

# Bellows, Diaphragms and Engineering Parts Made from PTFE.

*Versatile Solutions Featuring Maximum Precision*



**elringklinger**  
Engineered Plastics

# Bellows, Diaphragms and Engineering Parts Made from PTFE.

Pages 4 – 7

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**Bellows**  
for medical, food  
and general  
industrial applications

**Diaphragms**  
for the chemical and  
pharmaceutical industries

**Other Engineering Design  
Elements**  
such as milled parts,  
deep drawing parts,  
isostatically compression-  
molded parts

**Rollers and Rolls**  
PTFE- and PU-coated rollers  
and rolls for  
high-performance printers



## Technical Consulting Support

### Innovations from PTFE

With its seals and engineering design elements ElringKlinger has been one of the technology leaders in its field for over 50 years. We develop tailored solutions from PTFE, PTFE compounds and other high-performance plastics as well as composite parts combining PTFE with other plastics or metals for customers around the world. Our solutions meet the toughest demands to be found in the field – with economy and reliability guaranteed.

### Top Performance and Functional Reliability

Engineering parts and tubings made from PTFE: the right choice when it comes to high thermal stress. In addition to their outstanding tribological properties, these compounds offer excellent chemical resistance to aggressive media. For applications in the food and pharmaceutical industry, our special compounds are used.

We will be pleased to support you in designing your engineering components. Please complete and return the technical questionnaire or contact us directly. Our application engineers will provide you with an installation/assembly proposal and/or a quotation as quickly as possible.

### Quality and Environmental Policy

Top quality and an active commitment to environmental protection are key to ElringKlinger's sustained success in the marketplace. That is why we are certified according to ISO/TS 16949 and DIN EN ISO 14001.



**Material Data**  
**Technical questionnaires**



## Properties of Fluoroplastics

PTFE is a linear polymer from carbon and fluorine with exceptional properties.

### Nearly Universal Chemical Resistance

The extremely stable combination of fluorine and carbon atoms and the almost complete shielding of the carbon chain by the fluorine atoms give PTFE nearly universal chemical resistance. Only hydrocarbon combinations containing fluorine and melted alkali metals cause PTFE to swell or produce a limited chemical reaction on the surface. Even after prolonged storage, no water absorption can be

noted. In extreme climatic conditions PTFE shows nearly unlimited weather resistance. Worthy of particular mention are PTFE's good physiological properties.

### High Thermal Stability

across a wide temperature range. PTFE can be used within a temperature range from  $-200^{\circ}\text{C}$  to  $+300^{\circ}\text{C}$ .

### Good Sliding Properties

even in dry running conditions.

### Friction Coefficient

Of all solids, PTFE has the lowest coefficients of friction. The static and dynamic coefficients of friction are nearly identical, which means that there is no stick-slip effect with PTFE even at very low sliding speeds.

### Excellent Anti-Adhesive Properties

PTFE has very low adhesion. This is due to the strong bond between the carbon chain and the fluorine atoms and their low polarization capabilities.

PTFE is difficult to wet, but following a chemical pre-treatment it is suitable for glueing with good adhesive bonding.

### Good Electric Properties

PTFE has outstanding electric insulation properties which are nearly constant across a wide temperature range. Added to this is a very low dielectric constant combined with a low dielectric loss factor.

### High Reverse Bending Strength



# PTFE Bellows



**P**TFE bellows are used as balancing elements between engineering parts. They are machined parts. Due to the different geometries of the folds highly flexible or pressure-resistant versions can be designed and manufactured.

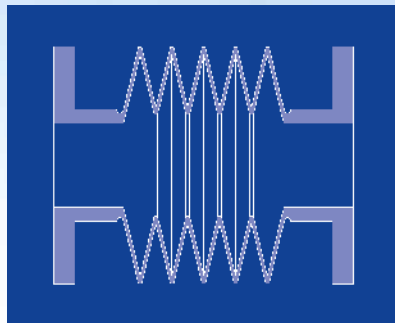
PTFE's outstanding material properties allow bellows to be used increasingly in medical, food and general industrial applications.

## **Benefits**

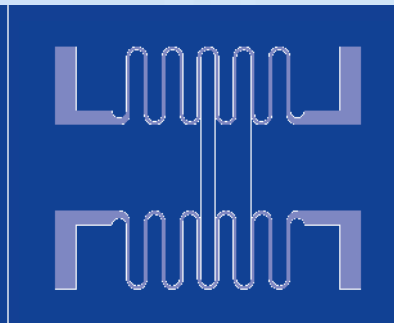
- Nearly universal chemical resistance
- FDA-conformable materials for food and pharmaceutical products
- Very good suitability for sterilization
- Anti-adhesive
- Wide temperature range from  $-60^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$
- Cost effective series production from in-house production of semi-finished goods to the final product
- High reverse bending strength
- Good dimensional stability
- Low tooling costs
- Freedom of design

# Applications

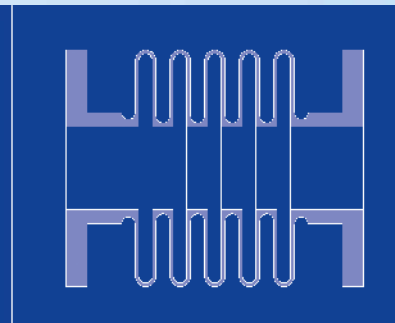
## Versions



**Pointed, Non-cut Folds**  
for maximum expansion and  
low pressures up to 3 bar.



**Round, Machined Folds**  
for improved cleaning and  
maximum reverse bending  
strength. Low to medium  
pressures up to 6 bar.

