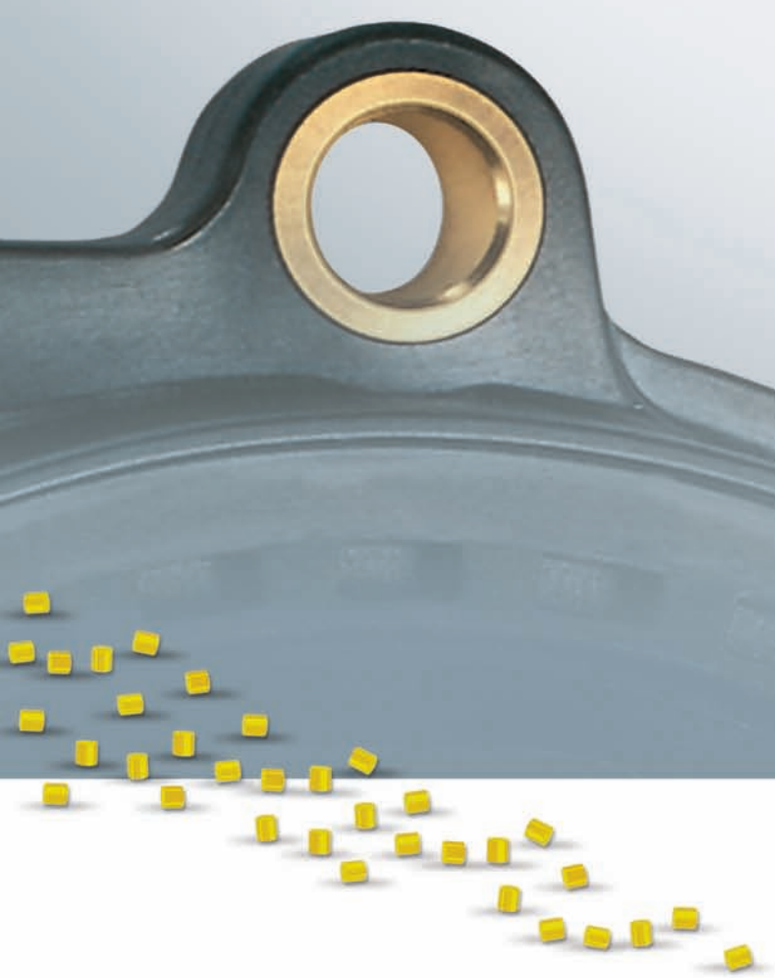
ALBIS GROUP

THE LINEAR PPS

Tedur®

The Unique Combination of Properties



ALBIS

PERSPECTIVES ON PLASTICS

TEDUR® – the driving force behind progress.

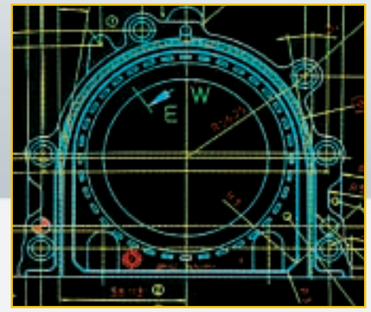
A linear polyphenylene sulphide of outstanding quality:

- Replaces metals and light metal alloys
- Substitutes high-temperature thermoplastics, thermosets and ceramics

Today's market requires new thermoplastic design and construction materials for demanding technical solutions. This requirement has led to the development of TEDUR® – a PPS of outstanding quality.
ALBIS's expertise successfully implemented in key industries is reflected in TEDUR® – the ideal material for engineers, designers and manufacturers. With its exceptional scope of properties, TEDUR® is equally suitable for "upward substitution" of plastics as it is for metal replacement. By making high demands on materials and effectively utilizing their properties, it is possible for manufacturers to realize sound system solutions while also achieving substantial savings in terms of weight and costs.
Thanks to its outstanding thermal, mechanical, physical and electrical properties in conjunction with its excellent flame retardant properties, and resistance to chemicals, TEDUR® delivers high performance in all applications.

The high-performance thermoplastic from ALBIS.

With TEDUR® from ALBIS, the entire plastics processing sector has at its disposal a high-grade thermoplastic for virtually universal use as a PPS, for example in the automotive industry, electronics and electrical engineering, lighting applications and industrial parts. TEDUR® is primarily used in the injection moulding process.



Today many structural components, particularly in automotive engine compartments, are made of TEDUR®, because TEDUR® can withstand high temperatures, as well as, changing oil and fuel qualities without a problem. TEDUR® is a material with which you can construct the future. There is a huge variety of other applications for which TEDUR® is eminently suitable – providing the basis for the technical solutions of tomorrow. Profit from its advantages and strengthen your competitiveness – with TEDUR® from ALBIS.

Linear PPS Compound from ALBIS

TEDUR® is the registered trademark of the PPS series developed by ALBIS. ALBIS manufactures reinforced high temperature-resistant, semi-crystalline raw materials based on linear polyphenylene sulphide produced from 1.4-dichlorobenzene and sodium sulphide in a polycondensation process. Thanks to its high-grade property profile, TEDUR® is used for an ever-growing range of applications and experiences particularly high growth rates in the field of thermoplastics .

