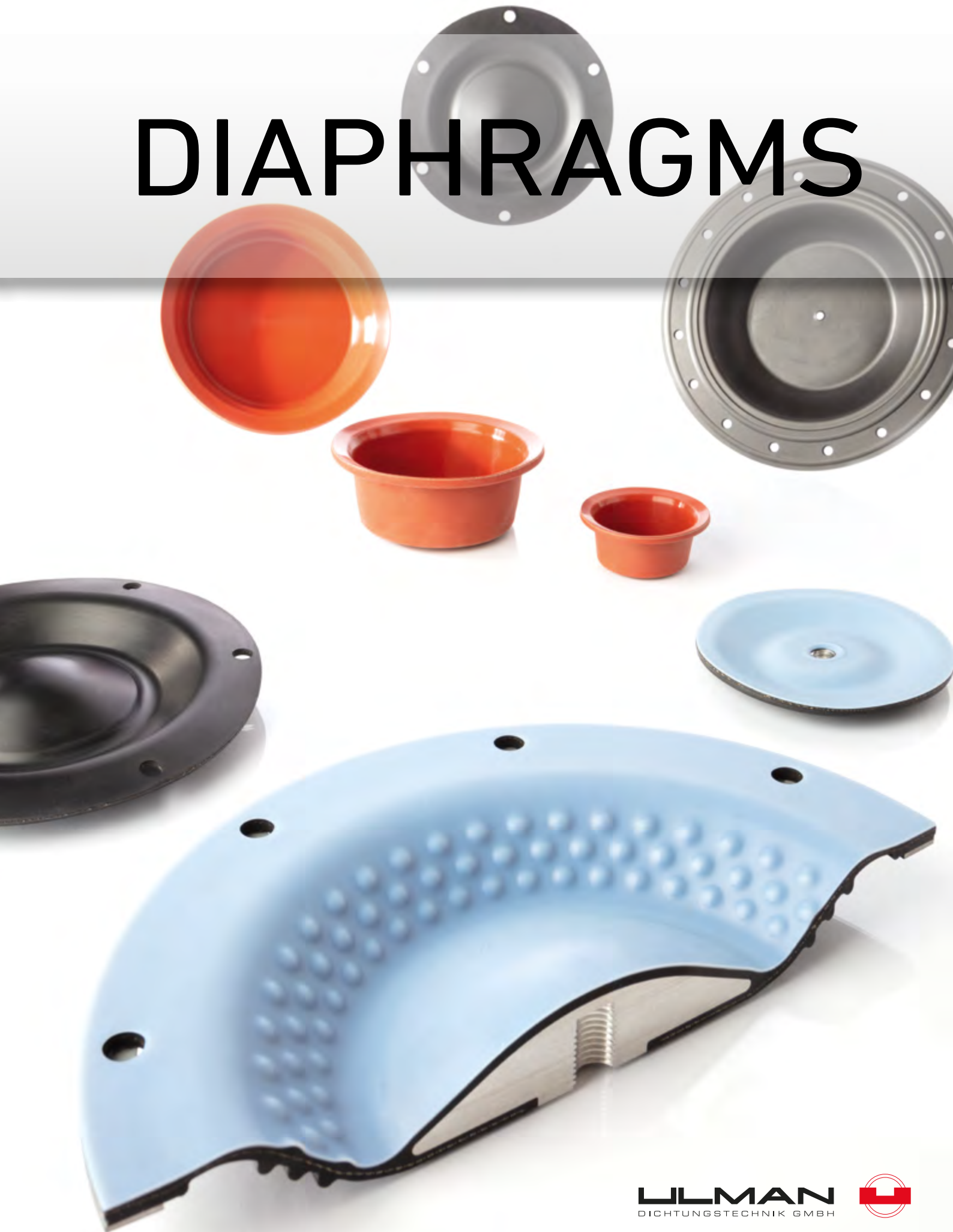


DIAPHRAGMS



The general and technical information provided in this catalog is based on previous experience and merely represents recommendations for standard applications.

For your specific application, our technical application consultants will be glad to assist you and work with you to develop a solution customized to your specific sealing requirements.

The specified product data has been determined under technically ideal laboratory conditions. These limit values may be lower in certain applications due to their dependence on the operating parameters (e.g. applied pressure, operating temperature, media contact, mating surface, friction, leakage, debris contamination, etc.). Against this background, we recommend testing the sealing solution in your specific application. ULMAN Dichtungstechnik GmbH accepts no liability for damages arising directly or indirectly in connection with the use of the data provided here.