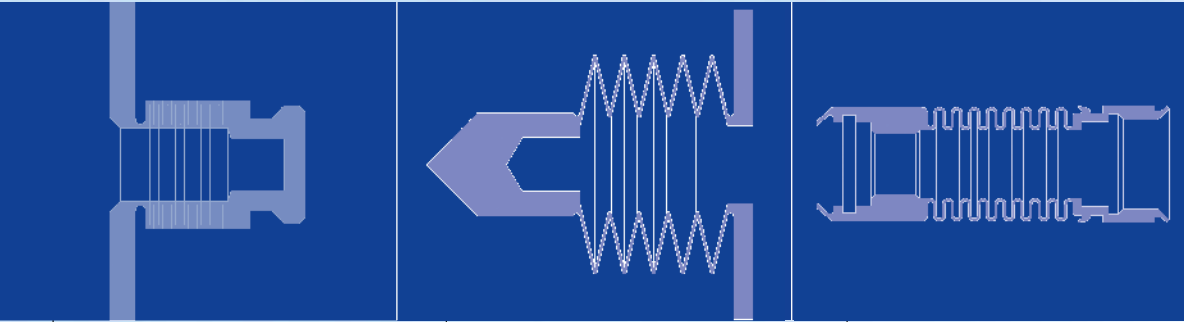


**Solid, Machined Folds**  
for high pressures above  
6 bar. Optimal with  
rectangular support on the  
rod or in the cylinder.

### Fields of Application

- As compensation for expansion in pipe systems
- For shielding sterile areas
- For filling systems
- With aseptic valves
- With solenoid valves
- With metering devices
- With pumps and valves

## Application Examples

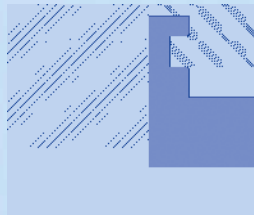


**Bellows for a solenoid valve in medical technology.**  
 High flexibility and frequency.  
 Physiologically harmless.  
 Resistant to aggressive cleaning agents.

**Bellows for filling valves**  
 Hermetical separation of the medium from the actuation mechanism. The tip is the sealing cone of the valve.

**Multi-functional bellows**  
 Separation of two areas with moving parts. Integration of sealing and guiding elements. Connections can be performed according to customer specifications.

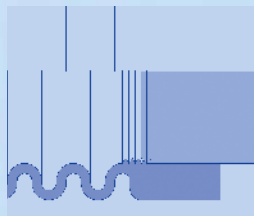
## Various Connecting Configurations



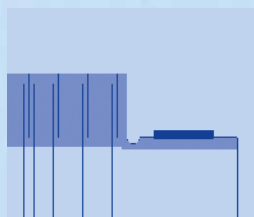
*Positive flange compression fit.*



*Clamping flange with additional O-ring seal.*



*Locating connection with thread.*



*Clamping by means of a sleeve.*

### Materials

- Typically, unfilled PTFE with FDA-conformance
- Modified PTFE with higher reverse bending strength
- Special versions with electrical conductivity
- With applications as metering, shut-off and sealing element the clamping flange, the sealing cone or the slide ring may be manufactured from a PTFE compound (e.g. glass fibers or ceramics)
- For information on materials with good reverse bending strength and low permeation, please see pages 20 – 23
- For your inquiry, please complete the technical questionnaire at the end of the catalog





# PTFE Diaphragms



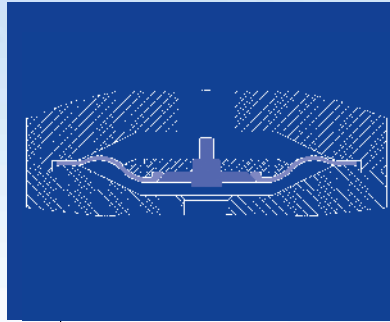
**D**iaphragms are hermetical seals between two spaces with media and pressures which, typically, differ from each other. Unlike piston and rod seals, there is no drag leakage at the contacting surfaces, and the requirements to be met in terms of tolerances and surfaces are lower.

Chemical resistance to aggressive media, flexibility and long service life are major requirements made on materials and the design of membranes. For perfect service, it is indispensable that diaphragms design and selection of the respective compound be adapted specifically to the particular application conditions.