TEDUR® – the unique combination of properties:

- Very high heat distortion temperature (above 260 °C)
- Very high continuous use temperature (up to 240 °C)
- Very high rigidity and hardness (modulus of elasticity up to 25,000 MPa)
- Good dynamic load bearing capacity
- Inherently flame retardant to UL94V-0 at 0.8 mm without flame retardant additives
- Outstanding resistance to hydrolysis and chemicals
- Very good processing properties due to high flow characteristics and wide processing range
- Very low water absorption
- Low tendency to creep even at elevated temperatures

A raw material for demanding applications.

TEDUR® - the choice of more and more manufacturers

TEDUR® is used for an ever-growing range of applications and experiences particularly high growth rates in the field of thermoplastics requiring demanding technical solutions:

- Optimum weight and cost reduction
- Optimised development processes
- Creation af new applications
- Development of components and solutions
- Realisation of innovative ideas

Automotive industry

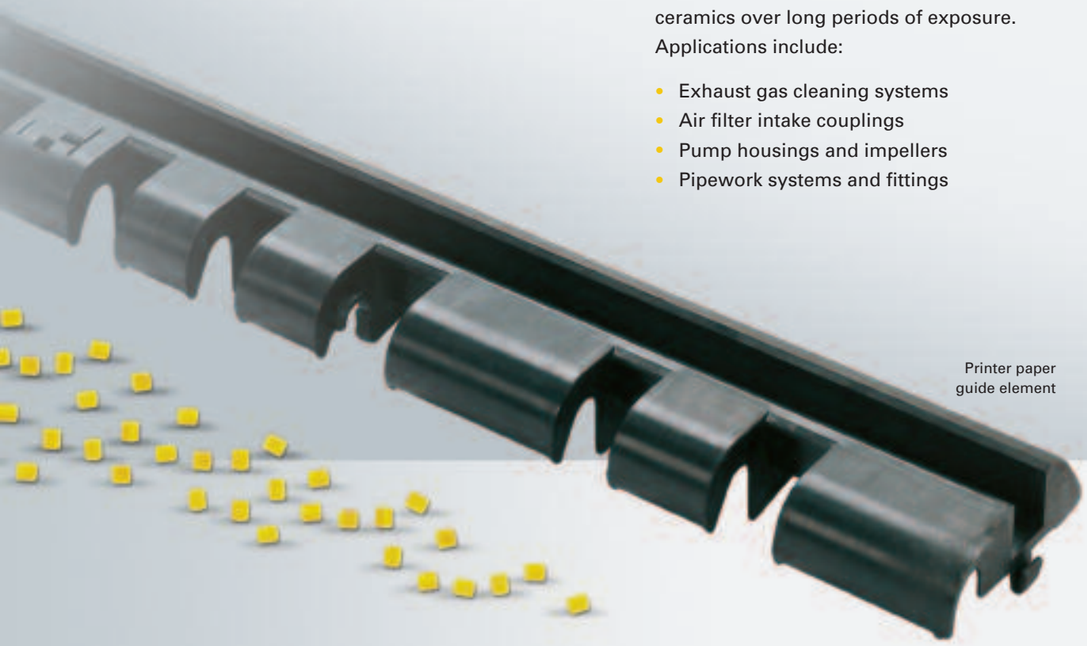
The use of TEDUR® is favoured in the automotive sector primarily due to its exceptional rigidity, strength and its resistance to chemicals and hydrolysis even at elevated temperatures. These outstanding properties are utilized in the following applications in the automotive sector:

- Fuel injection systems
- Lip seals
- Plungers for ABS brake systems
- Fuel economy systems
- Thermal sensors for coolant circuits
- Pump housings and impellers

Chemical industry

The extensive use of TEDUR® in the chemical plant industry is due to its excellent chemical and corrosion resistance, even when compared to metals and ceramics over long periods of exposure.
Applications include:

- Exhaust gas cleaning systems
- Air filter intake couplings
- Pump housings and impellers
- Pipework systems and fittings



Printer paper guide element

Electrical / Lighting systems, Domestic appliances

Suitable for many components that are subject to high levels of stress and strain in conjunction with high temperatures, TEDUR® with its inherent flame-retardant properties is the ideal material for moulded parts including:

- Plug connectors
- Plug and socket connections
- Coil housings
- Relay components
- Housings
- Technical components
- Base plates
- Parts for printers

The widespread use of TEDUR® is apparent in the most diverse applications. However, it is in the lighting sector where TEDUR® really shines. This high-grade material proves its advantages in the manufacture of:

- Lamp sockets
- Lamp shades
- Lighting units/spotlights
- Reflectors

and when used as a high-purity embedding compound for chip jacketing applications. Your designers and our application engineers make up the successful team that effectively takes your product
from idea to series production.
An unbeatable combination.

A highly interesting material for reflectors

The ideal material for new applications

Modern plastic technology is the basis for optimised weight and cost reduction.
TEDUR® fulfils all prerequisites for effectively optimizing development processes – from the realization of a new part design through the creation of new applications to the development of components and solutions that are ahead of their time. We place the material of the future in your hands: TEDUR® from ALBIS. Innovative ideas become reality.

