STASSKOL

HIGH-PERFORMANCE POLYMERS

The material makes the difference

STASSFURT **GERMANY** | HOUSTON **USA** | KUNSHAN **CHINA**

HIGH-PERFORMANCE POLYMERS

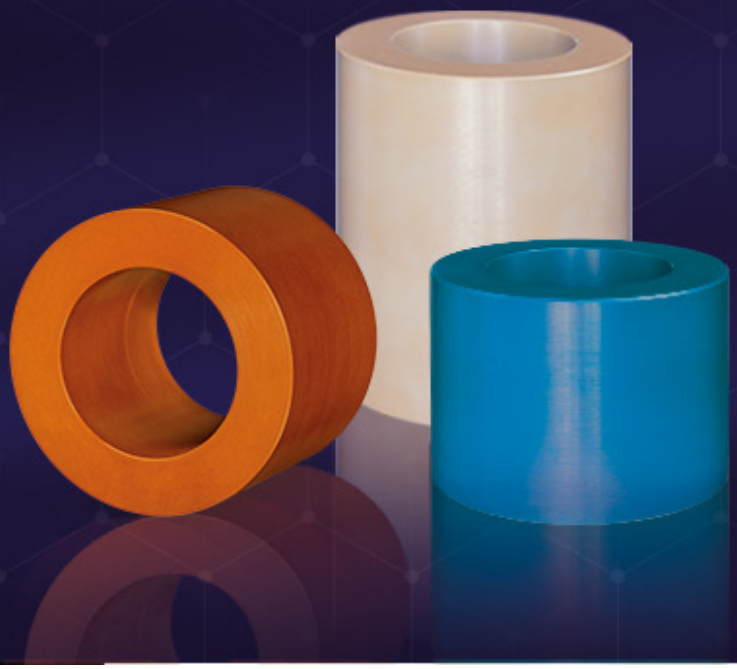
The material makes the difference

Tensile strength, wear rates, surface resistance and thermal expansion coefficients, these are all performance indicators which can be influenced decisively by using optimum material. That is why STASSKOL has carried out intense research and developments in the field of high-performance polymers for several decades and does so successfully. Our polymers according to our own recipes are already used successfully in several areas, as for example in the food industry, aviation and aerospace, vacuum technology, mechanical engineering or the petrochemicals industry, to name but a few.

Due to the use of a special manufacturing process, the STASSKOL high-performance polymers have outstanding properties. They are permanently temperature-resistant up to 300 °C, wear resistant in high-pressure processes up to 1,000 bar, resilient to acids, grease and solvents and can be manufactured with a diameter of up to 1,200 mm. Moreover, the polymers have very good cryogenic properties up to minus 270 °C, high heat resistance up to 470 °C (HDT/A) and excellent thermal and electrical insulation.

STASSKOL uses its own, worldwide unique test equipment for the development of its materials. The testing facility and in-house material manufacturing make it possible to develop individual polymers specifically tailored to the customer's application within a very short period.

However, the company not only offers semi-finished products, but also professional further processing as finished components. A state-of-the-art machining facility is available for this.



High-performance polymers are the future

In current times, new technology always poses new requirements for the materials to be used. Whilst high-performance polymers still were a speciality a few years ago, they have long since become established in the constructors' standard repertoire.

STASSKOL has concentrated on particularly highly performant materials. Here, we can name some examples such as polyaryletherketones like **PEEK**, **PEK** and **PEKEKK**, **PTFE** as well as modified **PTFE** and also **polyimides**, **polyamide-imidide** and **polyphenylene sulphide**, which are characterised by a constant service temperature above 150 °C.

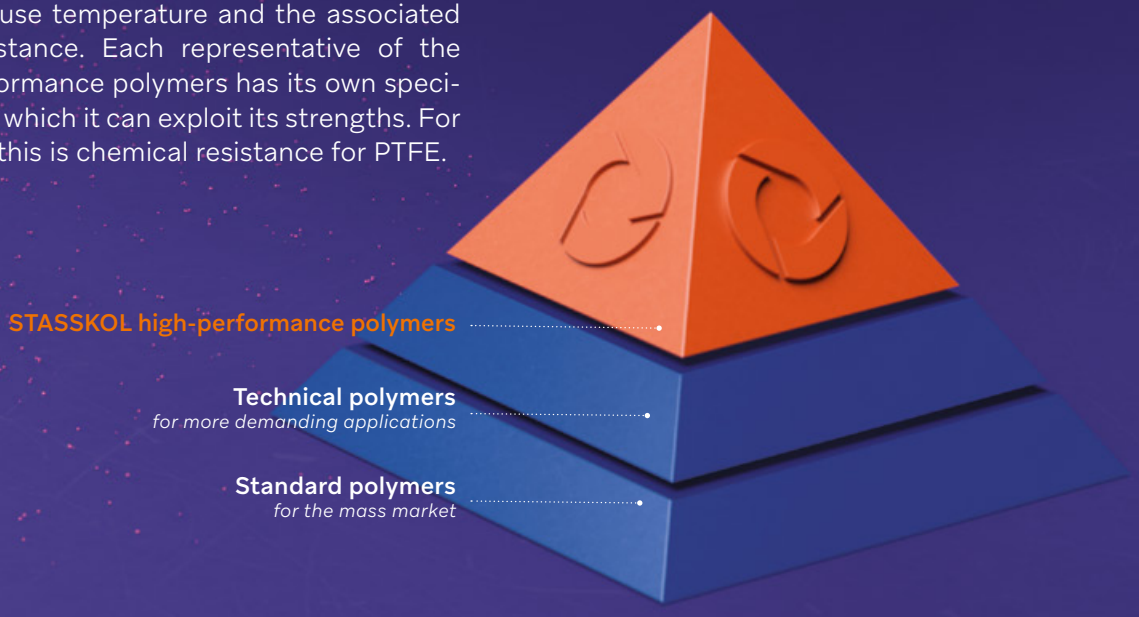
In addition to the standard polymers for the mass market and the technical polymers for more demanding applications, the high-performance polymers constitute **the top of the pyramid**.

Top performance not only refers to the high constant use temperature and the associated heat resistance. Each representative of the high-performance polymers has its own specific area in which it can exploit its strengths. For example, this is chemical resistance for PTFE.

