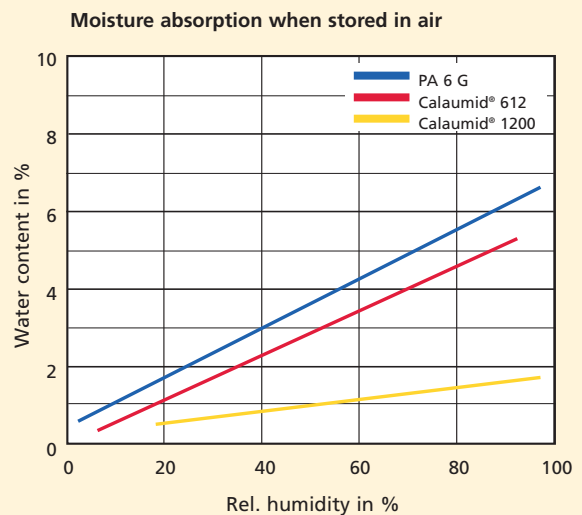
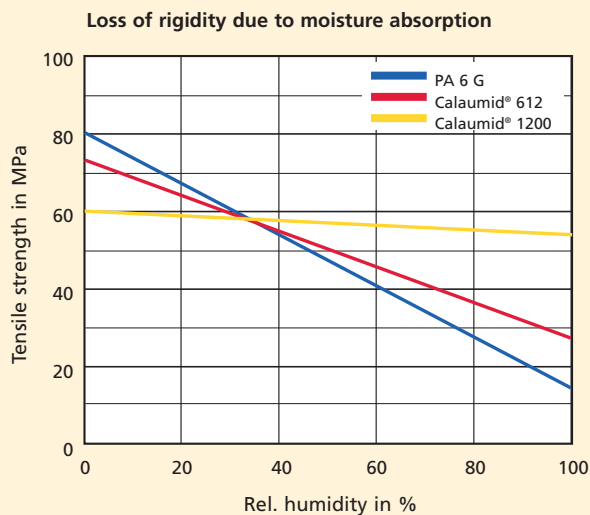
Due to the highly crystalline molecular structure, material properties are created which are far superior to those of conventional polyamides in many ways. The properties typical for polyamides and appreciated by users are thus mostly retained, e.g. wear resistance / abrasion resistance and the good sliding properties, and are further supported by the special molecular structure.

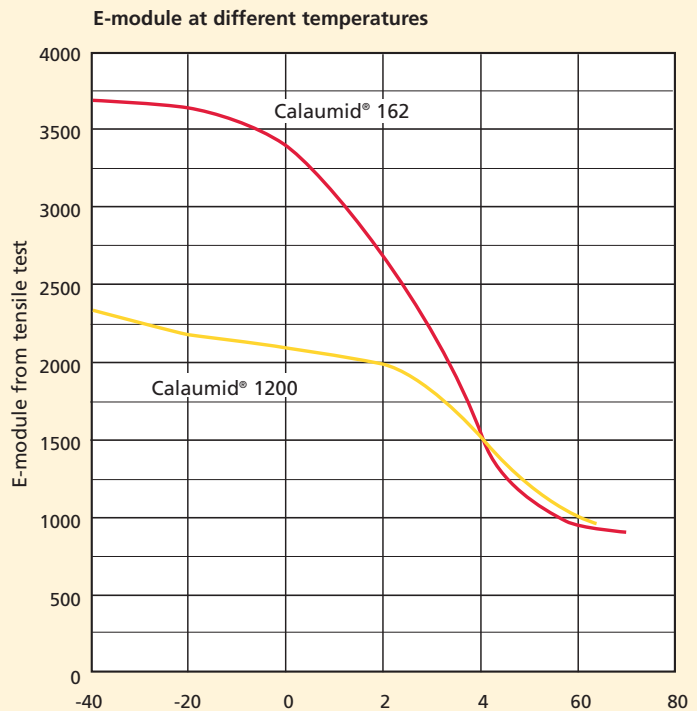


The main difference to the conventional polyamides is considered to be the material characteristics of tough yet hard. The Calaumid® materials exhibit a hardness which is essential for many technical applications, without becoming brittle and breakable. At the same time a high degree of toughness is assured.