Innovative types – individual profile.

Equipped to meet every challenge

ALBIS can offer an extensive product range of TEDUR® for injection moulding and extrusion. TEDUR® is supplied in the form of neutral or black granules. Various colours are available on request for the purpose of identification of moulded parts. One can choose from a variety of TEDUR® grades to ensure the properties of TEDUR® correspond to specific applications.

ALBIS can also develop special materials in close cooperation with the customer to suit specific requirements.

Pump housings for
Temperature control units

TEDUR® product range – Injection moulding grades

Type	Filler / Modification	Characteristics in brief
GF types		
TEDUR L 9105-1	GF30	Improved toughness, lower tendency to form flash
TEDUR L 9510-1	GF40	Balanced mechanical properties, KTW listed
TEDUR L 9510-5	GF40	Increased flowability compared to 9510-1
TEDUR L 9107-1	GF40	Improved toughness and bursting strength, lower tendency to form flash
TEDUR L 9511	GF45	Increased rigidity compared to 9510-1
TEDUR L 9113-2	GF60	Very high rigidity
TEDUR L 9114-1	GF60	Very high rigidity, encreased toughness compared to 9113-2
GF/MR types		
TEDUR L 9220-1	GF/MR 65	Balanced mechanical properties, lower tendency to warp
TEDUR L 9217-1	GF/MR 65	Increased toughness, lower tendency to form flash, high tracking resistance
TEDUR L 9214-1	GF/MR 65	High rigidity, outstanding dimensional stability
TEDUR L 9200-1	GF/MR 60	Improved toughness and strength, lower tendency to form flash
TEDUR L 9521-1	GF/MR 60	High tracking resistance
Reflector types		
TEDUR L 9523	GF/MR 60	High surface quality, suitable for direct metallization
TEDUR L 9310-4	GB/MR 60	Very high surface quality, suitable for direct metallization
TEDUR L 9560	MR50	Highest surface quality, suitable for direct metallization
Special types		
TEDUR L 9400-3.2	CF15	Good electrical conductivity
TEDUR L 9404-3.2	CF30	Very high rigidity and electrical conductivity
TEDUR L 9409-3.2	CF30 PTFE15	Very high rigidity and electrical conductivity, improved sliding-friction properties
TEDUR L 9406-3.2	CF/GF/MR 60	Very high rigidity and good electrical conductivity
TEDUR L 9422-1	GF30 PTFE15	Improved sliding-friction properties
TEDUR L 9421-1	GF40 PTFE10	Improved sliding-friction properties
TEDUR L 9300-1	GF/GB 40	Reduced tendency to warp compared to glass fibre reinforced types
Recycled types		
TEDUR R 9519	GF45	Reclaimed regrind material
TEDUR R 9529	GF/MR 55	Reclaimed regrind material

Further products und special types on request

Exceptionally resistant to continuous exposure in high temperature working environments.

A low creep rate, as well as, high rigidity and strength at higher temperature levels characterizes TEDUR®

Short-term properties

Moulded parts made of TEDUR® feature a high degree of hardness and rigidity. Tensile stress and expansion as a function of temperature confirms (Fig. 8.1) that, due to its high melting point at a temperature of about 285 °C, TEDUR® possesses high dimensional stability under heat. It can cope with a short-term thermal load above 260 °C.

Long-term properties

Finished parts produced from TEDUR® show little permanent deformation even under continuous static loads. TEDUR® also withstands high dynamic loads over longer periods. The continuous use temperature depends on the load and, in accordance with UL, is between 200 and 220 °C depending on the type involved. Even at temperatures above 200 °C, TEDUR® maintains characteristics corresponding to those of many thermoplastics at room temperature.

Stress-strain diagram
TEDUR® L 9510-1
DIN EN ISO 527-2

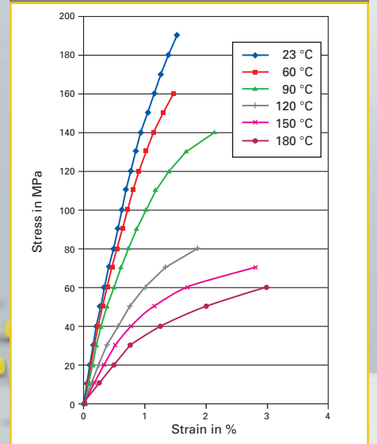


Fig. 8.1

Shear modulus curves, TEDUR® L 9113-2, L 9200-1 and L 9107-1 / DIN 53 445

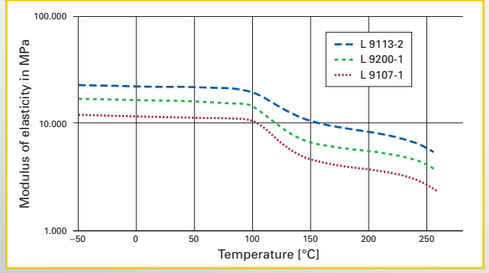


Fig. 8.2

Semi-crystalline matrix

The PPS matrix of TEDUR® is semi-crystalline. The glass-transition temperature TG is approx. 90 °C. The melting point is at approx. 285 °C. The high temperature stability is illustrated by the shear modulus curves (Fig. 8.2).