Due to its low friction coefficient, the material is excellently suited for components subjected to friction and wear and tear. This makes PTFE the ideal candidate for dynamic seals.

Polyaryletherketones (**PEK, PEEK, PEKEKK**) exploit their advantages when high resistance and temperature resistance are called for. From a temperature of max. 160 °C (glass transition), the mechanical properties are reduced as primarily for an E-module, which can at least be accommodated in-part by selecting appropriate filling materials.

Polyimide is a very high-quality polymer and difficult to process as a semi-finished product, however with use restrictions from -270 °C to max. + 300 °C an absolute allrounder regarding its temperature resistance. It is also highly stable and easy to machine.



TRADITION & PROGRESS

STASSKOL - a company with visions

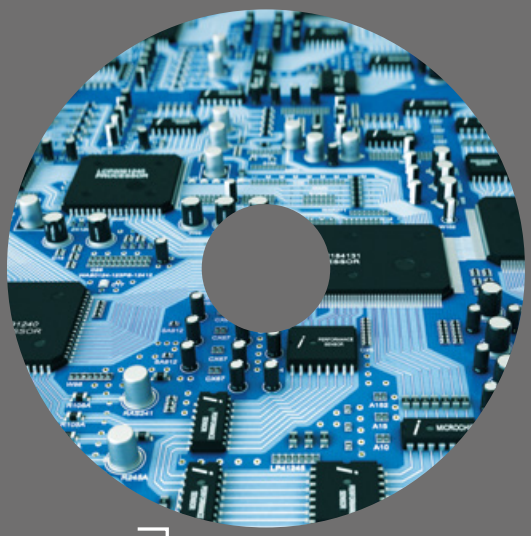
The company STASSKOL has worked in numerous sectors for more than 100 years. The company also manufactures individual sealing solutions for compressor construction customers and in the rotating equipment area. But STASSKOL was also already able to set noteworthy accents as a solution provider in other areas, for example in the chemical industry, food processing and electrotechnology. The different applications also pose varying requirements of the materials used, in our case mostly the polymers.

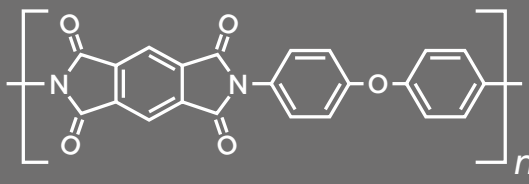
STASSKOL acts in Europe from its location in Stassfurt, Germany and has representations in India and Japan as well as additional manufacturing facilities in the USA and China. A total of more than 110 employees work for the company.

INDIVIDUAL RECIPES

The perfect mix

- Excellent mechanical properties due to the special manufacturing process
- Diameter: up to 1,200 mm, also in PEEK
- Compliant with food industry standards and detectable
- Development of individual high-performance polymers for your application
- Short delivery times
- Mechanical processing to a finished component in-house



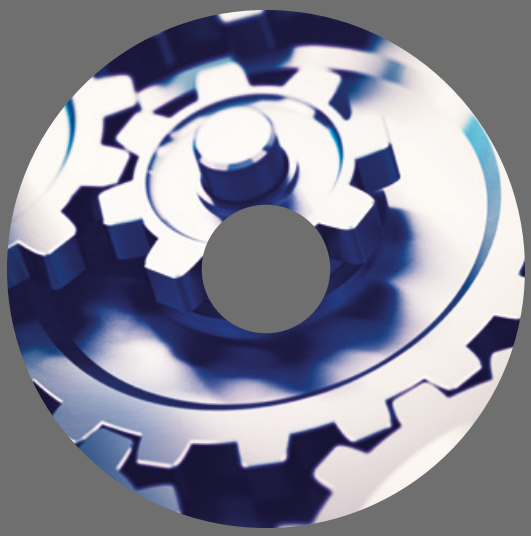


GROUP 92xx

ESKASINT

The group of the polyimides belongs to the absolute pinnacle of high-performance polymers. Its properties can be adapted to the challenge of the specific application by using appropriate filling material combinations. In particular, carbon fibres, molybdenum disulphide, PTFE and graphite play an important role in the optimisation of the properties of polyimides.

Applications:
Aviation and Space, Electrotechnology, Mechanical Engineering, Vehicle Manufacturing, Generators/Engines

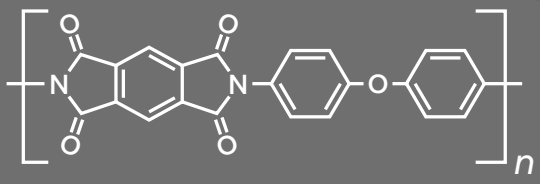


Properties

- Constant temperature resistance 300 °C (briefly up to 350 °C)
- High heat resistance up to 370 °C (HDT/A)
- Good cryogenic properties down to -270 °C
- High module resistance and rigidity, also at temperatures exceeding 260 °C
- Outstanding wear and tear resistance, also under pressure at high friction speeds.
- Excellent thermal and electrical insulation
- Low thermal conductivity
- High purity, low degassing at vacuum
- Easy to machine (please note our guideline)
- Good chemical resistance to acids, grease and solvents
- Inherently flame-retardant

Selected materials

MATERIAL	ADDITIVES	PROPERTIES
ESKASINT 9210	Graphite	Low wear and tear Good mechanical properties, suitable for high temperatures
ESKASINT 9205	Not filled	Very low friction coefficient, self-lubricating
ESKASINT 9233	PTFE	Good mechanical stability, high elongation at break, compliant with food industry standards
ESKASINT 9251	Molybdenum disulphide	Low friction, low wear and tear



GROUP 94xx

ESKASINT

Polyimides are characterised by their constant use temperature of between -200 °C and +280 °C. It is even briefly possible to realise up to 400 °C during application. This naturally also poses special challenges for processing the material.

