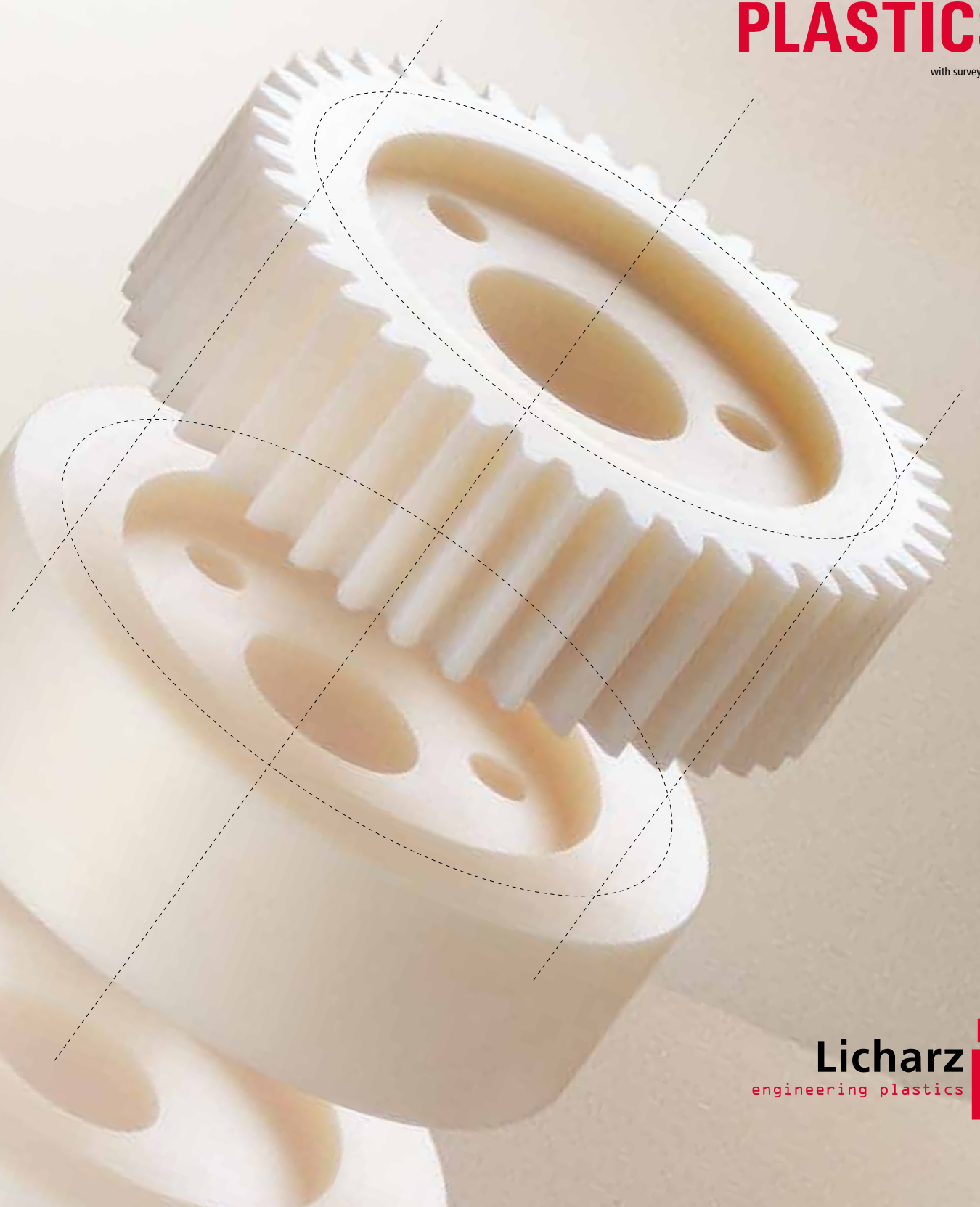
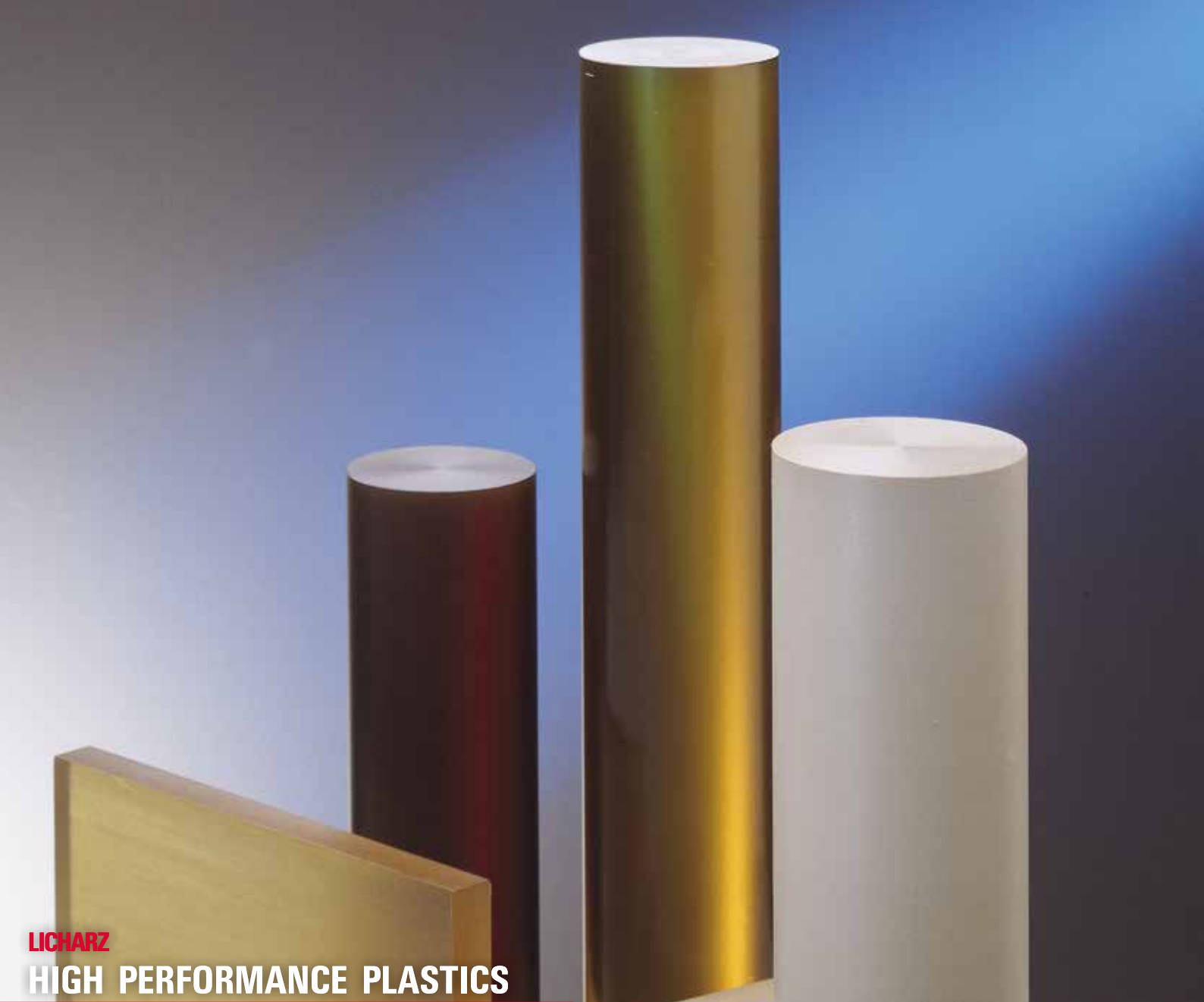