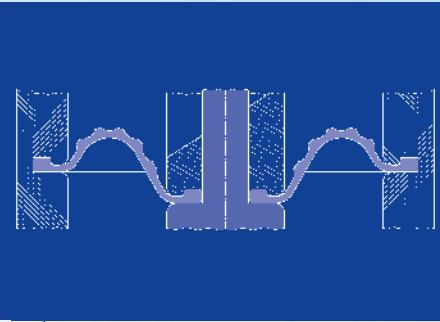
## **Benefits**

- Good reverse bending strength
- Nearly universal chemical resistance
- Very good suitability for sterilization
- Temperature resistance  
–60°C to +200°C
- FDA-conformable materials
- Freedom of design
- Homogeneous structure

# Applications



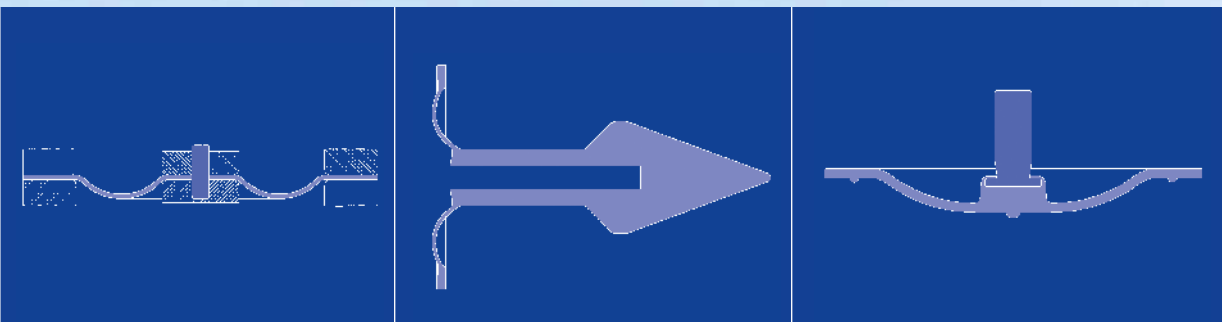
**Diaphragm**  
with metal core for painting  
pumps.



**Diaphragm**  
with grooves on the back  
for sterile valve with  
very smooth surfaces.

## **Fields of Applications**

- Metering devices for the pharmaceutical and food industries
- Pumps for the chemical industry
- Pumps for painting technology
- Pressure regulators
- Pharmaceutical valves



**Diaphragm**  
for fluid pumps in the  
chemical industry.

**Piston Diaphragm**  
with integrated sealing  
cone in filling lines.

**Formed Diaphragm**  
for actuating valves.



PTFE diaphragms are used in metering devices for the pharmaceutical and food industries as well as in pumps of the chemical industry and in painting technology.

Because of their outstanding physical and chemical properties PTFE diaphragms are being used in constantly increasing fields of application. The lift of the diaphragm is determined by its shape and design as well as the existing effective diameters.

To reduce the risk of damage, the sandwich diaphragm technology is primarily being used (principle of the double barrier, diaphragm technology with breakage sensor). This enables early detection of malfunctions for planned execution of timely repairs and appropriate corrective action which reduces production downtimes significantly. In addition, this helps prevent contamination of the media fluids to be pumped.

With multi-layered diaphragms and constant material thicknesses the actuating forces are considerably lower than those of single-layered diaphragms.

In addition to stamped diaphragms, machined diaphragms are increasingly being used. A major advantage over PTFE/elastomer composite diaphragms is the homogeneous structure and freedom of design offered by these diaphragms.

To increase service life, specially treated PTFE films and films made from modified PTFE are used.

For information on materials with good reverse bending strength and low permeation, see pages 20–23.

For your inquiry, please complete the technical questionnaire at the end of the catalog.

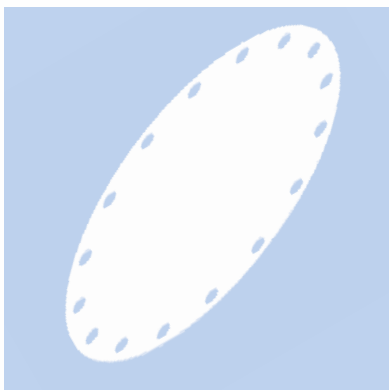
## Versions

### *Film Diaphragms*

- For large volumes
- For medium requirements regarding lift, service life, pressure
- More sophisticated design of clamping surfaces

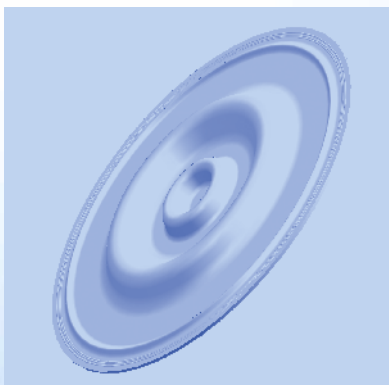
### *Flat Diaphragms*

- Only for very small lifts
- Lowest tooling and manufacturing costs
- Low assembly height



### *Diaphragms with Stamped Contour*

- High performance capability
- Low restoring forces
- Multi-layered designs (for evacuation of leakage, higher pressure strength)



### *Machined Diaphragms*

- For maximum requirements regarding lift, service life, pressure ( $H_{\max} \leq 0,30 \times \varnothing \text{ eff}$ )
- For specified installation spaces

### *Versatile Design Options*

- No dead space in clamping areas
- Leakage evacuation with multi-layered designs
- Reinforcement grooves, beads, cuts to avoid radial creasing
- Sealing elements to close openings
- Core/disc design for mechanical articulation



# Assembly and Design Instructions



In the clamping zone, the diaphragm is fastened between the housing flanges under sufficient pressure (thread-fastening, clamping). The diaphragm in this case acts like a static seal. Deformation damage caused by excessive clamping pressures must be avoided through flange stops and/or specified torque levels. Depending on the diaphragm material and diaphragm thickness, additional flat or profile seals may be used for sealing.