A further important feature is the low tendency to absorb moisture from the ambient air. Swelling which is common to polyamides due to moisture from the environment is minimised, and the dimensional stability of engineered parts is considerably improved. Where Calaumid® 1200 is used, dimensional changes due to moisture absorption can even be ignored, since in normal climate conditions 23/50 it absorbs a maximum of 0.9 % moisture and only 1.5 % to saturation in water. It is also used in many technical applications where hardness is a priority without becoming brittle and prone to breakage. At the same time a high toughness is assured. Furthermore the loss of rigidity due to moisture absorption is insignificant. Thus Calaumid® 1200 is eminently suitable for engineered components for which the special properties of polyamide are essential and long term stability is required.

Both materials also feature improved creep resistance, higher elasticity and very good wear resistance. Furthermore their excellent mechanical damping qualities and high degree of toughness even at low temperatures are impressive.





PA 6/12 G-FE and PA 12 G-FE

Calaumid® 612-Fe and Calaumid® 1200-Fe

Drive elements often transmit high torque, and to generate this high power, loads must be transmitted to the elements via the shaft-hub connection. In principle engineering plastics are suitable for these purposes. However, pure plastic designs often reach their limits in such cases. The allowable surface pressure in the keyway is often exceeded or the hubs become distorted under the high load. Furthermore, plastics are liable to notching, so that in extreme situations there is a danger that the groove in the side under load will give way. Further problems often arise when demands are made on tolerances which are not possible with plastic designs.

This is where the material varieties of Calaumid®-Fe, which have been developed for just these applications, come into use. The combination of Calaumid® with a metal core combines the advantages and specific properties of both materials in an unusual design material. The knurled metal core is completely covered with a low viscosity melt generated in the monomer casting process. After casting, the polymer cools down and shrinks onto the metal core. Between the core and the mantle, a powerful bond exists which assures optimal and dependable transmission of power.

Due to the surface structure of the metal core, a safeguard against radial and lateral slip is assured. The mantle consists of Calaumid® 612 or Calaumid® 1200, whichever is preferred.

Typical applications of Calaumid®-Fe are:

- Gears (spur gears, worm gears, bevel gears)
- Sprockets
- Castors, guide rollers and sheaves
- Cams
- Agitator blades
- Pump impellers

Further advantages of Calaumid®-Fe:

- Combined power plastic/metal combination
- Optimal power and torque transmission
- Reliable transmission of high axle power and torque
- Calculation and manufacture of the shaft/hub connection with traditional processes and tolerances for metal
- Lower momentum mass compared to purely steel constructions
- Higher degree of true running

Practice has shown that with this surface characteristic, power and torque transmission with plastic is successful and sufficiently high power/torque values can be transmitted. Practical results are also supported by the compression and torsion tests shown in fig. 1 and 2.

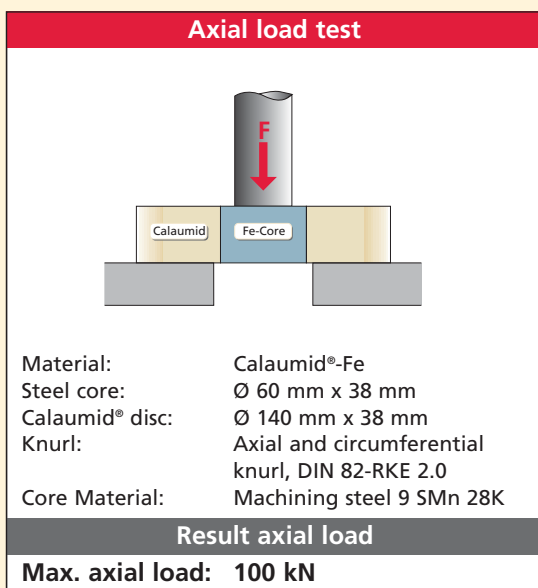


Fig. 1 Compression test

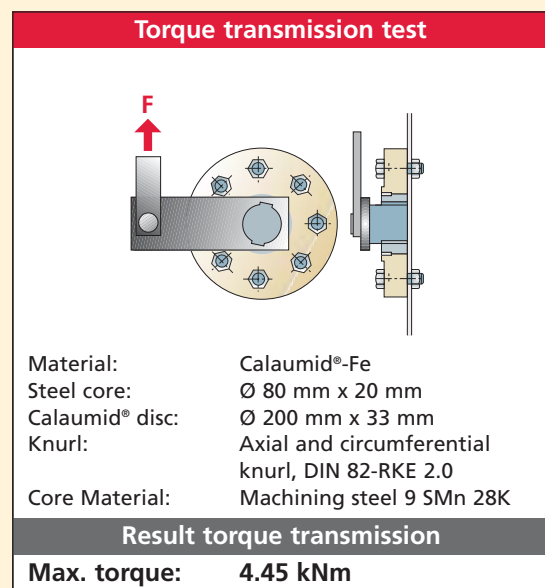


Fig. 2 Torsion test

Calauamid®-Fe is equipped standard with machining steel 9 SMn 28 K as core material.