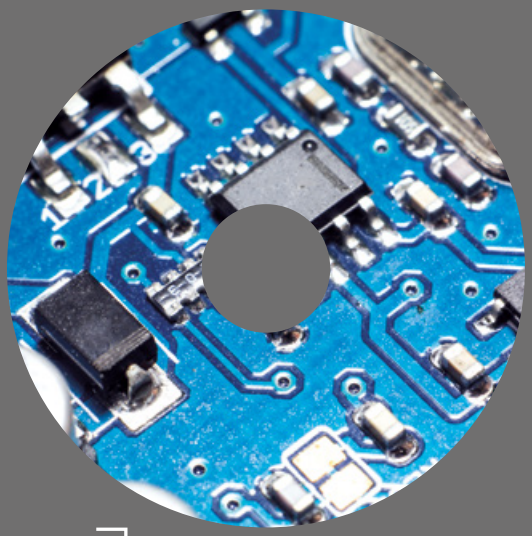
Applications:
Food Industry, Aviation and Space, Vacuum Technology, Pumps and Compressors, Electronics Industry, Mechanical Engineering, Vehicle Manufacturing, Generators/Engines

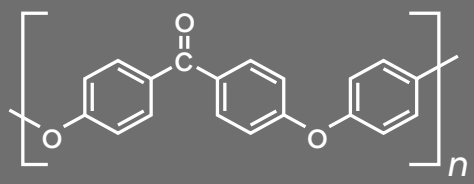
Properties

- Extremely high dimensional stability under hot conditions (up to 240 °C) in constant use
- High heat resistance up to 350 °C (HDT/A)
- Low friction coefficient and high resistance to wear and tear under extreme conditions
- Excellent radiation & plasma resistance
- Excellent thermal and electrical insulation
- Low thermal conductivity
- Good resistance to chemicals
- Constant thermal expansion coefficient and low cold flow
- Good processability (machining)
- Special recipes possible for customers (including die casting-capable compounds)

Selected materials

MATERIAL	FÜLLSTOFF	EIGENSCHAFTEN
ESKASINT 9410	Graphite	Low wear and tear Good mechanical properties, suitable for high temperatures
ESKASINT 9421	Carbon fibre	Good flexibility with high resistance
ESKASINT 9433	PTFE	Good mechanical stability, high elongation at break, compliant with food industry standards
ESKASINT 9451	Molybdenum sulphide	Low friction, low wear and tear





PEEK

GROUP 94xx

ESKAPEEK

PEEK is a thermoplastic, partially crystalline high-performance polymer and belongs to the group of polyaryletherketones. This high-performance polymer was originally developed for use in aerospace. With a fusion temperature of 343 °C, PEEK is highly temperature-resistant and flame-retardant. Under normal conditions, PEEK without additives is also a self-extinguishing material as it is only combustible with an oxygen concentration exceeding 35 vol. %.

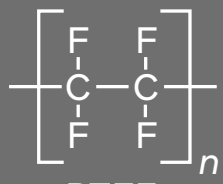
Applications:
Aviation and Space, Wind Power, Mechanical Engineering, Vehicle Manufacturing, Medical and Analysis Technology, Semiconductor Technology, Switchgear, Relay Stations

Properties

- Constant temperature resistance (260 °C) and briefly up to 300 °C
- Heat resistance up to 162 °C (HDT/A)
- Inherently flame-retardant
- Very low friction coefficient and high resistance to wear and tear
- Outstanding chemical stability
- Excellent electrical insulation (special mixtures available)
- Excellently machinable
- High dimensional stability
- Reduced internal stress due to special tempering processes
- Excellent radiation resistance
- Very high purity (materials available for the food industry)

Selected materials

MATERIAL	FILLING MATERIALS	PROPERTIES
ESKAPEEK 901	PTFE, carbon fibres, graphite	Good mechanical properties, low wear and tear
ESKAPEEK 904	Carbon fibres	Very high mechanical stability, high heat resistance
ESKAPEEK 905	Not filled	Good mechanical stability, high elongation at break, compliant with food industry standards
ESKAPEEK 916	Glass fibres	High mechanical stability, high heat resistance, good price
ESKAPEEK 925	Carbon fibres, very high filling level	Extremely high rigidity, good elongation at break
ESKAPEEK 942	Mineral substance, average filling level	Low diffusion
ESKAPEEK 944	Mineral substance, high filling level	Very high shape retention, low diffusion



PTFE

GROUP 100-899

ESKAFLON

PTFE is a highly fluorinated high-performance polymer which is characterised by high temperature resistance, excellent chemical stability as well as by low friction coefficients. This makes PTFE an ideal candidate where pressure, temperature and friction meet.

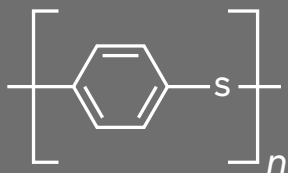
Applications:
Food Industry, Vehicle Manufacturing, Oil and Gas Engineering, Mechanical Engineering, Packaging and Tool Machinery, Construction Machinery, Cryogenics, Biogas Plants, Jigmaking

Properties

- Constant temperature resistance up to 260 °C (dependent on the mechanical load)
- Brief temperature resistance up to 300 °C
- High pressure resistance (for filled compounds)
- Virtually universal resistance to chemicals (all common acids and alkalis)
- Flame-retardant (even with pure oxygen) – BAM-certified material available
- Physiologically harmless (materials available for food applications)
- Antibacterial effect
- Lowest friction coefficient of all commercial polymers
- High resistance to wear and tear (for special tribologically optimised recipes)

Selected materials

MATERIAL	ADDITIVES	PROPERTIES
ESKAFLON 101	Glass fibres	For simple parts, high chemical resistance, compliant with food industry standards
ESKAFLON 202	Glass fibres, carbon, graphite	Wear and tear-free, average mechanical properties
ESKAFLON 401	Carbon, graphite, average filling level	Good mechanical properties, compliant with food industry standards
ESKAFLON 406	Carbon, graphite, high filling level	Excellent mechanical properties, compliant with food industry standards
ESKAFLON 449	Carbon, graphite, highest filling level	Low expansion, high rigidity, compliant with food industry standards
ESKAFLON 701	Special recipe	Wear and tear-free with Nitrogen
ESKAFLON 801	Special recipe	Excellent properties, mechanical wear and tear-free with Hydrogen
ESKAFLON 810	Polyimide	Very low friction, high temperature range, low abrasion



PPS

GROUP 81xx

ESKATRON

PPS is a thermoplastic, partially crystalline high-performance polymer which is characterised by high temperature resistance, outstanding chemical stability as well as by excellent mechanical rigidity. This makes PPS an ideal candidate where pressure and temperature meet in a distinct form.