With PTFE diaphragms, sealing performance can be improved by a V-profile surface structure of the respective assembly components, meaning the V-profile structure of the housing or supporting parts is pushed into the PTFE, resulting in improved sealing performance.

For mechanical articulation, the diaphragm is typically clamped between the supporting and the pressure disc. The individual components are joined by a threaded connection, riveting or vulkanized. When designing the support, it must be ensured that the surfaces contacting the diaphragm are burr-free and that there are sufficiently dimensioned transition radii.

General rule:  $R \geq 4 \cdot s$

R = radius; s = diaphragm thickness

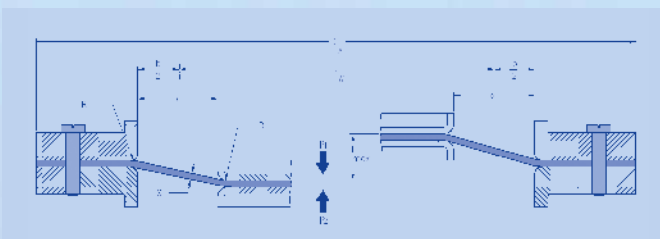
For perfect service, it is indispensable that diaphragm design and selection of the respective compound be adapted specifically to the particular application conditions.

We will be pleased to provide you with respective consulting support.

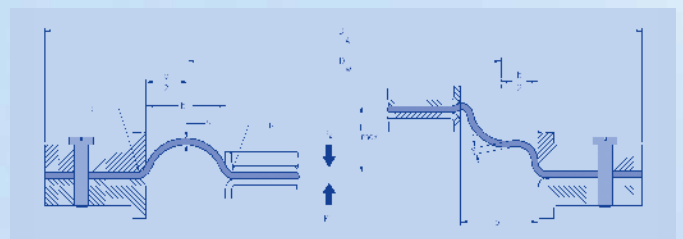
### Dimensioning Legend for Engineering Drawings

- $D_A$  Ø outside
- $D_w$  Ø eff
- b (radial bead width)
- S (membrane thickness in the bead area)
- P (pressure)
- $H_{max}$  (maximum lift)
- R (radii at the transition points)