The following are also possible as core materials:

- Stainless steel [V2A (1.4305), V4A (1.457 1)]
- Aluminium
- Brass

Other core materials are possible on request.

POM

Polyacetal

Polyacetal is a high crystalline thermoplastic with a high level of stability and rigidity as well as good sliding properties and wear resistance with a low level of moisture absorption. Its good dimensional stability, exceptional fatigue resistance and excellent machining properties make Polyacetal a versatile design material also for complex components. It satisfies high surface finish requirements.

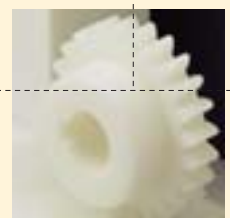
There is a difference between homopolymers (POM-H) and copolymers (POM-C), whereby the homopolymers have a somewhat higher degree of density, hardness and stability. Copolymers, however, have a higher impact toughness, greater wear resistance and thermal / chemical resistance.

The Polyacetal semi-finished products that we offer – from which we also manufacture finished products – are produced from POM-C in an extrusion process.

Main properties

- High stability
- High rigidity
- High hardness
- Good impact resistance, also at low temperatures
- Low level of moisture absorption (at saturation 0.8 %)
- Good creep resistance
- High dimensional stability
- Physiologically safe

Colours: natural, black



Sliding properties

POM-C has excellent sliding properties and good wear resistance. Together with its other outstanding properties, POM-C is well suited for sliding applications with medium to high loads. This also applies to applications where high levels of humidity or wetness are to be expected.

Because of the close static and dynamic coefficients of friction, low start-up moments can be implemented.

This does not apply to the types filled with glass, as their sliding properties are much worse than the unfilled types.

Weathering effects

POM-C is not resistant to UV rays. UV rays, in combination with atmospheric oxygen, oxidise the surface, and discolouration occurs or the surface becomes matte. If the material is subject to the effects of UV rays for a long time, it tends to become brittle.

Chemical resistance

POM is resistant to weak acids, weak and strong alkaline solutions, organic solvents such as petrol, benzene, oils and alcohols.

POM-C is not resistant to strong acids (pH < 4) or oxidising materials.

Behaviour in fire

POM-C is rated as normal flammable. When the source of ignition is removed, POM-C continues to burn, forming droplets. During thermal decomposition, formaldehyde can form. The oxygen index (= the oxygen concentration required for combustion) at 15 % is very low compared to other plastics.

Areas of Use

- General machine engineering
- Vehicle construction
- Precision mechanics
- Electrical industry
- Information technology

Applications

- Spring elements
- Bushes
- Gears
- Sliding elements
- Insulators
- Pump components
- Casing parts
- Valves and valve bodies
- Counter parts
- Precision parts

Machining

POM-C develops a fragmented chip and is thus ideally suited for machining on automatic lathes, but it is also possible to machine it on cutting machine tools. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut threads or insert threaded parts in the material. Generally no cooling or lubricating emulsion is necessary.

To limit material deformation due to internal residual stress in semi-finished products, the parts should always be machined from the geometrical centre of the semi-finished product, removing an even quantity of material from all sides.

If maximum dimensional stability is demanded from the finished components, the parts to be manufactured should be rough machined and stored for an interim period or heat treated. The parts can then be completed. More detailed information on interim storage and heat treatment, as well as other information about machining, is provided in the chapter on "Machining guidelines" in our range of products.

PET

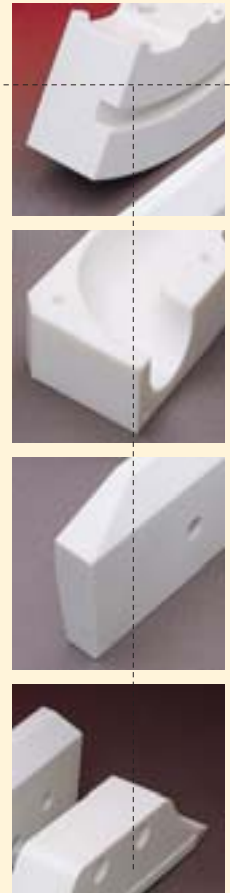
Polyethyleneterephthalate

The molecular structure of polyethyleneterephthalate can be produced either as an amorphous or semi-crystalline thermoplastic. The amorphous type is crystal clear with lower mechanical stability and inferior sliding properties.