DESIGNING WITH ENGINEERING

# PLASTICS

with survey tables





**LICHARZ**

## **HIGH PERFORMANCE PLASTICS**

*The competitive edge through engineered components made of plastic*

Polyvinylidene fluoride is a high crystalline thermoplastic with good mechanical, thermal and electrical properties. As a fluoroplastic, polyvinylidene fluoride has excellent chemical resistance without the disadvantages of low mechanical values and difficult workability of other fluoroplastics. The polyvinylidene fluoride finished products that we offer consist of high density polyvinylidene fluoride types produced by extrusion or moulding 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

## Colours

natural (white to ivory)

## Sliding properties

PVDF has good sliding properties, is resistant to wear and is very suitable for chemically stressed sliding applications that are also subjected to thermal influences. However, in component design, the relatively high coefficient of thermal expansion should be considered.

## Resistance to radiation/Weathering effects

PVDF is resistant to both  $\beta$ -rays and  $\gamma$ -rays as well as UV rays in connection with atmospheric oxygen. Hence PVDF is ideal for use in the pharmaceutical and nuclear industries and under weathering effects.

## 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.

## Behaviour in fire

Even without additives, PVDF is rated in the highest category as fire resistant. When the source of ignition is removed, PVDF extinguishes itself. At 78%, the oxygen index (= the concentration of oxygen required for combustion) is very high compared to other plastics.