Anwendungen:
Electrotechnology, Mechanical Engineering, Automotive Engineering, Chemical Plants

Properties

- Constant temperature resistance up to 240 °C (dependent on the mechanical load)
- Brief temperature resistance up to 260 °C
- High pressure resistance (also at lower content of fillers)
- Very good resistance to chemicals (except for strong acids and alkalis)
- Very good mechanical properties (high rigidity)
- High creep resistance, also in case of heavy pressure loads
- Very good dimensional stability
- Good electronic insulator
- Very high purity
- High resistance to wear and tear (for special tribologically optimised recipes)
- Diameter up to 1,200 mm possible in special cases

Selected materials

MATERIAL	ADDITIVES	PROPERTIES
ESKATRON 8101	Carbon fibres, PTFE, graphite	High resistance to wear and tear, high mechanical rigidity
ESKATRON 8102	Carbon fibres, PTFE, graphite	Very high resistance to wear due to higher filler content
ESKATRON 8114	Glass fibres	Glass fibre-reinforced material for high mechanical loads

FURTHER PPS-BASED RECIPES AVAILABLE UPON REQUEST

Customised recipes

The decision in favour for the optimum high performance polymer as matrix material is only the first step towards the perfect material. Filling materials such as glass fibre or carbon fibres for reinforcement or dry lubricants such as molybdenum sulphide or graphite actually provide the polymer with the important target properties for its application such as mechanical rigidity, hardness and resistance to wear and tear – here, the perfect mix is often the decisive factor.

High-performance polymers are manufactured at STASSKOL based on powdery components using an optimised system. This has the advantage that, in addition to standard materials, individual customer mixtures can be manufactured fast and efficiently.

We are happy to jointly develop a new material which is ideally suited to your application. To achieve the target properties, numerous analysis methods are available.

Tensile and bending tests, the determination of impact strength, thermal expansion and heat resistance as well as the characterisation of wear and tear properties with numerous gaseous atmospheres depict only an excerpt of the available existing analytical methods. Often, particularly the connection of the filling materials to the high-temperature polymer matrix is the decisive factor. Here, scanning electron microscopy proves to be a helpful means for making the correct choice when using compatibilizers.

You can also use our competences to analyse a competitor's material and to copy it using "reverse engineering" and outdo it with further optimisation.

Challenge us and use our options to develop the optimum materials for your applications.

Processing on a large scale

Special applications require special recipes which repeatedly push the limits of what is feasible. To shift the limits of properties such as mechanical rigidity, temperature resistance or wear resistance, selected filling materials and lubricants are added to the high-performance polymer.

For standard processes such as extrusion and die casting, the share of filling materials and lubricants is strictly limited as the mixture must be capable of flow.

To overcome this limit, STASSKOL has perfectioned the hot compression molding of high performance polymers. Highly filled polymer recipes can be processed into semi-finished products by an optimised process using pressure at a high temperature.

The specifically prepared tool concept allows a high variation of diameters up to more than 1,200 mm. In the large diameter area, STASSKOL has thus developed a unique selling point.

In addition to an innovative tool concept, STASSKOL also has hydraulic presses up to a maximum load of 800 tons in order be able to manufacture semi-finished products with the corresponding size.

The reduction of internal stress to a minimum is an important prerequisite for several applications – for this, large furnaces are available for tempering the high-performance polymers.

Use our competence in polymer processing to obtain the ideal material for your application in customised dimensions and thus to optimise the cost/benefit ratio.

We continuously develop our processing methods in accordance with our customers' needs.

Ask us for your desired dimensions!

Tribologically optimised high-performance polymers with a high

wear resistance

Friction & wear are the central factors for tribological applications. Here, different materials come into contact without the addition of a liquid lubricant under relative motion. This may result in temperatures becoming thigh and increased wear, which then drastically reduces the working life of the components.

STASSKOL has always been engaged in tribologically optimised materials. Here, fillers and dry lubricants are added to the high-performance polymers. Thus, both wear and tear and friction are minimised significantly - in favour of the durability of your products.

Background

Tribologically optimised materials provide the key to reliable, long-term use. This not only results in high customer satisfaction, but also saves resources, thus being environmentally sound.

For example, PTFE has the lowest friction coefficient of all commercial polymers, however its wear is extremely high due to the low intermolecular forces. Filling materials such as carbon or carbon fibres increase the wear resistance. Dry lubricants such as graphite and molybdenum disulfide ensure that the friction coefficient remains at a low level.

STASSKOL owns tribometers for the optimisation of such recipes, which measure friction and wear. The materials can be tested here applying the widest range of gases and adapted parameters, both using reciprocating and rotational movement. As tribology is always a system property, the application conditions are reproduced as closely as possible.

Due to the several decades' experience in pump and compressor sealing, STASSKOL has acquired unique expertise in the field of tribologically optimised materials. Today, a large range of standard PTFE-, PEEK-, PPS- and polyimide-based materials are available for a wide scope of applications.

However, in addition to these established recipes we also use our experience to specifically develop the ideal material for your application.

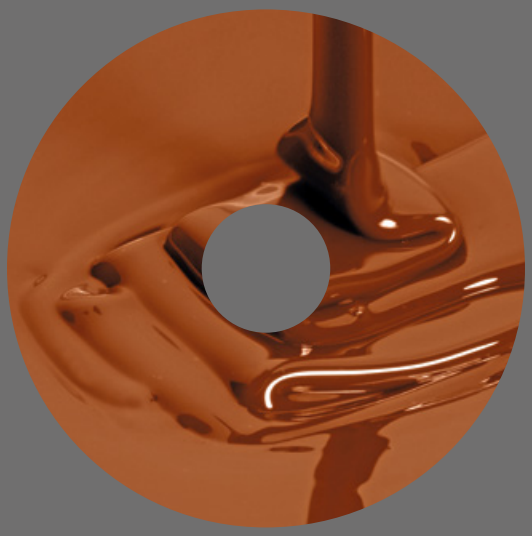
Please ask us!