The semi-crystalline types, on the other hand, have a high level of hardness, rigidity and stability with excellent sliding properties and low sliding abrasion. Because of its good creep resistance, low level of moisture absorption and excellent dimensional stability, the material is ideally suited for complex parts with the highest demands on dimensional stability and surface finish. For the reasons mentioned above, only the semi-crystalline type is suitable for sliding applications.

The wear resistance and sliding properties of PET-GL have been improved compared to pure PET by adding a special, homogeneously distributed solid lubricating agent.

The polyethylene terephthalate semi-finished products that we offer – and from which we also manufacture all finished products – are manufactured from semi-crystalline types in an extrusion process.



Polyethylene terephthalate

- High stability
- High rigidity
- High hardness
- Low moisture absorption (at saturation 0.5 %)
- Very good creep resistance
- Very high dimensional stability
- Constantly low sliding friction
- Very little sliding abrasion
- Physiologically safe

Colours

PET: natural, black

PET-GL: light grey

Sliding properties

PET has excellent sliding properties, very good wear resistance and, in combination with its other properties, is an excellent material for highly loaded sliding applications. This also applies to applications where high levels of humidity or wetness are expected.

The modified type PET-GL is especially suitable for highly loaded sliding applications in dry running operations due to its integrated solid lubricating agent. The solid lubricating agent "self lubricates" the PET-GL, which gives it excellent sliding properties and highest wear resistance with a much higher load-bearing strength (pv limiting value) compared to pure PET. It also prevents the stick-slip effect. The other properties are equal to those of pure PET.

Weathering effects

PET is not resistant to UV rays. The material surface changes when subjected to UV rays in combination with atmospheric oxygen. If the material is to be subjected to UV rays for longer periods, a black coloured type is recommended.

Chemical resistance

PET is resistant to weak acids and alkaline solutions, salt solutions, perchlorinated and fluorinated hydrocarbons, oils, fuels, solvents and surface-active substances. Strong polar solvents have an irreversible swelling effect. PET is not resistant to strong acids or alkaline solutions, esters, ketones or chlorinated hydrocarbons.

Behaviour in fire

PET is rated as normal flammable. When the source of ignition is removed, PET continues to burn, forming droplets. The oxygen index (the oxygen concentration required for combustion) at 23 % is average compared to other plastics.

Areas of use

- General machine engineering
- Vehicle construction
- Precision mechanics
- Electrical industry
- Information technology

Applications

- Ratchet wheels
- Bushes
- Gearwheels
- Sliding elements
- Insulators
- Casing parts
- Counter components
- Precision bearings
- Cam disks

Machining

PET develops a brittle, flowing chip and is suitable for machining on automatic lathes, but it can also be machined on cutting machine tools. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut a thread into the material or insert a threaded element. Generally no cooling or lubricating emulsion is necessary.



LICHARZ STANDARD PLASTICS:

PE, PP, PVC and PC

PE

Polyethylene

Polyethylene is a semi-crystalline thermoplastic with high toughness and chemical resistance, low mechanical strength in comparison to other plastics and cannot be used at high temperatures. The individual polyethylenes differ in regard to their molar mass (molecular weight), which is important for the respective physical properties. This means that in addition to the common properties that all types have, certain ones have type-specific properties.

The polyethylene semi-finished products that we offer – from which we also manufacture finished products – consist of high density polyethylene types produced by extrusion or moulding processes.

Main properties

- Low density compared to other materials (0.94 g/cm³)
- High impact resistance, also at low temperatures
- Minimum water absorption (< 0.01 %)
- Excellent chemical resistance
- High corrosion resistance
- Anti-adhesive
- Very good electrical insulator
- High vibration absorption
- Physiologically safe (does not apply to reprocessed semi-finished products)

Sliding properties

PE-HD (PE 300; molar mass approx. 200,000 g/mol) is very suitable for welding due to its relatively low molar mass; however, it is not abrasion resistant and has low stability values. This leads to a high level of sliding abrasion, which excludes its use in sliding applications.