## Areas of use

- Chemical and petrochemical industries
- Pharmaceutical industry
- Textile industry
- Paper industry
- Food industry

## Applications

- Pump parts
- Fittings and fitting components
- Valves and valve components
- Seals
- Friction bearings
- Component parts in plant/apparatus engineering

## 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 degrade 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.

# Polytetrafluoroethylene (PTFE)

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Polytetrafluoroethylene 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. To improve the mechanical properties, polytetrafluoroethylene is compounded with fillers such as glass fibre, carbon or bronze. The polytetrafluoroethylene finished products that we offer consist of high density polytetrafluoroethylene types produced by extrusion or moulding processes.

## Main properties

- Excellent sliding properties
- Highest chemical resistance, also to solvents (limited with PTFE + bronze)
- Resistant to hydrolysis (limited with PTFE + bronze)
- High corrosion resistance (limited with PTFE + bronze)
- Broad temperature deployment spectrum (-200 °C to +260 °C)
- Resistant to weathering
- Does not absorb moisture
- Physiologically safe (not PTFE + carbon/ + bronze)
- Good electrical insulator (not PTFE + carbon/+ bronze)
- Good thermal insulator (not PTFE + carbon/+ bronze)
- Anti-adhesive
- Virtually unwettable with liquids
- Fire resistant

## Colours

PTFE pure: white

PTFE + glass: light grey

PTFE + carbon: black

PTFE + bronze: brown

## 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 constructively improved by equipping the sliding element with several chambers. It must be ensured that the chamber is fully enclosed so that the slip lining cannot escape ("flow out").

**PTFE + glass** has worse sliding properties than pure PTFE due to the filler, but it can bear much higher loads. Sliding abrasion and the coefficient of elongation are reduced, while creep resistance and dimensional stability increase. The glass particles embedded in the material cause higher wear on the mating part than pure PTFE.

**PTFE + carbon** has similarly good slip properties as pure PTFE, but because of the addition of a filler, it has much better mechanical stability. As with glass as a filler, sliding abrasion and the coefficient of elongation are reduced, while creep resistance and dimensional stability increase. Sliding elements filled with carbon can be used for applications that are occasionally or constantly surrounded by water.

**PTFE + bronze** has the best mechanical values of all filled PTFE types and is very suitable for sliding applications. The filler causes the lowest sliding abrasion of all PTFE types. In addition to this, thermal conductivity, and consequently the dissipation of friction heat from the friction bearing, is considerably improved compared to other sliding materials, which leads to a longer life.

## Weathering effects

All PTFE types are very resistant to UV rays, even in combination with atmospheric oxygen. No oxidation or discolouration has been observed.

## Chemical resistance

Unfilled PTFE is resistant to almost all media apart from elemental fluorine, chlorotrifluoride and molten or dissolved alkali metals. Halogenated hydrocarbons cause minor, reversible swelling. In the case of filled PTFE, due to the filler one can assume a lower chemical resistance, although it is the filler that forms the reaction partner to the medium, not the PTFE. As a rule, it can be said that the types filled with carbon are not much less resistant than pure PTFE. The types filled with glass are resistant to acids and oxidising agents but less resistant to alkalis. The types filled with bronze have a much lower chemical resistance than pure PTFE. Before using filled PTFE types in chemically burdened environments, their resistance to the respective medium should always be tested.

## Behaviour in fire

PTFE is rated as fire resistant in the highest category. It does not burn when an ignition source is added. The oxygen index (the oxygen concentration required for combustion), at 95% is one of the highest compared to other plastics.

## Areas of use

- Chemical industry
- Machine engineering
- Precision mechanics
- Electrical industry
- Textile industry
- Paper industry
- Food industry
- Aerospace industry
- Building and bridge construction

## Applications

- Friction bearings
- Bearing bushes
- Shaft seals
- Piston rings
- Valve seats/seat rings
- Insulators
- Flat seals
- O-rings
- Test jacks
- Thread guides
- Anti-adhesive liners

## Machining

PTFE is difficult to weld and even then only by using a special process. It can be machined on 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. 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 up to 1.2%. This means that finished parts that are dimensionally stable at 23 °C can have considerable dimensional deviations at temperatures below 19 °C. This must be considered in the design and dimensioning of PTFE components. When the material is being machined, attention must be paid 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 degrade 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.