In order to ensure the accuracy of the information provided in this catalog, we reserve the right to make changes without prior notice.

With this edition, the previous editions no longer apply.

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ABOUT US

As an internationally active full-service provider for sealing technology, the ULMAN Group has more than 50 years of experience in the industry. With over 1,600 long-standing customers, we, ULMAN Dichtungstechnik GmbH, based in the Swabian town of Gärtringen, are now one of the leading suppliers in Germany. In addition to our location in Gärtringen with its management, sales, purchasing, technology, development, QA, logistics, marketing and human resources department, our group of companies also includes the company's own production facility ULMAN Produktion GmbH & Co. KG in Neudenau near Heilbronn and ULMAN Industriebedarf GmbH in Vienna.

This alliance enables us to offer a comprehensive product portfolio: Standardized O-rings, custom-fit diaphragms and a numerous of special designs.

Supplemented by stuffing box packings, pure graphite rings (packing rings), flat gaskets, metal seals, high-temperature insulation and sealing products as well as GORE® seals and our established expertise, our products are used in many sectors and industries.

You will find our seals in the following areas of application, for example:

- Automotive
- Drinking water
- Chemical
- Medicine
- Mechanical engineering
- Electronics
- Foodstuff
- Hydraulics and pneumatics
- Pumping- and valve construction
- Gas applications
- and much more.

OUR MISSION

INNOVATIVE - HIGH QUALITY PRODUCTS - OPTIMAL SOLUTIONS - RELIABLE SERVICES -
ALWAYS MEETING THE HIGHEST DEMANDS OF OUR CUSTOMERS

Every day, we focus on our most important:

CORPORATE VALUES:



INNOVATION



RELIABILITY



QUALITY

INNOVATION

As a future-oriented company, our aim is to drive innovation. Our daily work consists of realizing innovative product solutions. Numerous product and material developments in our own test series and test facilities have already enabled ULMAN to boast many internationally patented developments.

RELIABILITY

We are consistently committed to optimally meeting all sealing requirements. We accompany our customers throughout the entire process, from prototype development to series production - we offer excellent availability and the best possible technical support. We embody partnership, today and in the future - with 100% passion.

QUALITY

We focus on extensive testing and continuous quality optimization so that we can keep our promise of high quality standards. Our quality management team continuously carries out internal product and process audits to ensure stable process control for all manufacturing and process steps.

WHAT SETS US APART

- **Customer proximity:** High availability and fast response times strengthen the partnership-based cooperation and satisfaction of our customers. Our comprehensive support before, during and after the project distinguishes us as a reliable service provider.
- **Technical expertise:** Developing and implementing innovative product solutions is an essential part of our activities. We hold international patents for numerous product and material developments
- **Material and application knowledge:** With the simulation of components in their installation position and under load, we receive valuable support in the design of seals and the most suitable materials with the help of finite element analysis (FEA)
- **Quality assurance:** Regular product and process audits guarantee continuous quality optimization. Our efficient quality management is certified according to the DIN EN ISO 9001:2015.
- **Environmental awareness:** Our contributions to the environment and sustainability have been confirmed with the DIN EN ISO 14001:2015 certificate. Low-paper work in the office, photovoltaic system, energy-saving lighting and energy-efficient machines and systems are just part of our commitment.
- **Logistics infrastructure:** Our AutoStore system, the heart of our logistics infrastructure, extends over two levels and can be expanded as demand increases. Energy-efficient robots and the implemented warehouse management system offer high picking reliability and speed, enabling us to achieve an OTD of > 99.5 %.

Diaphragms



1. INTRODUCTION

Elastomer moulded diaphragms are sealing elements which function as moving, resilient walls that hermetically separate two spaces from each other.

The characteristic feature of diaphragms is their ability to perform a stroke motion in their mounting plane a stroke motion vertically to the flange retention.

They are used to transform pneumatic or fluid pressure into mechanical power. Inversely, mechanical power can be used for volumetric displacement.

Important for ideal function and service life is, that the diaphragm stroke always results from the change in shape of the diaphragm and not from the expansion of the elastomer material.

Diaphragms are sealing solutions for control, storage and pump functions.