PE-HMW (PE 500; molar mass approx. 500,000 g/mol) has better sliding properties because of its higher molar mass and is also more abrasion resistant than PE-HD. In combination with its good toughness, it is suitable for use in low stress components that are not subject to any high degree of sliding abrasion.

PE-UHMW (PE 1000; molar mass approx. 4,500,000 g/mol). Because of its high molar mass it has very good wear resistance, bending strength and impact resistance and good noise absorption. Due to its excellent sliding properties and low sliding abrasion, it is the ideal material for lightly loaded components.

Both PE-HMW and PE-UHMW are also available as reprocessed materials, although it must be noted that the respective physical properties are slightly reduced.

Chemical resistance

All PE types are resistant to acids, alkaline solutions, salts and salt solutions, alcohols, oils, fats, waxes and many solvents. Aromatics and halogenated hydrocarbons cause swelling. All PE types are not resistant to strong oxidising materials (e.g. nitric acid, chromic acid or halogens), and there is a danger of stress corrosion cracking.

Machining

In addition to the good welding properties of PE-HD and PE-HMW, all PE types can also be machined. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut a thread into the material or insert a threaded element. As a rule, no cooling or lubricating emulsion is necessary.

Polypropylene is a semi-crystalline thermoplastic with high rigidity and very good chemical resistance. Characteristic for polypropylene is a CH₃ side-group in the monomer structural unit, which can be aligned in various spatial positions during polymerisation.

Main properties

- Low density compared to other materials (0,91 g/cm³)
- Minimum water absorption (< 0.01 %)
- Excellent chemical resistance, also to solvents
- High corrosion resistance
- Relatively high surface hardness
- Very good electrical insulator
- Physiologically safe

Sliding properties

PP-H is subject to strong sliding abrasion and is thus not suitable for use in sliding applications.

Chemical resistance

PP-H is resistant to acids, alkaline solutions, salts and salt solutions, alcohols, oils, fats, waxes and many solvents. Aromatics and halogenated hydrocarbons cause swelling. PP-H is not resistant to strong oxidising materials (e.g. nitric acid, chromic acid or halogens) and there is a danger of stress corrosion cracking.

Machining

In addition to its good welding properties, PP-H can also be machined. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut a thread into the material or insert a threaded element. Generally no cooling or lubricating emulsion is necessary.

PVC

Polyvinylchloride

Polyvinylchloride – hard (PVC-U) is an amorphous thermoplastic with no added plasticiser. It has a high hardness and rigidity. According to DIN 16 927 the material is classified as normal shock resistant, however its toughness values border on being rated as highly shock resistant, which gives it a high degree of safety in regard to the design of components. The polyvinylchloride semi-finished products that we offer – from which we also manufacture finished products – are produced in extrusion or press processes.

Main properties

- Hard surface
- High rigidity
- Low water absorption
- Excellent chemical resistance
- Fire resistant (UL 94 V 0)
- Easily thermoformed
- Can be bonded
- Good cutting properties

Sliding properties

PVC-U is not subject to any major sliding abrasion and is thus suitable for use in sliding applications.

Chemical stability

PVC-U is resistant to acids, alkalis, alcohols, oils, greases, aliphatic carbohydrates and petrol. PVC-U is not resistant to benzole, chlorinated carbohydrates, ketones and esters. Tension cracks can arise from contact with strongly oxidising agents (e.g. nitric acid or chromic acid).

Machining

In addition to its good welding properties and the possibility of bonded connections, PVC-U can also be machined. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut a thread into the material or insert a threaded element. Cooling or lubricating emulsion and cutting oils are not recommended as the additives in it can lead to tension cracks. However cooling, as a rule, is not necessary. If cooling is required, however, water or oil-free compressed air should be used.

Polycarbonate is an amorphous, thermoplastic with high mechanical strength and rigidity as well as good creep qualities. The material is, by virtue of its amorphous molecular structure, translucent and transparent. Particular features are the excellent impact resistance over a large range of temperatures which remain constant even at low temperatures. The combination of impact resistance and transparency make polycarbonate the ideal material for armoured windows, outer casings and safety glass for machines and the building trade. Special types are available for glazing where impact resistance remains almost unchanged for years despite weather conditions. These modified types are considered practically indestructible. The polycarbonate semi-finished products we offer, from which we also manufacture finished products, are produced in an extrusion process.