Selected materials

MATERIAL	ADDITIVES	PROPERTIES
ESKAFLON 313	PTFE, bronze, carbon fibres, MoS_2	Application with Air
ESKAFLON 701	PTFE, carbon fibres, MoS_2	Application with Nitrogen
ESKAFLON 801	PTFE, carbon fibres, graphite	Application with Hydrogen
ESKAFLON 8101	PPS, PTFE, carbon fibres, graphite	Application with Hydrogen, high pressure resistance

The right additives bring success

Graphite (left) and molybdenum disulfide (right) as efficient dry lubricants

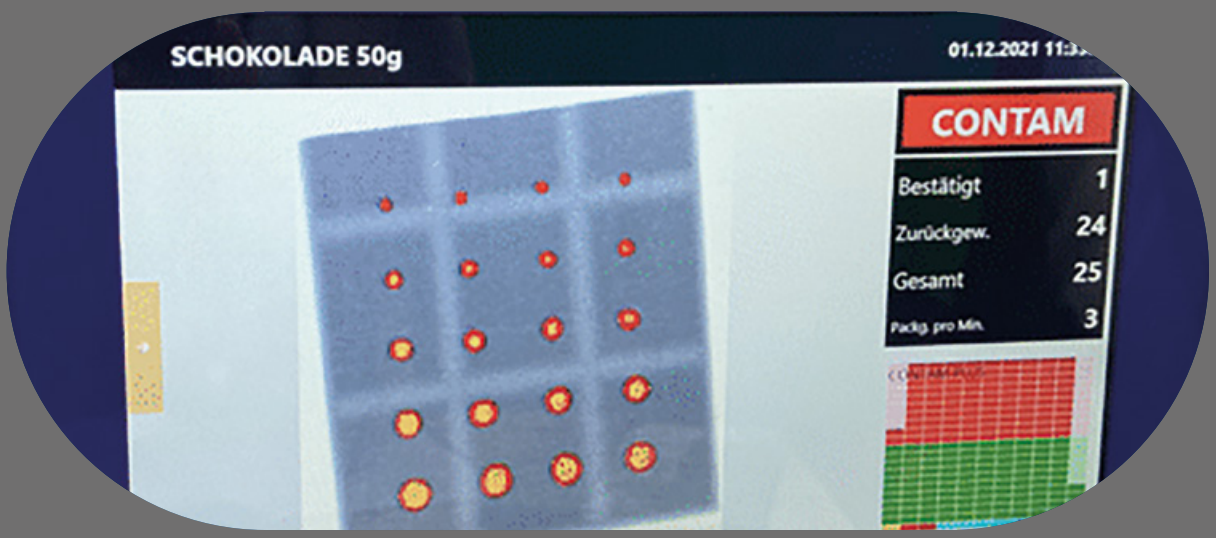


High-performance polymers
for the food sector with excellent

detectability

Consumer protection has top priority in the food processing industry. The contamination of food via polymer particles must therefore be pevented. STASSKOL has developed high-performance materials for this purpose, which in addition to good mechanical properties, excellent temperature resistance and low bonding set new standards regarding detectability.

Our XD series materials can be recorded using X-ray detection, whilst the DD series materials can also be identified using metal detection.



Polymer solutions for the food industry

We cannot imagine the food industry without polymers any longer. As a replacement for metal, they not only enable considerable weight reduction, but also normally make the use of external lubrication redundant.

Furthermore, fluoropolymers such as PTFE and polyaryletherketones such as PEEK demonstrate excellent chemical resistance. Therefore, regular cleaning and sterilisation of the surfaces is unproblematic.

Detectable high-performance compounds

STASSKOL offers various solutions for the use of polymers in the food industry. Here, a special development includes the detectable polymers. In case of machine damages, polymer particles can easily be recognised, and the contaminated food safely discharged using a combination of X-ray and metal detectors.

With the help of our strong partner Mettler Toledo, we were able to develop compounds which allow the detection of considerably smaller particle sizes than was possible to-date using the competitors' materials. Our expertise is based on precise analyses of radiation-absorbing effects and the influences of electromagnetic fields dependent on the properties and particle size of the polymer.

Thus, STASSKOL contributes to the fulfilment of a successful HACCP concept.