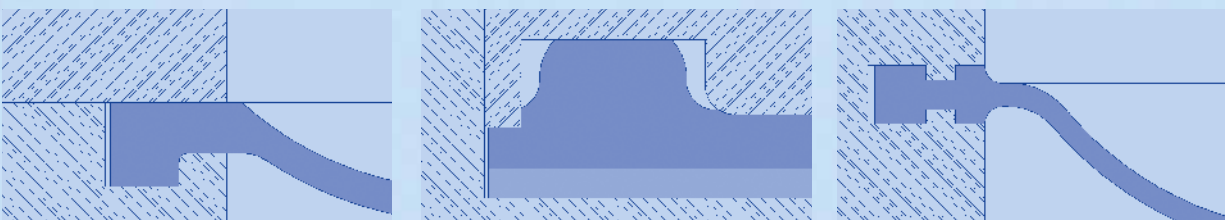
### Flat Diaphragms

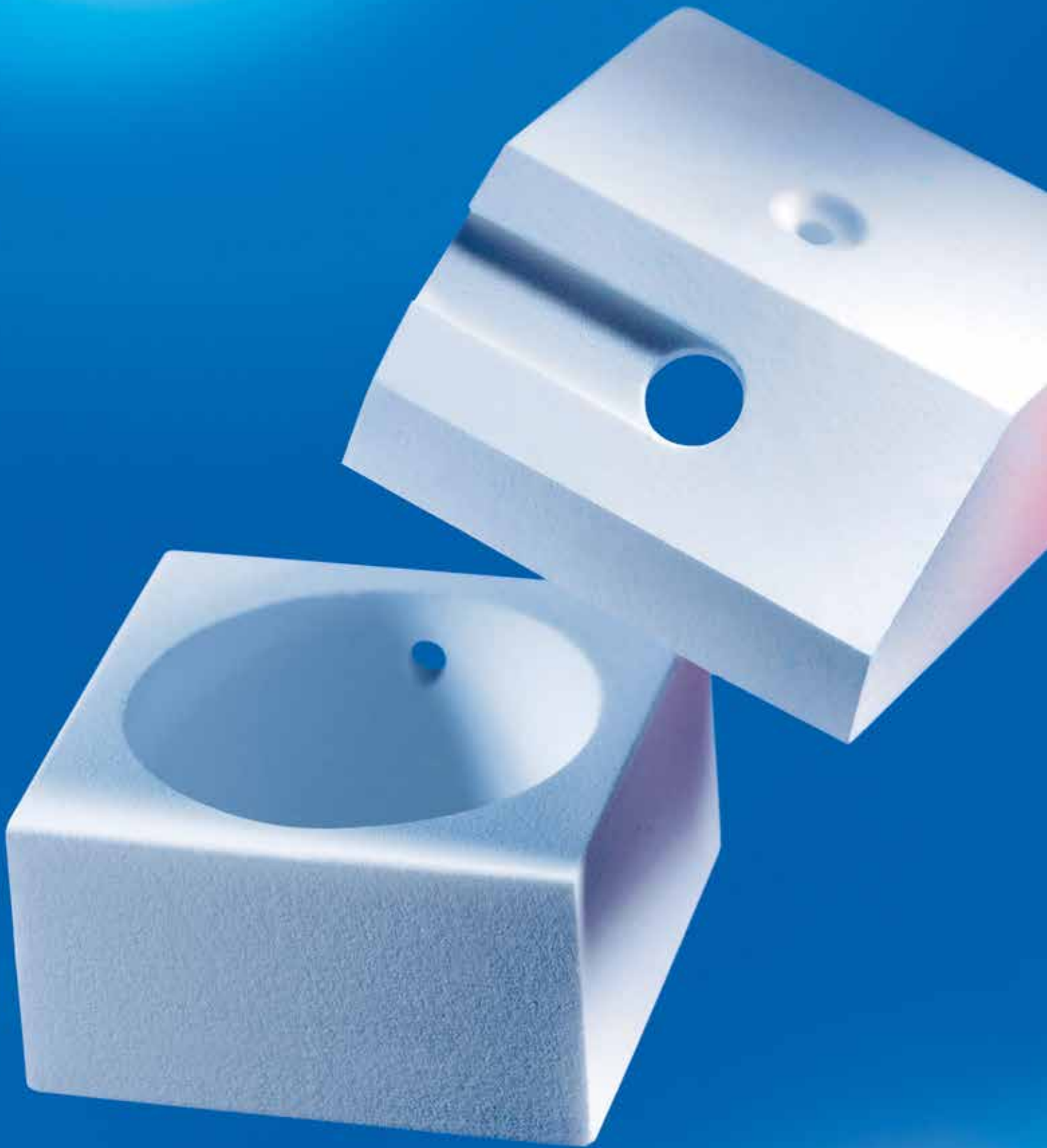


### Diaphragm with Bead



### Other Clamping Options





## Other Engineering Design Elements

**E**lringKlinger are masters in the art of making the best of plastics. We offer a wide range of materials that are optimally adapted to your needs. PTFE – the versatile high-performance plastic material – plays a superior role as the base material for new product ideas.

PTFE as an engineering design material or as a permanent composite with metals, elastomers and other plastics. Permanent strength even in extreme conditions.

But we also process other highly durable plastics such as

- PE-UHMW (ultra-high molecular polyethylene)
- POM (polyoxymethylene)
- PA (polyamide)
- PEEK (polyetheretherketone)

One of the crucial prerequisites for the functional performance and quality of assembly components is accomplished professional processing: From single parts to cost efficient volume production.

We continuously improve our manufacturing processes and develop new methods for quality assurance.

Our experience in this specialty field and our specified, integrated quality management system ensure that ElringKlinger products and problem solutions fully meet the requirements of our customers.

The product and application examples below are provided to give design and development engineers ideas of what is possible. Trust us to be your partner when it comes to translating product ideas into optimum solutions with functional reliability assured. That is why: what you need you will get from ElringKlinger. Try us!



### **Protective Covers**

are used in the food, chemical and pharmaceutical industries. This example shows a probe with a PTFE cover for protection from aggressive media, welded at the face side (photo, right). Another version: Temperature sensor with PTFE cover. Lining of electrical heating elements as protective sheathing in electroplating and microelectronics applications (photo, left).

### **PTFE Blow Molded Tube**

to protect the feeder cable in the lambda sensor from dirt and bending.

### **Trockar Tube**

used in endoscopic surgery. The device with a spiral-shaped PTFE tube enables the performance of surgical procedures with relatively low loss of blood.

## Deep Drawing Parts

### Typical Characteristics

- Low material consumption
- Allows complex geometries
- Parts have thin walls
- For cost-effective manufacturing of large-volume production
- Material properties can be influenced positively



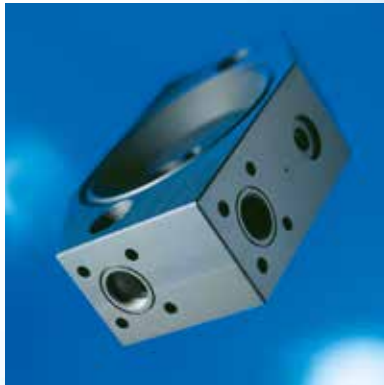
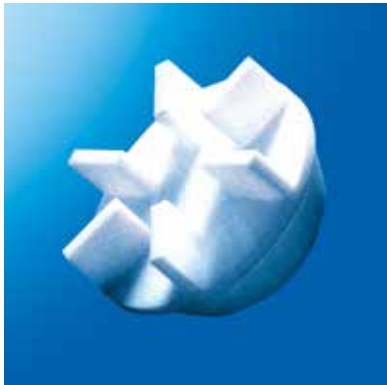
### Protective Cap for Steering Angle Sensors

- Protection of electronics
- Temperature stability up to +150°C
- Chemically resistant to aggressive oils and cold cleaners

### Sliding Tiles for Dyeing Machines

- Good sliding properties
- Easy assembly and removal
- Cost-effective manufacture
- High chemical resistance
- Easy to clean (anti-adhesive)

## Milled Parts



### PTFE Agitator Blade with Sintered-in Magnets

for use in electroplating technology.