ADVANTAGES

- No lubrication required
- No maintenance necessary
- Wear-free
- Long service life
- Can be used in almost all media due to the large choice of elastomer materials
- Lower demands on tolerances and surface quality in the installation space, in contrast to other sealing elements
- Diaphragms in thin-walled design:
Virtually friction-free / no breakaway forces (stick-slip effect)

2. FIELDS OF APPLICATION

Diaphragms are used in a wide variety of technical areas.

The **main applications** of use can be divided into three categories based on the function that the diaphragm fulfills in the respective application:

Diaphragms are frequently used for **force conversion of differential pressures**:

- Diaphragms in operation:
 - > Servo elements
 - > Actuators
 - > Switching elements
 - > Force transducers
 - > Load cells
 - > Brake boosters
- Diaphragms used for controlling purposes:
 - > Pressure reducers
 - > Pressure controllers
 - > Flow controllers
- Diaphragms in valves:
 - > Overpressure valves
 - > Safety valves
 - > Shutoff valves
 - > Check valves

Another application area for diaphragms is in **the implementation of mechanical force**. Typical examples in this area are the diaphragms used in pumps:

Diaphragms in pumps:

- > Compressed air diaphragm pumps
- > Dosing pumps
- > Mechanical pumps
- > Diaphragm compressors
- > Vacuum pumps

As a result of their moving sealing surface diaphragms are also used **to separate media** and for **pressure compensation**.

- Diaphragms in:
 - > Pressure accumulators
 - > Expansion vessels
 - > Pulsation dampers



3. BASIC DIAPHRAGM SHAPES

The multitude of diaphragm designs can be reduced to a few basic forms (Fig. 1).

The application determines the size and shape of the diaphragms.



Based on the type of possible pressurisation, the basic diaphragm shapes can be divided into two categories (Table 1).

Diaphragm Basic Shape	Pressurisation
Rolling Diaphragm	one-sided
Bead Moulded Diaphragm	one-sided
Disc-shaped Diaphragm	double-sided
Spherical Diaphragm	double-sided
Flat Diaphragm	double-sided

Table 1: Differentiating Feature Type of Pressurisation

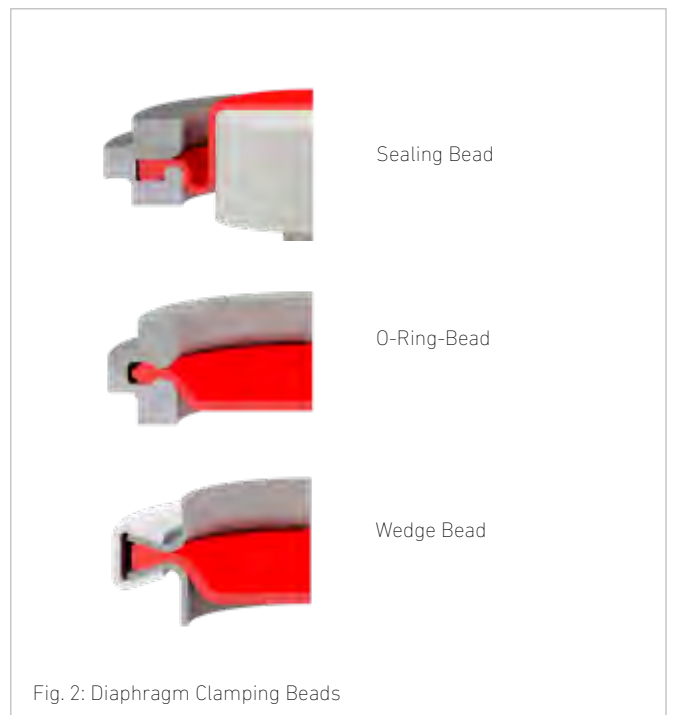
Design of the diaphragm clamping areas:

In order to fix the diaphragm into the housing, it is clamped between two flanges in the clamping. Different diaphragm are used depending on the diaphragm design and the design of the diaphragm.

Fig. 2 shows some examples of the optimum design of the clamping areas:

Sealing bead: One flange is flat while the groove is fitted in the opposite flange.

- **Sealing Bead:**
The groove is fitted into one flange side.
» Rolling Diaphragm
- **O-Ring-Bead:**
The groove is inserted into both flanges.
» Disc-shaped Diaphragm
- **Wedge Bead:** A metal crimp ring will be assembled to the cylinder housings with special crimping tools.