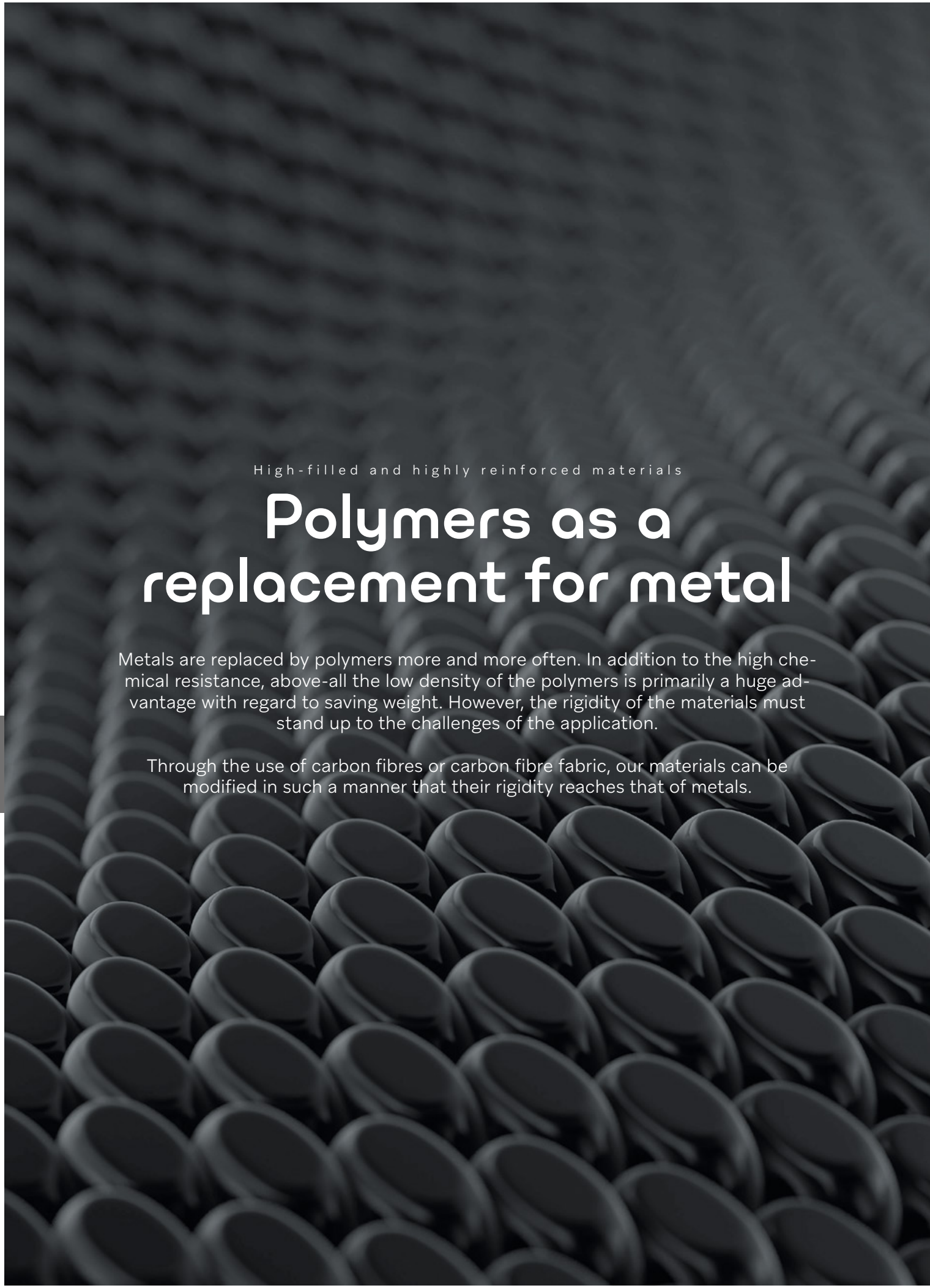
Selected materials

MATERIAL	RECIPE	DETECTABILITY
ESKAFLON XD	PTFE + inorganic filling material	X-ray detection, pigmentation possible
ESKAPEEK XD	PEEK + inorganic filling material	X-ray detection, pigmentation possible
ESKAFLON DD	PTFE + magnetic filling material	X-ray and metal detection, no pigmentation possible
ESKAPEEK DD	PEEK + magnetic filling material	X-ray and metal detection, no pigmentation possible

Customer-specific solutions and certification

It is always possible to further develop our detectable compounds in order to find the optimum material solution for your area of use. Thus, the concept can be transferred to further base polymers (e.g. polyimides) and the recipe adapted to the requirements of the application.

Here, all of our materials meet the requirements of the US Food and Drug Administration (FDA) as well as the European specifications for food contact materials.



High-filled and highly reinforced materials

Polymers as a replacement for metal

Metals are replaced by polymers more and more often. In addition to the high chemical resistance, above-all the low density of the polymers is primarily a huge advantage with regard to saving weight. However, the rigidity of the materials must stand up to the challenges of the application.

Through the use of carbon fibres or carbon fibre fabric, our materials can be modified in such a manner that their rigidity reaches that of metals.

Background

Compared with basic polymers, high-performance polymers have an inherent higher rigidity. In particular, thermoplastic high-performance polymers such as polyarylketones (e.g. PEEK or polyphenylene sulphide) can trump with a high E-module and high tensile strength.

To be able to use polymers to replace metals, a lot more is needed as the rigidity of metals is considerably higher than that of native high-performance polymers.

To increase the rigidity of the materials, hard coal, carbon fibres, but also fabric mats consisting of carbon fibres are inserted into the high-performance polymers. Here, mechanical properties which come very close to those of metal materials can be achieved, in particular at high to very high filling levels.

STASSKOL has developed the decisive processing method for this with its Hot Compression Moulding. Filling levels in excess of 50 vol.-% can be realised using it, meaning that the majority of the material consists of filling materials.

An advantageous side-effect of the strongly increased rigidity of the polymers is the reduction of their thermal expansion.

PTFE even has a very high thermal expansion coefficient compared to other polymers. For example, we were able to reduce it to the thermal expansion coefficient of aluminium for our ESKAFLON 449, making the material particularly attractive as bearing material at higher temperatures - in contact with aggressive media.

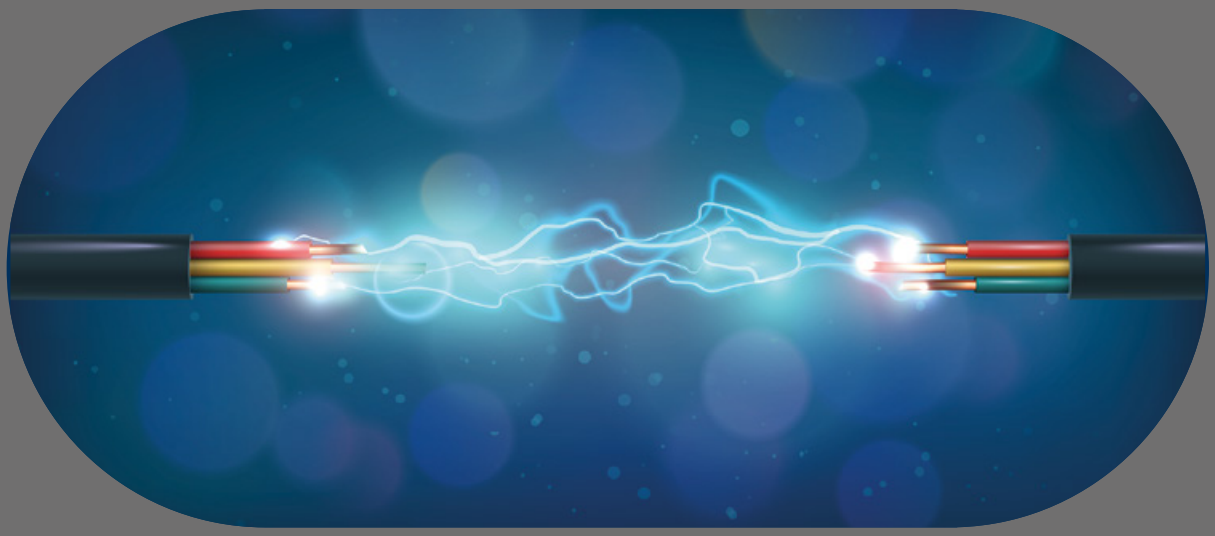
For PEEK-, PSS- or polyimide-based materials, we already start at a level with more rigidity and lower thermal expansion. Here, too, the properties can be further improved by using the right filling materials in high concentration (e.g. ESKA- PEEK 904).