Thermal expansion

TEDUR® is available with up to 70 % filler and/or reinforcement fibers. Depending on the type of filler, this material may be used to manufacture high strength components capable of withstanding high mechanical loads or components with ceramic-like properties, with particularly low thermal expansion and high dimensional stability (Fig. 9.1).).

Linear coefficient of thermal expansion of TEDUR® injection moulding qualities

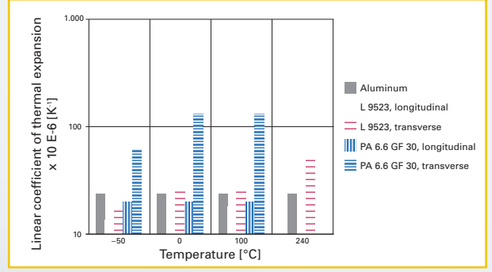
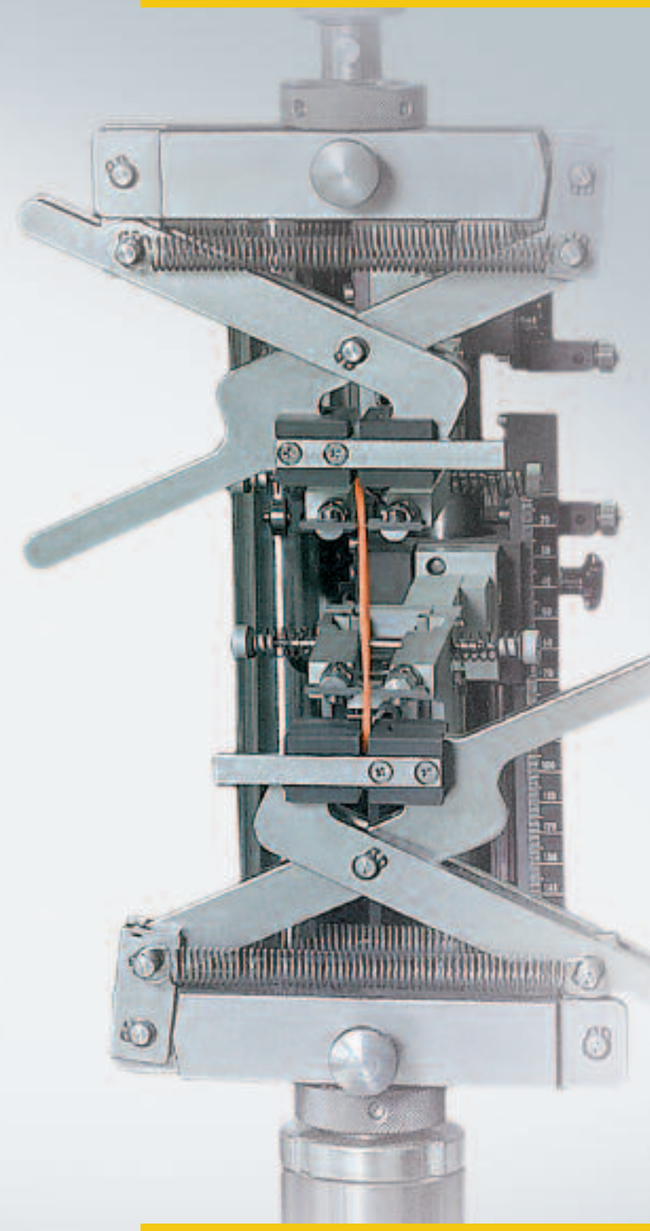


Fig. 9.1



Highly resistant to chemical attack and hydrolysis.

Even at high temperatures, TEDUR® displays good resistance to mineral oils, fuels, organic solvents, diluted acids and alkaline solutions.
TEDUR® is chemically degraded by strongly oxidizing media such as nitric acid. Concentrated hydrochloric acid weakens the glass fiber/PPS compound and in doing so causes reduction of its mechanical properties. Table 10.1 provides a representative overview of the outstanding chemical resistance when stored in various solvent and acid solutions.

Chemical resistance test conducted on TEDUR® L 9511 (GF 45) after storing for 10 days without load application