4. DIAPHRAGMS

4.1 FABRIC REINFORCED MOULDED DIAPHRAGMS

Elastomer diaphragms without a fabric reinforcement separate the media from each other and simultaneously take up the tensile stress resulting from the pressure load and kinematics.

Applications with high pressure loads (greater than approx. 1 bar, depending on the geometry and wall thickness of the diaphragm) use a fabric reinforcement.

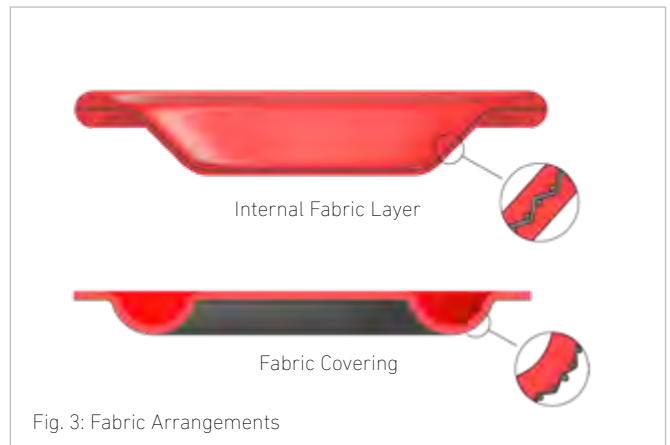
Fabric provides the necessary strength and absorbs the dynamic loads and high process pressures acting on the diaphragm. The elastomer is solely responsible for the sealing function.

Fabric reinforcement is essential for a long service life and a high number of load cycles.

Depending on the diaphragm type or the diaphragm insert, different fabric arrangements are possible (Fig. 3):

- **Fabric insert:** The fabric reinforcement is embedded in the centre layer of the cross-section.
- **Fabric overlay:** The fabric reinforcement is applied to the surface of the pressureless side.

A special technology in our production process enables us to guarantee the exact course of the fabric even in the transition radii.





4.2 RMG ROLLER-TYPE DIAPHRAGMS

Roller-type diaphragms are highly flexible, thin-walled diaphragms with fabric reinforcement on the reverse side of the pressure. RMO roller-type diaphragms are also available in special designs without reinforcement fabric.

As a result of the thin walls and the large diaphragm height in relation to the diameter the following advantages are given:

- An almost constant inherent resistance
- A large stroke length in relation to the diameter
- An uniform active area over the entire stroke

On account of their special advantages, roller-type diaphragms are primarily used in process control, for instance in measuring, displaying or controlling devices. During assembly, it is necessary to take into account that the diaphragm is upended so that the reinforcing fabric side is on the pressureless side.

We manufacture roller-type diaphragms according to customers' design and we are also in the position to

produce special geometries upon request. The application temperature range is -50 °C to $+80\text{ °C}$ depending on the used elastomer.

Standard rollertype diaphragms made out of NBR with fabric reinforcement allow media pressure up to 8 bars. Special grades are available for roller-type diaphragms made of other material combinations (FKM, EPDM, VMQ ...) as well as for high-temperature and high-pressure applications.



Fig. 4: Installed Rolling Diaphragm



4.3 PTFE COMPOSITE DIAPHRAGMS

PTFE composite diaphragms are used wherever pure elastomer diaphragms reach their mechanical limits.

In the chemical industry, in particular, the use of aggressive media places increased demands on the chemical resistance of the sealing element. The use of PTFE grades are recommended here.

PTFE composite diaphragms consist of several components (Fig. 5):

- **Foil (PTFE)**
- **Elastomer diaphragm**
(NBR, HNBR, EPDM, CR, SBR, FKM, VMQ, FVMQ)
- **Fabric insert** (polyamide / HT polyamide)
- **Supporting plate** (brass, aluminium, steel, stainless steel)