In addition to the high rigidity, these recipes also provide all the further advantages of our high-performance polymers - in particular their very good chemical resistance, a feature otherwise only found in the area of metals in extremely cost-intense alloys.

You can find some of the recipes from our standard range below. Alternatively, we are happy to advise you when selecting the right material solution for your application.

Selected materials

MATERIAL	ADDITIVES	PROPERTIES
ESKAFLON 449	PTFE, carbon, inorganic	Highest filled PTFE with very low, excellent thermal wear and tear resistance
ESKAPEEK 904	PEEK, carbon fibres	Carbon-fibre-reinforced PEEK with very good wear and tear resistance
ESKASINT 9404	Polyimide, carbon fibres	Carbon-fibre-reinforced polyimide with a high service temperature limit

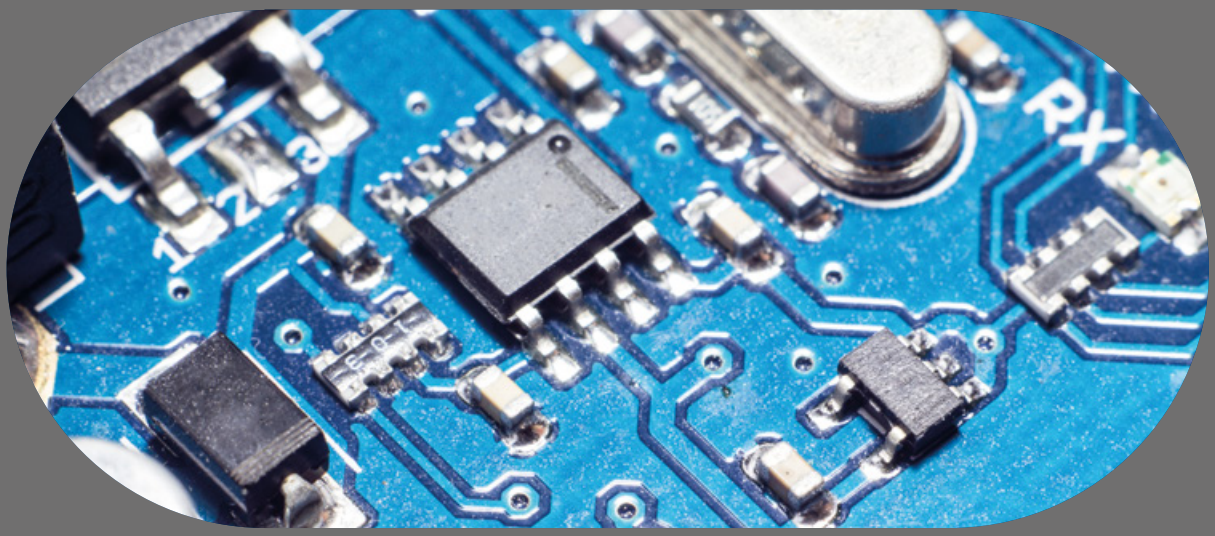


Electrically non-conducting and electrically conducting materials

ESD & ELS materials

High-performance polymers find more and more use in electrotechnology,
whether as a component for electrical switching
or as a part of casing - the task is to avoid static charging,
thus ensuring that the electronic assembly functions.

Special filling materials enable the polymers to be modified in such
a manner that the surface resistance of the materials is drastically reduced.



Background

Unfilled polymers have both very high surface resistance and very high contact resistance. Thus, they denote ideal electrical insulators. With suitable additives at the right concentration, the conductivity of high-performance materials can be increased considerably.

High conductivity or a low surface resistance is a decisive advantage for components in electronic systems or production plants for electrical components. Electrical loads are discharged fast and efficiently by the polymer components so that the electrical systems are protected effectively.

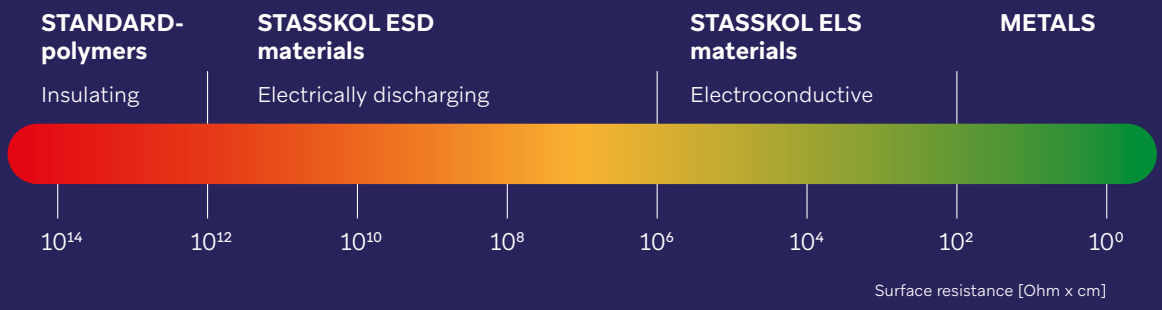
Also, in Mechanical Engineering the avoidance of electrical charging is of paramount importance. Here, the focus is primarily placed on casing components for explosion protection for ATEX applications.

The excellent electrical properties of the modified polymers can be combined ideally with the further advantages of these materials (temperature resistance, high mechanical rigidity, chemical resistance, etc.).

Initially, the area must be established in which the surface resistance must lie to fulfil the requirements of the application (see graph below).

Contact us so that we can offer you the right solution from our ESD & ELS materials series.

Range of the surface resistance



The right additives make the difference

Graphite (left) and carbon nanotubes (right) for high electrical conductivity

High-performance polymers for sealing applications under

Oxygen

The sealing of Oxygen really is one of the most demanding applications in the area of high-performance polymers.