Medium	Storage temperature °C	Bending test Residual value in % after storage	Weight change in %	Length change Δ in %
Initial status		280 N/mm² = 100 %	-	-
Acetone	56	100	−0.2	±0
Ammonia solution 30 %	77	85		
Aniline	100	70	+3.4	+0.2
Benzene	80	70	+2.6	+0.3
Break fluid DOT 4	180	100	+1.1	±0
Butanol	99	100	+0.1	+0.4
Butyl acetate	100	100	+0.1	+0.1
Chlorobenzene	100	45	+5.8	+0.5
Chloroform	61	55	+5.3	+0.3
Cyclohexanone	100	80	+0.5	+0.1
Ethanol	78	100	−0.3	−0.1
Ethylene glycol	100	100	−0.3	±0
Freon 22	45	100	+0.1	±0
Hydraulic fluid Hydran 37	100	100	−0.2	±0
Caustic potash solution 30%	100	80		
Methanol	64	100	−0.4	±0
Methylene chloride	40	65	+2.6	+0.1
Engine oil Shell 15W-40	180	100	±0	±0
Caustic soda 30%	100	100	+0.9	+0.1
Nitric acid 10%	100	50	+0.7	+0.2
Hydrochloric acid	100	65	−4.7	±0
Sulphuric acid 50%	100	100	+0.4	+0.1
Sulphuric acid 80%	100	100	+0.6	±0
Tetrahydrofuran	65	65	+2.6	+0.1
Transformer oil	100	100	−0.1	−0.1
Xylene	100	75	+2.2	+0.2

Table 10.1

Storage of TEDUR® in glycol/water

Only a slight reduction in tensile strength occurs when the TEDUR® GF and GF/MR types are stored in glycol/water mixtures at 130 °C for up to 600 h, the tensile strength remains constant as the storage time increases. TEDUR® has a proven record of success when used in coolant systems in engine applications (Fig. 10.2).

Tensile strength when stored in glycol/water at 130 °C

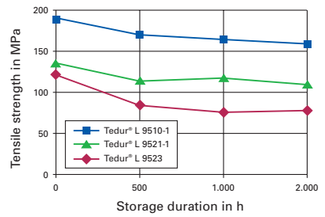
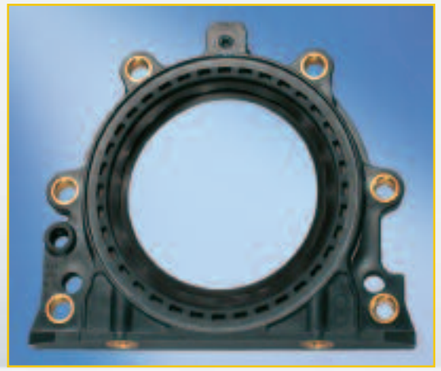


Fig. 10.2

Thermal sensor for engine cooling circuits

Long term exposure to hot air and oil

Behaviour during continued use at elevated temperatures is of particular significance for applications in the automotive engine compartment. The following illustrations (11.1 – 11.6) show the elongation at tear, modulus of elasticity, yield stress, as well as, the impact strengths of TEDUR® L 9200-1 as a function of exposure time and storage temperature under various conditions. Largely, the mechanical properties remain constant as the storage duration increases.



Integrated lip seal

TEDUR® L 9200-1 (GF/MR 60)

Elongation at tear as a function of storage time/storage temperature

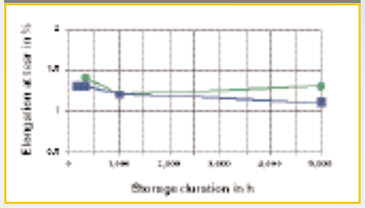


Fig. 11.1

Elongation at tear as a function of storage time/storage temperature

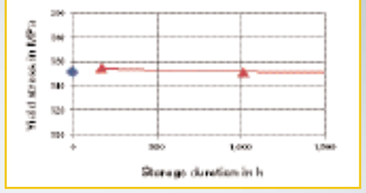


Fig. 11.4

Modulus of elasticity as a function of storage time/storage temperature

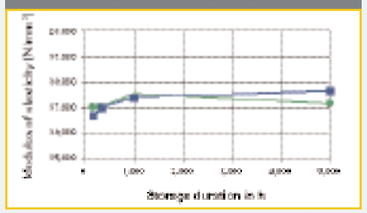


Fig. 11.2

Modulus of elasticity as a function of storage time/storage temperature

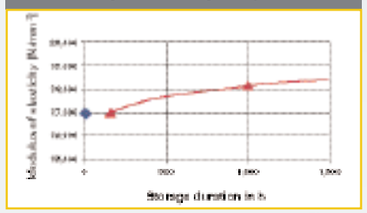


Fig 11.5

Impact strength as a function of storage time/storage temperature

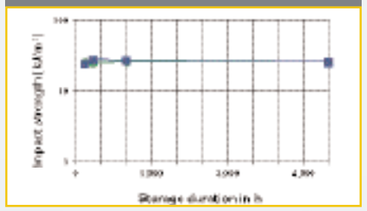


Fig. 11.3

Impact strength as a function of storage time/storage temperature

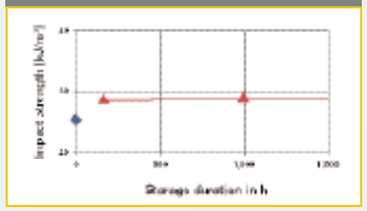
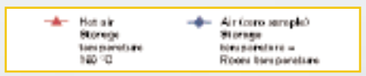


Fig. 11.6



Outstanding flame retardant properties.

Flame retardant without the addition of flame retardant additives.

Tested and rated very good. All TEDUR® grades comply with UL94V-O requirements down to a wall thickness of 0.8 mm, without the need for flame retardant additives. You will find the UL-listed TEDUR® types under file No. E 80168.