Main properties

- Excellent transparency
- High toughness even at low temperatures
- High dimensional stability
- Good electrical insulator
- High stiffness
- High creep resistance over a high range of temperatures
- Applicable over a vast temperature range (- 100 to + 120 °C)
- Physiologically safe
- Good welding and bonding properties

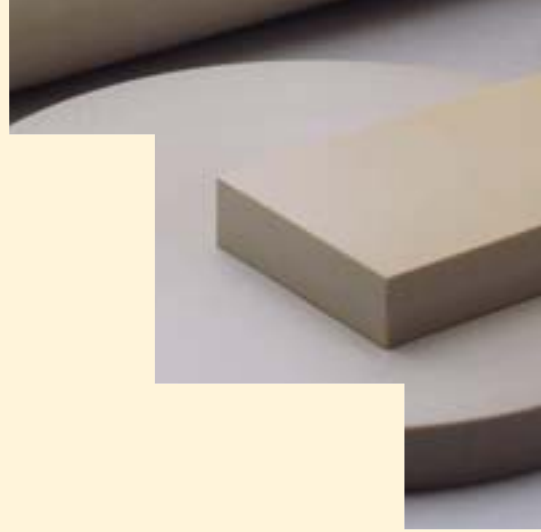
Chemical stability

PC is resistant to mineral oils, weak and dilute acids and aliphatic carbohydrates. It is unstable towards strong acids and alkalis, chlorinated and aromatic carbohydrates as well as solvents. It is also not resistant to hydrolysis.

Machining

In addition to its good welding properties and bonding ability, PC can be machined without problem. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It can also be tapped or receive threaded inserts. Use of cooling-lubricating emulsions and cutting oils are not recommended as the additives here can cause tension cracks to form. Cooling, however, generally not necessary. If cooling is required, use of water or oil-free compressed air is recommended.

Semi-finished products of PC can be reshaped by various means. For example machine covers can be given the required form by bending or bevelling (either cold or warm). Light domes, bowl shapes or similar components can be manufactured by vacuum forming, positive forming or pressure forming.



LICHARZ
HIGH-TEMPERATURE PLASTICS:

PVDF, PTFE and PEEK



Polyvinylidenefluoride is a high crystalline thermoplastic with good mechanical, thermal and electrical properties. As a fluoroplastic, Polyvinylidenefluoride has excellent chemical resistance without the disadvantages of low mechanical values and difficult workability of other fluoroplastics. Our polyvinylidene semi-finished products – from which we also manufacture all finished products – are manufactured in extrusion or press processes.

Main properties

- Low density in comparison to other fluoroplastics
- Good mechanical stability compared to other fluoroplastics
- Can be used continuously at high temperatures (+ 140 °C in air)
- Absorbs practically no water
- Good dimensional stability
- High chemical resistance
- Good hydrolytic stability
- Weather resistant
- Radiation resistant
- Good electric insulator
- Fire resistant (UL 94 V 0)
- Physiologically safe
- High abrasion resistance

Chemical resistance

PVDF is resistant to acids and alkaline solutions, salts and salt solutions, aliphatic and aromatic hydrocarbons, alcohols and aromatics. PVDF is not resistant to ketones, amines, fuming sulphuric acid, nitric acid or to several hot alkalis (concentration related). Dimethyl formamide and dimethyl acetamide dissolve PVDF.

Machining

In addition to its good welding suitability, PVDF can also be machined on machine tools. With the respective surface treatment, PVDF can be bonded with a special solvent adhesive. Fluoropolymers decompose at temperatures above approx. 360 °C and form highly aggressive and toxic hydrofluoric acid. As polymer dust can form when the material is being machined, smoking should not be permitted at the workplace.

PTFE

Polytetrafluorethylene

Polytetrafluorethylene is a high crystalline thermoplastic with excellent sliding properties, anti-adhesive surfaces, excellent insulation properties, an almost universal chemical resistance and an exceptionally broad temperature deployment spectrum. However, this is offset by low mechanical strength and a high specific weight compared to other plastics. The polytetrafluorethylene semi-finished products that we offer – from which we also manufacture all finished parts – are produced in pressure sintering and ram extrusion processes, films are produced in a skiving process.