To master this task, a chemically inert polymer (PTFE) with a sophisticated filling recipe is required. The ESKAFLON 305 combines high sealing efficiency with excellent fire resistance - tested by the Bundesanstalt für Materialforschung und -prüfung [Federal Institute for Material Research and Testing] (BAM).

Background

Applications using pure Oxygen pose the highest requirements of a sealing material. In particular under high temperatures and pressures, an uncontrolled burn-off may occur.

To minimise the risk of Oxygen burn-off, a special recipe based on PTFE named ESKAFLON 305 was developed, which combines an excellent sealing efficiency with a high flame recistance - and this checked by the Bundesanstalt für Materialforschung und -prüfung [Federal Institute for Material Research and Testing] (BAM).

The test has proved that the ESKAFLON 305 can be used with the following maximum parameters:

Compression ratio V	Maximum application temperature	Maximum Oxygen pressure
<= 5	175 °C	100 bar

The application spectrum for the material ESKAFLON 305 ranges from use in oxygen-carrying fittings to sealing rings for Oxygen pumps.

Thus, for example, STASSKOL was able to provide technical support for the course record flight of the Luftsport-Verein Gifhorn e.V. [Aerial Sports Club].

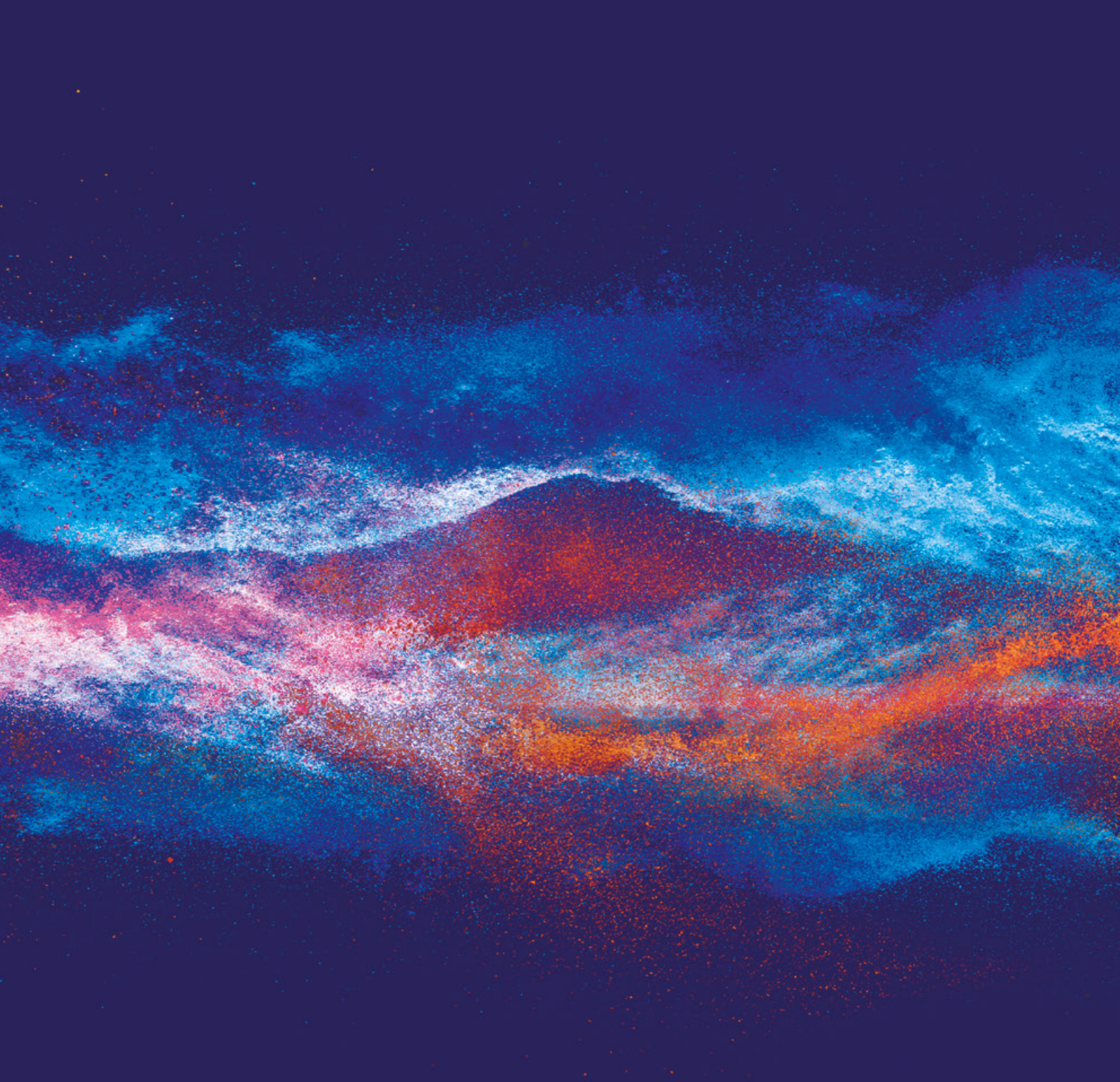
Here, the old grooved hydraulic rings made of NBR [Perbunan] were replaced with dry running sealing rings consisting of ESKAFLON 305. This not only increased the sealing efficiency of the pump, but also stopped corrosion, which had always been a problem up to then.

Course record flight
of the Luftsport-Verein Gifhorn e.V. [Aerial Sports Club]

In addition to such attractive and rare applications, STASSKOL uses ESKAFLON 305 in Oxygen compressors with reciprocating movement, (the reciprocating compressors) as standard sealing material.

Top requirements exist for the production of ESKAFLON 305.

Here, only high-quality filling materials are used. The properties of both the raw materials and the mixture are subject to stringent controls during the production process. This is the only way to ensure that the material is suitable for use with pure Oxygen.



Sales force for high-performance polymers
+49-152-38297113

STASSKOL GmbH
Maybachstrasse 2
D-39418 Stassfurt
Germany

+49-3925-288-100
halbzeuge@stasskol.de
www.stasskol.de