Tailor made electrical properties.

An excellent insulator

TEDUR® is an excellent insulator and is characterized by a low dielectric loss factor. TEDUR® has proved its worth particularly at high temperatures.
The good electrical and dielectric properties of TEDUR® are largely constant over a large temperature and frequency range and are hardly influenced by ambient moisture.

Electrical conductivity

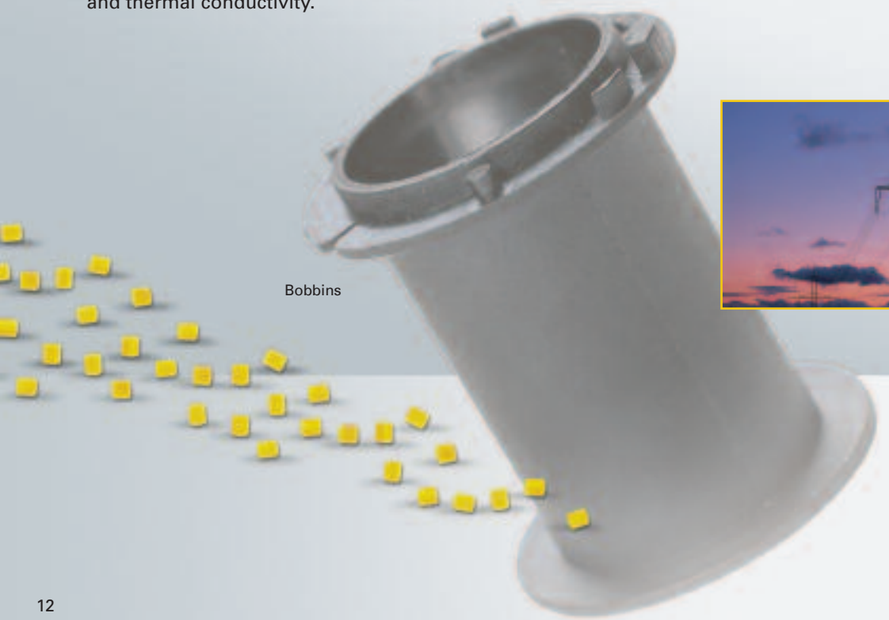
ALBIS supplies electrically conductive TEDUR® materials with carbon-fibre fillers offering a specific surface resistance of < 10^6 Ω in conjunction with improved tribological properties, mechanical strength levels and thermal conductivity.

Tracking resistance

TEDUR®	Filler content (%)	CTI
L 9510-1	GF 40	150
L 9512	GF 42	125
L 9511	GF 45	125
L 9300-1	GF/GK 40	175
L 9200-1	GF/MR 60	225
L 9523	GF/MR 60	200
L 9521-1	GF/MR 60	250
L 9560	MR 50	175
L 9530	MR 55	200

Tracking resistance (CTI, 100 drops, solution A in accordance with DIN VDE 0303/3) of various TEDUR® types

Fig. 12.1



Bobbins

TEDUR® – suitable for much more.

Machining

Machining operations such as turning, drilling, milling and sawing can be conducted without any problems on finished parts made of TEDUR® provided the machining tools are equipped with carbide bits or inserts.

Welding

Weld strengths can be achieved with parts made of glass fiber-reinforced TEDUR® that are on a par with those of other glass fiber-reinforced, semi-crystalline thermoplastics. The weldability decreases with higher filler content.
The resistance to breaking of up to 40 N/mm², determined in tests of the welded joints, is however distinctly below the material strength. Processes suitable for TEDUR® are:

- Ultrasonic welding
- Friction welding
- Heated tool welding
- Induction welding

Bonding

In view of the material's excellent resistance to chemicals, it is not possible to bond TEDUR® parts using solvent-based adhesives. Suitable adhesives include:

- Cyanoacrylates
- Epoxy resins
- Polyurethanes
- Silicon adhesives

Adhesion surfaces pretreated with corona, plasma, flame or roughened with abrasive result in stronger bonded joints.

Painting

The colour stability of dyed PPS compounds is not sufficient to withstand prolonged exposure to high temperatures or UV light. A paint coating is therefore essential where outdoor applications are concerned.
As is the case with bonding, it is also possible when using the painting process (by corona discharge for instance) to improve paint adhesion by pretreating the surface accordingly.
Suitable paint systems for TEDUR® parts include:
Acrylic resin, silicone resin or polyurethane-based one-component or two-component paints. If silicone resin paints are to be used, a PU primer is required to ensure adequate adhesion. The conductive TEDUR® types permit electrostatic paint application.

Metallizing

Reflective metal surfaces, e.g. for reflectors, can be produced by vapour-application of the metal layer in a vacuum.
The outstanding surface properties of selected TEDUR® materials renders unnecessary intermediate painting that is normally a standard procedure used on filled thermoplastics to achieve high-gloss finishes.
Treatment with argon plasma is recommended before the vapour application procedure in order to achieve effective adhesion of the aluminum layer.

Injection moulding with TEDUR®.