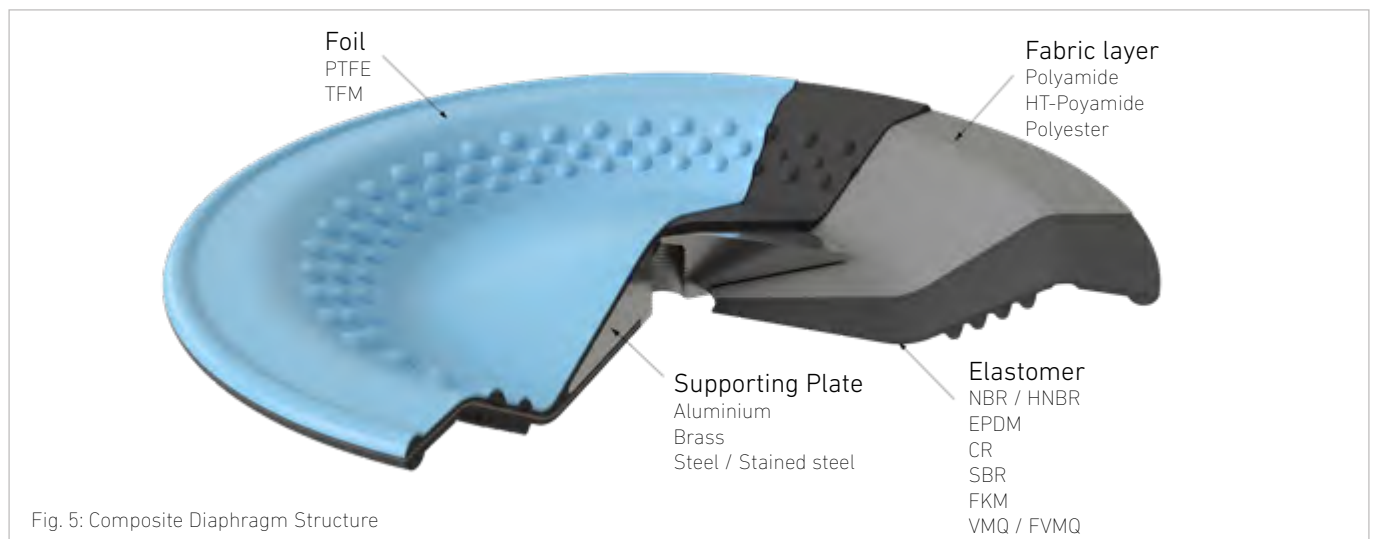


Fig. 5: Composite Diaphragm Structure

PTFE foil is chemically bonded to the elastomer diaphragm and forms a closed surface to the medium. This protects the elastomer material from aggressive environmental influences.

Chemical resistance of the PTFE grades ranges from pH 0 to pH 14. In terms of physiological safety, the PTFE film fulfils the requirements of FDA 21CFR 177.1550 and is therefore suitable for use in the food sector.

PTFE diaphragms are usually equipped with a fabric reinforcement in order to fulfil the requirements of increased media resistance as well as strength. In this case, a fabric insert is used in which the fabric is embedded in the centre of the cross-section. In addition to stability, this also increases the service life of the diaphragm.

Dead space must be avoided in the interest of system cleaning and sterilization (CIP/SIP). PTFE composite diaphragms permit the integration of the supporting or mounting plates inside the diaphragm.

The integrated support or clamping disc can be designed with either an external or internal thread. In this case, a fabric insert is used in which the fabric is embedded in the centre of the cross-section.

Due to the patented PTFE diaphragm surface structure „SOF“, high load cycles and a long operating lifetime are achieved even with highly stressed diaphragms or diaphragms with unfavourable geometry ratios. The patented surface structure causes a reduction in stress in the PTFE when the diaphragm unrolls. This prevents undefined, uncontrolled buckling during unwinding and thus early failure of the diaphragm.



5. MATERIALS

When selecting a suitable material, each application must be checked for individual application parameters. Different material combinations are used depending on the requirements.

Our technical support will be pleased to help you select the right material for your application.

Below is a list of our standard grades for the respective material categories. Furthermore, we offer material qualities that comply with DVGW, KTW-BWGL, EN 16421 (ex.W270), WRAS, FDA, among others. Special qualities, such as electrically conductive elastomers, are available on request.

The control of the **chemical, mechanical and thermal requirements** is essential for the diaphragm function.

1. Elastomers:

Chemical resistance therefore takes centre stage for elastomers. In terms of long-term behaviour, the material must retain its strength, elasticity and flexibility even under thermal stress.