Main properties

- Excellent sliding properties
- Highest chemical resistance, also to solvents
- Resistant to hydrolysis
- High corrosion resistance
- Broad temperature deployment spectrum
- Resistant to weathering
- No moisture absorption
- Physiologically harmless
- Good electrical insulator
- Good thermal insulator
- Anti-adhesive
- Non-flammable

Sliding properties

PTFE has excellent sliding properties, and because of its very close static and dynamic abrasion values, it prevents the stick-slip effect. However, due to its low mechanical strength, PTFE has high sliding abrasion and a tendency to creep (cold flow). Hence, unfilled PTFE is only suitable for sliding applications with low mechanical load. Its load bearing capacity can be mechanically improved by embedding the sliding element in a chamber. It must be ensured that the chamber is fully enclosed so that the part cannot escape ("flow out").

Chemical resistance

Unfilled PTFE is resistant to almost all media apart from elementary fluorine, chlortrifluoride and molten or dissolved alkaline metals. Hologenated carbohydrates cause a slight, reversible swelling. In the case of filled PTFE a lowering of chemical resistance can be encountered, whereby it is not the PTFE but rather the filling material that forms the reaction partner to the medium

Machining

PTFE is difficult to weld and then only by using an involved, special process. It can be machined. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut a thread into the material or insert a threaded element. PTFE can also be bonded when the surface has been suitably treated by etching with special etching fluid.

Up to approx. 19 °C, PTFE is subject to a phase transition which is normally accompanied by an increase in volume of at 1.2 %. This means that finished parts that are dimensionally stable at 23 °C can show considerable dimensional

deviations at temperatures below 19 °C. This must be taken into consideration in the design and dimensioning of PTFE components. When the material is being machined, attention must be paid so that good heat dissipation is guaranteed for parts with minimum tolerances, otherwise the good insulation properties can lead to dimensional deviations in finished parts after cooling because of the heat build-up and thermal expansion.

Fluoropolymers decompose above approx. 360 °C forming highly aggressive and toxic hydrofluoric acid. As polymer dust can form when the material is being machined, smoking should not be permitted at the workplace.

PEEK

Polyetheretherketone

Polyetheretherketone is a semi-crystalline thermoplastic with excellent sliding properties, very good mechanical properties, even under thermal load and has excellent resistance to chemicals. The high continuous working temperature rounds out the profile of this high-performance plastic and makes it a virtually universally useable design material for highly stressed parts. The polyetheretherketone semi-finished products that we offer – from which we also manufacture finished parts – are produced in extrusion or press processes.

Main properties

- High continuous working temperature (+ 250 °C in air)
- High mechanical strength
- High rigidity
- High creep resistance, also at high temperatures
- Good sliding properties
- High wear resistance
- High dimensional stability
- Excellent chemical resistance
- Hydrolysis resistant
- Good electrical insulator
- Radiation resistant
- Physiologically safe
- Fire resistant (UL 94 V 0)

Colours: natural (similar to RAL 7032), black

Sliding properties

PEEK combines ideal sliding properties with high mechanical strength and heat stability as well as superb chemical stability. It is therefore particularly suited to sliding functions. For construction parts particularly subject to high friction loads and wear, there is a version modified with carbon fibre, PTFE and graphite available, which gives highest resistance to wear, low friction values and high pv limit values.

Resistance to weathering

PEEK is resistant to X rays, β -rays and γ -rays. Hence PEEK is ideal for use in the pharmaceutical and nuclear industries. PEEK is not resistant to UV rays in combination with atmospheric oxygen.

Chemical resistance

PEEK is resistant to non-oxidising acids, concentrated alkaline solutions, salt solutions, cleaning agents and paraffin oils. It is not resistant to oxidising agents such as concentrated sulphuric acid, nitric acid or hydrogen fluoride.

Behaviour in fire

PEEK is rated fire resistant in the highest category. When the source of ignition is removed PEEK is self-extinguishing. The oxygen index (the oxygen concentration required for combustion) is 35 %.

Areas of use

- Chemical and petrochemical industries
- Pharmaceutical industry
- Food industry
- Nuclear industry
- Aerospace industry
- Defence technology

Applications

- Gears
- Friction bearings
- Spools
- Fittings (e.g. housings for hot water meters)
- Valves
- Piston rings
- Parts for car engines (e.g. bearing cages)

Machining

In addition to its good welding and bonding properties PEEK can be easily machined. The semi-finished products can be drilled, milled, sawed, planed and turned on a lathe. It is also possible to cut a thread into the material or insert a threaded element. Generally no cooling or lubricating emulsion is necessary.

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