- Good chemical resistance

### Pump Housing

for use in the chemical and semiconductor industries.

- Allows complex geometries
- Allows large dimensions
- Different manufacturing technologies available

### Ulbricht's Spheres Made from Porous PTFE

for use in optical measuring systems.

For additional information on engineered porous PTFE parts such as filter elements, Lambert's reflectors for projection screens, etc., please see our "Materials Catalog" as well as our "Light Flyer."

### Back Plates

in heat exchangers up to dimensions of 3000 x 1500 mm.

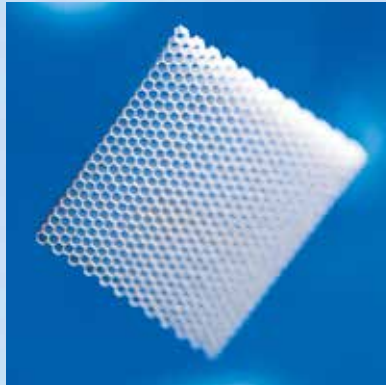




## Isostatically Compression-Molded Parts

### *Typical Characteristics*

- Low material consumption
- Allows complex geometries



### **Honeycomb**

for use in heat exchangers of power plants.

- Good chemical resistance



### **Extinguishing Nozzles**

for use in high-voltage switches.

- Good electrical insulation
- High temperature resistance

## Complete Solutions



### **Double Piston Pump**

for use in home dialysis devices; consisting of a modified PE piston and rod seal as well as a POM housing. Complete assembly from a single source.



### **Metering Piston with Injected Elastomer**

for use in the food and cosmetics industries.





**Benefits**

- Excellent anti-adhesive properties
- High temperature resistance
- Nearly universal chemical resistance
- Very good sliding properties
- Good wear resistance
- Adjustable thermal conductivity
- Adjustable electrical/dielectric conductivity

**Application Examples**

- Feed rolls and rollers
- Fuser rollers
- Pressure rolls and rollers
- Guide rolls and rollers

**Manufacturing Process of PTFE**

**Coatings**

- Roller coatings with PTFE films
- Assembly of FEP-/PTFE shrink wraps

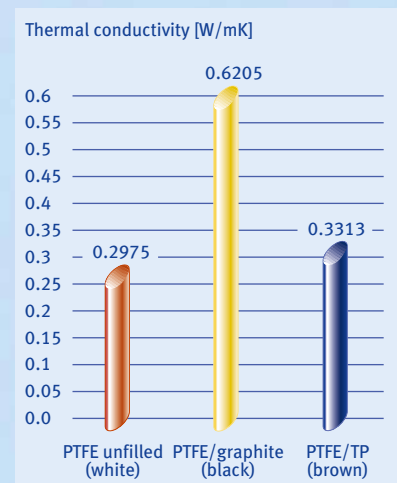
**Rolls and Rollers with PTFE High-Performance Coating**

The properties of PTFE can be influenced by processing methods and by adding fillers. Optimum adaptation to the respective application conditions is possible.

**PTFE with Fillers**

- Increased service life due to fillers
- Improved thermal conductivity due to fillers

**Thermal Conductivity of Coatings for Fuser Rolls <sup>(2)</sup>**



# Rolls and Rollers



## *Polyurethane-Coated Rolls and Rollers for Paper Feeding*

### **Feeding Systems**

Today two different technologies are used for feeding paper webs. We develop and manufacture both feeder rolls for paper with a so-called feeding perforation and newly developed feeding systems for tractor-less paper feeding.

### **Feeding Systems for Stacked Paper (PU-elastomer)**

#### **Benefits**

- Long service life due to wear-resistant surface
- Quick and precise paper feeding due to high accuracies
- Good chemical resistance
- Low masses/weights
- Application-specific engineering design (surfaces, roller materials, dimensions)



### **Feeding Systems for Reel-Fed Paper (PU foam)**

#### **Benefits**

- Reduction of paper costs by 30 – 50% by tractor-less paper feeding
- No disposal of edge trim needed
- Reliable feeding of light-weight papers
- Long service life due to wear-resistant surface
- Quick and precise paper feeding
- Good chemical resistance
- Low masses/weights
- Application-specific engineering design (surfaces, roller materials, dimensions)



# New Materials and their Properties

In the past, with applications requiring the utilization of modified PTFE, certain limitations regarding reverse bending properties had to be accepted. Now ElringKlinger has managed to launch a new product on the market, HS 22121, which combines all the advantages of modified PTFE.