With ist excellent flow properties for long flow ranges, TEDUR® is easily injection moulded, with the moulded parts exhibiting exceptional dimensional stability over a wide temperature range.

Flow range – wall thickness diagram

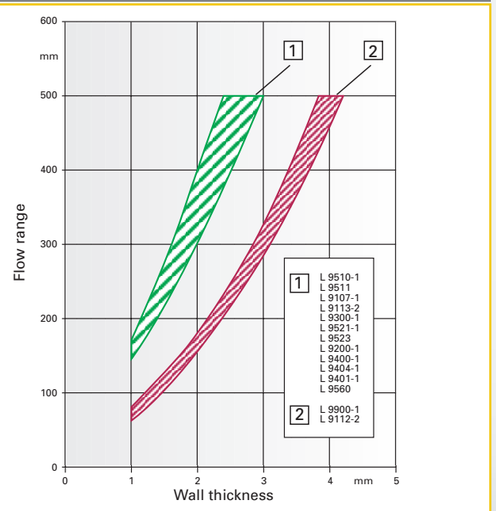


Fig. 14.1

Drying

TEDUR® is mainly processed by means of injection moulding. TEDUR® is not hygroscopic and absorbs maximum 0.05 % moisture from the air. Drying for a period of 3 h at 130 °C is recommended in order to remove moisture in the granules.

Steels

TEDUR® normally contains a high percentage of filler. Consequently, there is an increased risk of wear in the injection moulding unit and mould. The cylinders and feed screw should therefore be manufactured from corrosion-resistant steels. Hardened corrosion-resistant steels such as X155 CrVMo 121, X165 CrMoV12, as well as, X42 Cr13 have proven to be best suited for the cavities.

Machine parameters

Depending on the nozzle geometry, the use of needle-type injection nozzles is recommended. Good results are achieved with 3-zone feed screws with an L/D ratio from 18 : 1 to 22 : 1 and a flight depth ratio of 2 : 1 to 2.5 : 1. The metering range should be between 1 and 3D. Deviating from the suggested metering range is not advisable.

Melt temperatures

Due to the highly defined melting point of 285 °C, TEDUR® can be injection moulded from a temperature of 300 °C. The high thermal stability of TEDUR® makes melt temperatures of up to 360 °C possible, thus opening up an extensive processing range.
A temperature increase of 40 °C signifies a reduction of the melt viscosity by more than half. The normal melt temperatures are between 320 and 350 °C, and therefore by using maximum mould temperatures it is thus possible to double the flow range values. Fig. 14.1 shows the flow range – wall thickness diagram for the TEDUR® product range. In order to avoid corrosion damage to the mould, the melt temperature should not be increased above 350 °C.

Mould temperatures

TEDUR® is a semi-crystalline material. The crystalline phase has a decisive influence on the mechanical, as well as, thermal properties and consequently, should reach the maximum possible degree of crystallinity immediately after processing. Mould temperature ranges >140 °C are necessary to obtain maximum crystallinity.

Injection speed/venting

Depending on the machine setting, TEDUR® materials have a high to very high solidification and crystallization rate. This property allows for very short cycle times. On the other hand, it requires fast injection speeds to prevent cooling and solidification of the melted mass during the injection moulding process thus avoiding poor quality, non homogeneous surfaces. Particular steps must be taken to ensure effective venting of the moulds since compressed air leads to burning that can have a negative effect on the service life of the moulds. Venting channels of 0.006 – 0.01 mm have proven ideal.

Injection pressure/moulding pressure

High injection speeds require high injection pressures. A pressure of approx. 700 bar is recommended, depending on the type of part.

Screw speed/back pressure

Maximum screw circumferential speeds of 0.25 m/s are recommended. A back pressure of <50 bar is normally sufficient. Deviating screw speeds and higher back pressures can cause damage to the filler, as well as, to the polymer matrix.

Shrinkage

Due to its high filler content and high intrinsic rigidity, distortion of TEDUR® is very low. Shrinkage and distortion depend largely on processing conditions, sprue design, as well as, gate position and wall thickness, etc. The following reference values for free shrinkage have been determined for TEDUR®:

TEDUR®	Filler content	Processing shrinkage (l/q)
L 9107-1	GF 40	0.30/1.10**
L 9510-1	GF 40	0.40/1.00*
L 9511	GF 45	0.40/1.00*
L 9200-1	GF/MR 60	0.30/0.90**
L 9521-1	GF/MR 60	0.35/0.80*
L 9523	GF/MR 60	0.35/0.80*
L 9560	MR 50	1.00/1.10**

Fig. 15.1

*Moulding shrinkage in accordance with DIN 16901.
**Free shrinkage measured on dumbbell test specimen, ISO 527.

Develop the future – in dialogue with ALBIS.

Create the trends of tomorrow with ALBIS today

Never before has the growth market of high performance plastics been greater than today. The areas of usage are expanding rapidly. Step-by-step, more materials, especially metals, are being replaced by more flexible and affordable plastic solutions. New application possibilities are being opened up that, until recently, appeared inconceivable. The pressure to innovate is increasing. ALBIS is a driving force in this dynamic market. We develop ground-breaking solutions of plastic and new generations of fascinating possibilities. ALBIS is establishing the trends of tomorrow today.