# Polyetheretherketone (PEEK)

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Polyetheretherketone is a semi-crystalline thermoplastic with excellent sliding properties, very good mechanical properties, even under thermal load and an excellent resistance to chemicals. The high continuous working temperature rounds off the profile of this high-performance plastic and makes it a virtually universally useable design material for highly loaded parts. The polyetheretherketone finished products that we offer consist of high density polyetheretherketone types produced by extrusion or moulding 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
- Resistant to hydrolysis
- Good electrical insulator
- Radiation resistant
- Physiologically safe
- Fire resistant (UL 94 V 0)

**Colour** natural (≈ RAL 7032), black

## Sliding properties

PEEK ideally combines good sliding properties with high mechanical strength and thermal stability as well as excellent chemical resistance. Because of this, it is suitable for sliding applications. Modified types containing carbon fibre, PTFE and graphite, with highest wear resistance, a low coefficient of friction and a high pv limiting value, are available for component parts that are subject to especially high abrasion and wear.

## Weathering effects

PEEK is resistant to x-rays,  $\beta$ -rays and  $\gamma$ -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 or 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
- Bobbins
- Fittings (e.g. casing for hot water meters)
- Valves
- Piston ring
- 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.

Polysulfone is an amorphous thermoplastic with high mechanical strength and rigidity and remarkably high creep resistance across a wide temperature range and high continuous working temperature for an amorphous plastic. In addition, Polysulfone is transparent because of its amorphous molecule structure. Its very good resistance to hydrolysis and very good dimensional stability round off the profile. The polysulfone finished products that we offer consist of high density polysulfone types produced by extrusion or moulding processes.

## Main properties

- High continuous working temperature (+160 °C in air)
- Very good resistance to hydrolysis (suitable for repeated steam sterilisation)
- High toughness, also at low temperatures
- High dimensional stability
- Good electrical insulator
- High mechanical stability
- High rigidity
- High creep resistance across a wide temperature range
- Good resistance to radiation
- Physiologically safe
- Fire resistant (UL 94 V 0)

## Colour

Natural (honey yellow, translucent)

## Sliding properties

PSU is subject to strong sliding abrasion and is thus unsuitable for sliding applications.

## Resistance to radiation/weathering effects

PSU is resistant to x-rays,  $\beta$ -rays,  $\gamma$ -rays and microwaves. Hence PSU is ideally suited for use in the pharmaceutical, food and nuclear industries.

## Chemical resistance

PSU is resistant to inorganic acids, alkaline solutions and salt solutions, as well as cleaning agents and paraffin oils. It is not resistant to ketones, esters, chlorinated hydrocarbons or aromatic hydrocarbons.

## Behaviour in fire

PSU is rated as fire resistant in the highest category. When the source of ignition is removed, PSU is self-extinguishing. The oxygen index (the oxygen concentration required for combustion) is 30%.

## Areas of use

- Electro-technology
- Electronics
- Vehicle construction
- Equipment engineering
- Aerospace industry

## Applications

- Bobbins
- Inspection glasses
- Sealing rings
- Equipment casing
- Insulating sleeves

## Machining

In addition to its good welding and bonding properties PSU 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.

# Polyetherimide (PEI)

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Polyetherimide is an amorphous thermoplastic with high mechanical stability and rigidity as well as remarkably high creep resistance across a wide temperature range and high continuous working temperature for an amorphous plastic. In addition, polyetherimide is transparent because of its amorphous molecule structure. Its very good resistance to hydrolysis and very good dimensional stability round out the profile.

The polyetherimide finished products that we offer consist of high density polyetherimide types produced by extrusion or moulding processes.

## Main properties

- High continuous working temperature (+170 °C in air)
- High mechanical stability
- High rigidity
- High creep resistance across a broad temperature range
- High dimensional stability
- Very good resistance to hydrolysis (suitable for repeated steam sterilisation)
- Good electrical insulator
- Good resistance to radiation
- Physiologically safe
- Fire resistant (UL 94 V 0)

## Colour

Natural (amber, translucent)

## Sliding properties

PEI is subject to strong sliding abrasion and is thus unsuitable for sliding applications.

## Resistance to radiation/weathering effects

PEI is resistant to x-rays,  $\beta$ -rays and  $\gamma$ -rays as well as UV-rays in combination with atmospheric oxygen. Hence PEI is ideally suited for use in the pharmaceutical and nuclear industries and under weathering effects.

## Chemical resistance

PEI's resistance should be tested before it is used with ketones, aromatic hydrocarbons or halogenated hydrocarbons. Alkaline reagents with pH values > 9 should be completely avoided.

## Behaviour in fire

PEI is rated as fire resistant in the highest category, also without additives. When the source of ignition is removed, PEI is self-extinguishing. The oxygen index (the oxygen concentration required for combustion), at 47% is very high compared to other plastics.

## Areas of use

- Electro-technology
- Electronics
- Vehicle construction
- Equipment engineering

## Applications

- Bobbins
- Inspection glasses
- Equipment casing
- Insulating sleeves



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