### Benefits

- Higher permeation density
- Low cold flow
- Lower porosity
- Smoother surfaces
- Lower Stretch Void Index
- Weldability
- FDA-conformance

In certain aspects, the new material extent even significantly surpasses the excellent reverse bending properties of non-modified standard PTFE types. The combination of these properties was not possible in the past.

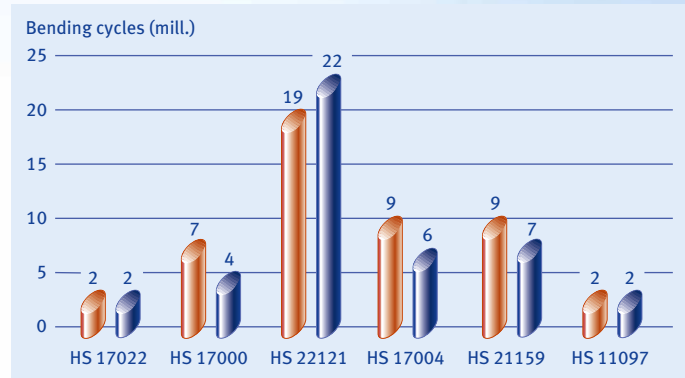
HS 22121 is equally suitable for use as a diaphragms or bellows.

In addition to the high reverse bending resistance, the material's reduced cold flow improves the retention of the diaphragm and/or bellows in the clamping area; another plus in terms of sealing performance and service life.

The results of the reverse bending test were determined by bending a test rod with a 1-mm thickness at a frequency of 4 Hz without media contact by 180° respectively.

### Reverse Bending Test 180° <sup>(2)</sup>

SPI test rod, 1 mm thick, average value

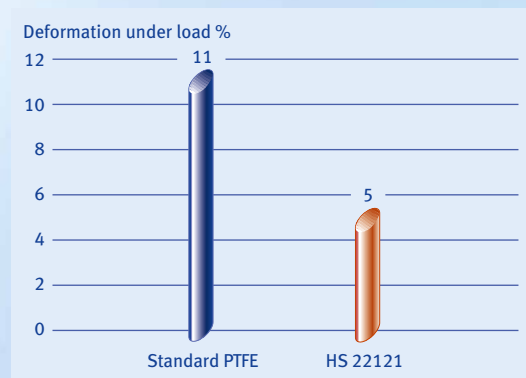


- Parallel to peeling direction
- Perpendicular to peeling direction

HS 22121 is also available as an anti-static version specifically for use in applications involving contact with solvents.

### Cold Flow Benefits <sup>(2)</sup>

Measuring conditions: 15 N/mm<sup>2</sup>, 100 hrs of pressure loading, 24 hrs of pressure relief, results in permanent deformation



For long service life, bellows and/or diaphragms should be designed with thin walls. Consequently, it is all the more important that the material used have a high barrier effect with regard to permeation. This is the case with modified PTFE materials and applies to aggressive, gaseous chemicals such as SO<sub>2</sub>, HCl or Cl<sub>2</sub> as well as to water. The latter poses a challenge for fluoropolymers particularly at high temperatures and/or in the vapor phase or in the form of aqueous, aggressive chemicals.

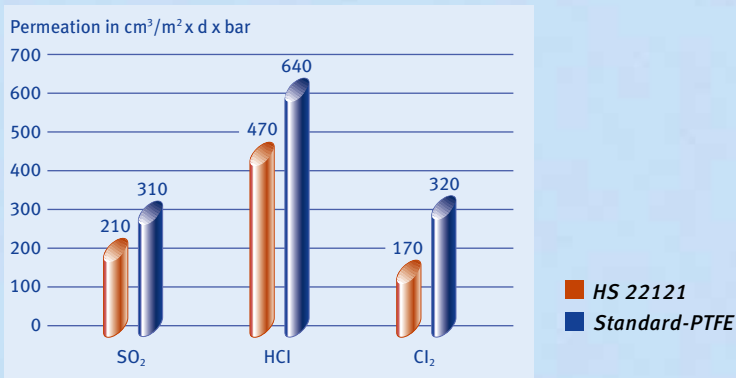
Further information about material you will find in our catalog "Compounds and Semi-Finished Products Made from PTFE"