Materials	Applications / Characteristics
NBR	Hydraulic, pneumatic, standard for compressed air and mineral oil
HNBR	Aliphatic hydrocarbons (low aromatic content), high-temperature application, abrasion-resistant
EPDM	Cold and hot water, steam, alkalis, acids, alcohols, ketones, food industry
CR	Refrigerants, frigene, silicone oil, good refrigeration flexibility
FKM / FPM	Mineral and silicone oils, aromatic hydrocarbons, high thermal and chemical resistance
VMQ / MVQ	Vegetable and animal oils and fats, high-temperature applications, food industry, medical technology
FVMQ / MFQ	Aliphatic engine oils, high-molecular chlorinated hydrocarbons, fuels in refrigeration applications
SBR	Alcohols, glycol, abrasion-resistant

Table 1: Elastomers

2. Fabric:

Fabric reinforcement of pure elastomer diaphragms is used in applications with high pressurisation. The fabric provides the necessary strength. Accordingly, the fabric elongation of the diaphragm under pressurisation should be low. The operating temperatures are an important factor when selecting the fabric. Basically, the strength values of the fabrics decrease with increasing temperatures.

With applications subject to high mechanical loads, care must be taken to ensure that the fabric/elastomer bond cannot break.

Materials	Applications / Characteristics
Polyamid	Very effective adhesion, for highly stressed diaphragms
Polyester	Standard for roll diaphragms, high strength with thin fabric cover
HT-Polyamid	Nomex®, very efficient high-temperature behaviour

Table 2: Fabric

3. Insert Parts:

Depending on the application, integrated metal parts (backing discs) must be determined according to strength and chemical resistance.

Metal parts are vulcanised into the diaphragm to ensure that the rubber-metal connection remains stable over the entire operating life.

Materials	Applications / Characteristics
Brass	Standard for small diameters
Aluminium	Standard
Steel	Standard for high loads
Stainless Steel	Chemical consistency

Table 3: Insert Parts

4. Foils:

PTFE foil chemically bonded to the elastomer provides a protective layer against aggressive media.

In addition to the appropriate chemical and mechanical resistance for the application, the foil must also meet the requirements in terms of diffusion behaviour and flexural fatigue strength.

Materials	Applications / Characteristics
PTFE	Virgin
TFM	Modified PTFE, standard quality
TFM-A	Modified PTFE, special quality for high chemical and mechanical loads
TFM-B	Modified PTFE, premium quality for extreme chemical and mechanical loads

Table 4: Foils

6. ULMAN PRODUCTION GMBH & CO. KG

ULMAN Produktion GmbH & Co. KG has over 30 years of experience in the development and manufacture of diaphragms. KG has been able to set itself apart from other market players with international patents in diaphragm technology.

When producing our diaphragms, we attach great importance to high-quality materials, first-class workmanship and careful quality checks in order to guarantee our customers an outstanding product with a long service life.

ISO 3302 is the standard for the production quality of moulded diaphragms (replacement for DIN 7715 „Rubber parts permissible dimensional deviations“ moulded articles made of soft rubber (elastomers)).

Thanks to our manufacturing expertise and our competence in materials, we are able to customise the individual components of the diaphragms to the requirements and wishes of our customers. Furthermore, we are able to develop the optimum solution for the respective application.

We offer customised products „Made in Germany“ and want to become your reliable partner in diaphragm technology, especially in the application of pumps and compressors.

6.1 DIAPHRAGM ENGINEERING

Elastomer diaphragms are sealing elements that do not require standardisation or international standards.

Many years of experience in diaphragm development allow us to design diaphragm concepts optimised for our customers' applications and requirements.

Every diaphragm application is individual characterised by the interaction of a large number of different parameters, such as pressure, temperature, media and operating conditions.

In order to check the feasibility of your diaphragm application, we draw up a specification sheet for each case of usage. The specification sheet forms the basis for the development and optimisation of the diaphragm.

To design an optimised diaphragm concept, early cooperation between the customer and ourselves as a diaphragm manufacturer is essential.

Our technical consultants are pleased to provide you with professional and technical advice on your diaphragm application requirements any time.

6.2 PRODUCTION

In our production facility in Neudenau near Heilbronn, we have modern, product-specific production equipment in addition to testing systems for product and material development.

This is where we manufacture customised elastomer moulded diaphragms up to a diaphragm diameter of 550 mm.

Several processes are available for diaphragm production:

- **Non-fabric diaphragms** (rubber moulded parts) are usually manufactured using the injection moulding process (injection moulding) or the transfer moulding process (transfer moulding).
- **Fabric-reinforced moulded diaphragms and PTFE composite diaphragms** are manufactured exclusively using the compression moulding process.



Do you have any questions?

We will be happy to advise and support you on a wide range of issues in the field of general and specialised sealing technology. Do not hesitate to contact us:

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