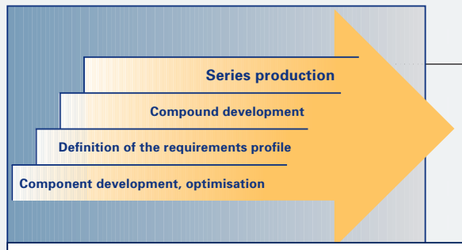
These results have many advantages for our customers. Together with us, they assume a leading role in technological developments and thus optimise:

- Product solutions,
- Material handling,
- System costs,
- Market position,
- Expenses.

From the idea to series production

In professional dialogue with our customers, we go through the individual steps in component development, all the way to the release and start of series production. On the basis of customer demands, prerequisites and influencing factors, we test the compliance of all plastic-related requirements. These also include strength and rigidity calculations, as well as, the rheological tool design for the task. We bring many years of practical experience in the optimization of production conditions, the commissioning of production tools and on location service. An optimal result, tested in theory and practice stands at the end of the cooperative development process.

The intensive cooperation between end users, injection moulders and engineering offices with the ALBIS laboratory and the ALBIS application development and sales departments, leads to the optimal solution. Regionally and on location, you are supported by application technicians from ALBIS with many years of practical experience in all areas of plastic processing.

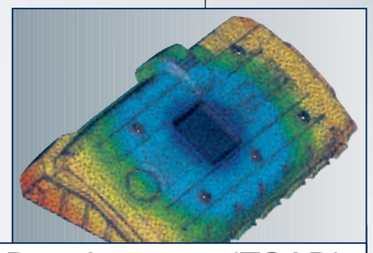


Strategic Account Management (SAM)

We offer our customers successful project management for product development and process optimisation with well-founded industry know-how.

Marketing + Sales

The detailed knowledge of national and international markets makes our marketing and sales professionals important dialogue partners. Our customers can evaluate and use opportunities in an easy exchange of know-how – in the respective domestic markets and beyond.



Technical Service and Development (TSAD)

Individual on-site attendance offers our customers competent support in issues ranging from optimal selection of materials to trouble-shooting – all the way to application development.

The Know-how Network

Central Know-how

The wide-ranging ALBIS know-how in product and process development, and the strategic market development carried out in our pilot plant, in marketing and product management – is all centrally situated in Hamburg, and available for all partners and customers.

THE LINEAR PPS

TEDUR®

Convincing advantages

A linear polyphenylene sulphide of outstanding quality:

- Replaces metals and light metal alloys
- Substitutes high-temperature thermoplastics, thermosets and ceramics

TEDUR® – the unique combination of properties:

- Very high heat distortion temperature (above 260 °C)
- Very high continuous use temperature (up to 240 °C)
- Very high rigidity and hardness (modulus of elasticity up to 25,000 MPa)
- Good dynamic load bearing capacity
- Inherently flame retardant to UL94V-0 at 0.8 mm without flame retardant additives
- Outstanding resistance to hydrolysis and chemicals
- Very good processing properties due to high flow characteristics and wide processing range
- Very low water absorption
- Low tendency to creep even at elevated temperatures

Certification

Our customers' satisfaction with our products and services is supported by the performance and effectiveness of our quality management system established in all our European branches according to ISO/TS 16949:2002. The constant improvement in the effectiveness of the quality management system was certified for the first time in September 2005 by the Deutsche Gesellschaft zur Zertifizierung von Managementsystemen mbH (DQS). After a successful reappraisal, the certificate is valid until 2011.

ALBIS

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ALBIS GROUP

THE LINEAR PPS

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Sales office Frankfurt a. M.
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Sales office Nuremberg
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Sales office Stuttgart
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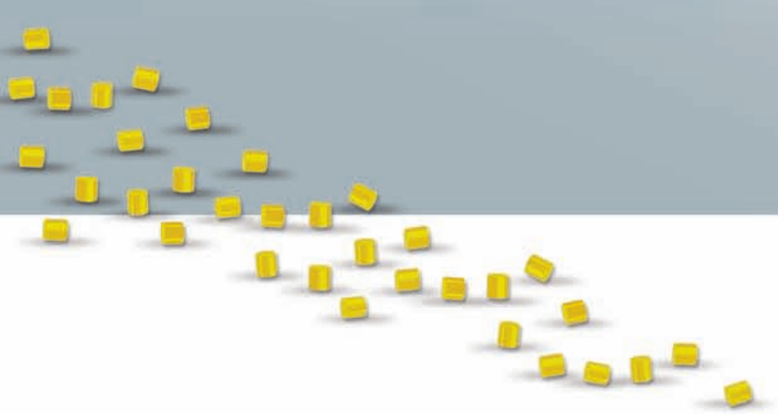
ALBIS worldwide

Austria · Czech Republic · France · Germany
Great Britain · Hong Kong · Hungary
Netherlands · Poland · PR China · Russia Spain
· Sweden · Switzerland · Turkey · USA



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