### Higher Barrier Effect of HS 22121

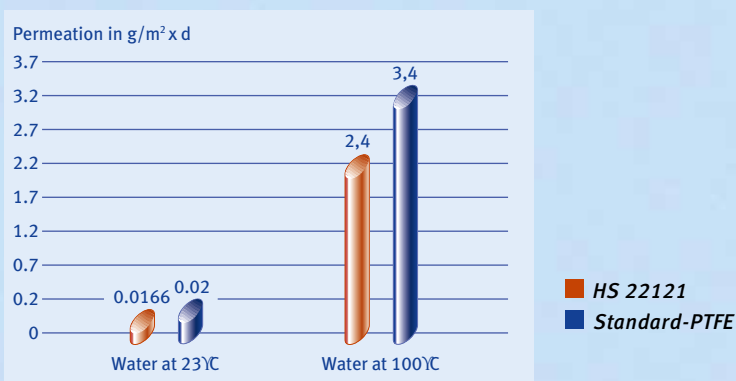
#### a) Aggressive Media<sup>(2)</sup>

Measuring method: According to DIN 53380, film thickness: 1 mm



#### b) Water and vapor<sup>(2)</sup>

Medium: Water, measuring temperature: 23°C or 100°C, film thickness: 1 mm



# The Most Commonly Used Fillers and their Influences on Compound Properties

<i>PTFE-Type</i>	<i>Influence of Fillers</i>	<i>Filler Content in % of Weight</i>	<i>Limits of Use</i>
PTFE filled with glass fibers	<ul style="list-style-type: none"> <li>• higher pressure and wear resistance as well as better thermal conductivity</li> <li>• very good chemical resistance</li> <li>• good dielectric properties</li> </ul>	up to 40%	resistant to organic solvents, non-resistant to alkaline solutions and acids
PTFE filled with carbon fibers	<ul style="list-style-type: none"> <li>• very low deformation under load</li> <li>• good wear resistance, even in water</li> <li>• higher thermal conductivity and lower thermal expansion than glass fibers</li> <li>• very good chemical resistance</li> </ul>	up to 25%	carbon fibers are chemically inert
PTFE filled with carbon	<ul style="list-style-type: none"> <li>• high pressure resistance and hardness</li> <li>• good sliding properties and wear behavior</li> <li>• good thermal conductivity</li> <li>• good chemical resistance</li> <li>• low volume and surface resistivity</li> <li>• electrically conductive</li> </ul>	up to 35%, also in combination with graphite	compound is brittle, filler may be attacked by oxidizing media
PTFE filled with graphite	<ul style="list-style-type: none"> <li>• good lubricating effect</li> <li>• low friction coefficient</li> <li>• no static charging</li> <li>• good thermal conductivity</li> <li>• very good chemical resistance</li> </ul>	typically up to 5%, in exceptional cases up to 15%, also in combination with glass fibers or carbon	high abrasion when used with hard metals, is attacked by oxidizing media
PTFE filled with molybdenum disulfite (MoS <sub>2</sub> )	<ul style="list-style-type: none"> <li>• good sliding properties and wear behavior</li> <li>• good no-lube operation in combination with bronze</li> </ul>	up to 10%, also in combination with glass fibers or bronze	not resistant when used with hot, concentrated sulfuric acid
PTFE filled with bronze	<ul style="list-style-type: none"> <li>• good sliding properties and wear behavior</li> <li>• low cold flow</li> <li>• good thermal conductivity</li> <li>• lower chemical resistance</li> <li>• high pressure resistance</li> </ul>	up to 60%, also in combination with MoS <sub>2</sub>	may be attacked by acids and water
PTFE filled with organic fillers (high-performance thermoplastics)	<ul style="list-style-type: none"> <li>• outstanding sliding properties and wear behavior</li> <li>• good chemical resistance</li> <li>• high pressure resistance in some cases</li> <li>• suitable for soft mating surfaces, e.g. aluminum</li> <li>• non-abrasive</li> </ul>	up to 20%, may be higher in combination with different fillers	depending on the respective filler

## (1) Limit Values:

Limit values have been compiled with great care based on years of experience. Values, however, will not be deemed binding and are provided without guarantee. Please note that the desired function is only assured when considering the specific conditions of a particular application. In any event, we recommend prior sampling and testing. Our development team will be happy to assist you with requisite expertise and in-house test rigs.

## (2) Diagrams:

The information provided in these diagrams is based on comparative values determined by ElringKlinger. These values have been obtained under specifically defined conditions and may not be transferred exactly to other applications. The diagrams, however, allow you to draw a basic comparison between our seal designs and compounds.

# Technical Questionnaire

## Diaphragms/Bellows

Please complete and return by fax to:

+49 7142 583-200



### 1.1. Pressure Conditions, Diaphragm

Pressure (bar): \_\_\_\_\_

Differential pressure (bar): \_\_\_\_\_

### 1.2. Pressure Conditions, Bellows

Pressure interior (bar): \_\_\_\_\_

Pressure exterior (bar): \_\_\_\_\_

### 2. Operating Conditions

Permanent temperature (°C): \_\_\_\_\_

Peak temperature (°C): \_\_\_\_\_

Frequency/# of strokes/lifts: \_\_\_\_\_

Medium: \_\_\_\_\_

Stroke/lift (mm): \_\_\_\_\_

Diaphragm feeding volume (cm<sup>3</sup>): \_\_\_\_\_

Required service life: \_\_\_\_\_

Application: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Company (Address)

Contact person

Phone

### 3.1. Dimensions, Diaphragm

Clamping dimensions D (mm): \_\_\_\_\_

Type of retention/fixing: \_\_\_\_\_

### 3.2. Dimensions, Bellows

Inner Ø (mm): \_\_\_\_\_

Outer Ø (mm): \_\_\_\_\_

Length min/max (mm): \_\_\_\_\_

### 4. Special Needs/Design

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### 5. Requirement

Once-off (pieces): \_\_\_\_\_

Monthly (pieces): \_\_\_\_\_

Annually (pieces): \_\_\_\_\_

\_\_\_\_\_

Fax

\_\_\_\_\_

E-Mail

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