ULTRASONIC TECHNOLOGY GROUP

TECHNICAL PRESENTATION

Membrane welding solution - single workstation

Tuesday, October 22, 2024

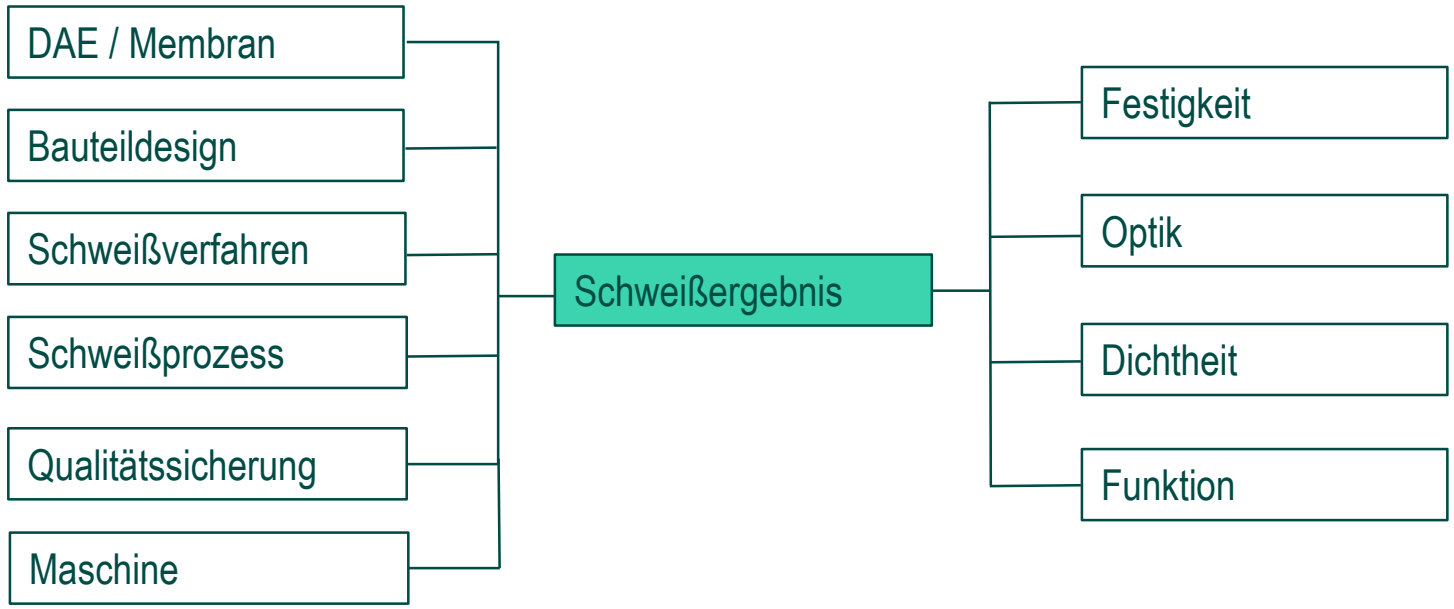
Inhalt

- Design of pressure equalization elements
- Installation and design guidelines
- Welding methods and processes
- Quality assurance and testing procedures
- Punch and seal unit

Factors influencing product quality

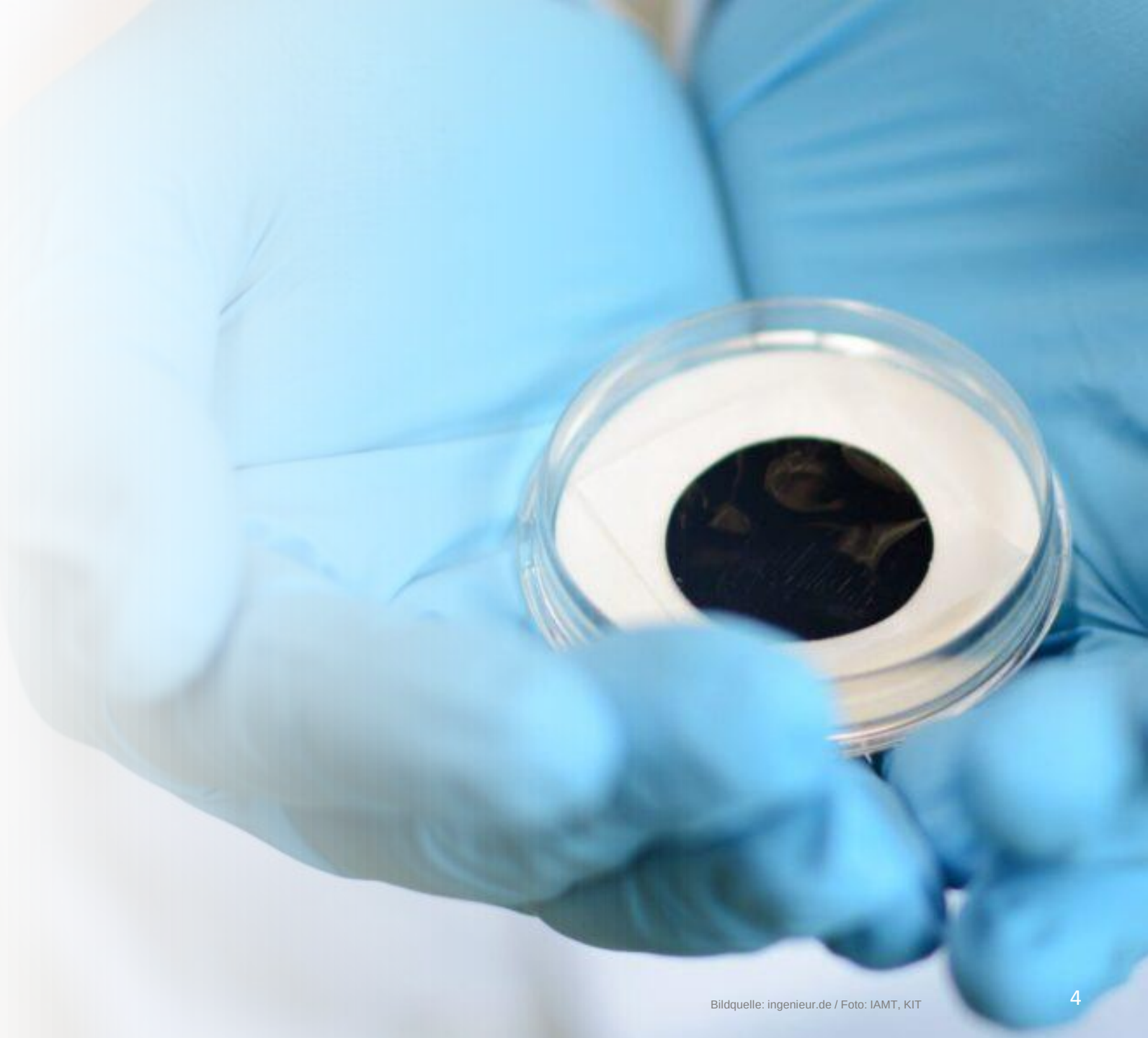
The part quality after welding does not depend solely on the welding process, but also on various other influencing factors.

The materials from which the joining partners are made form the basis for this.



Structure and function of DAE

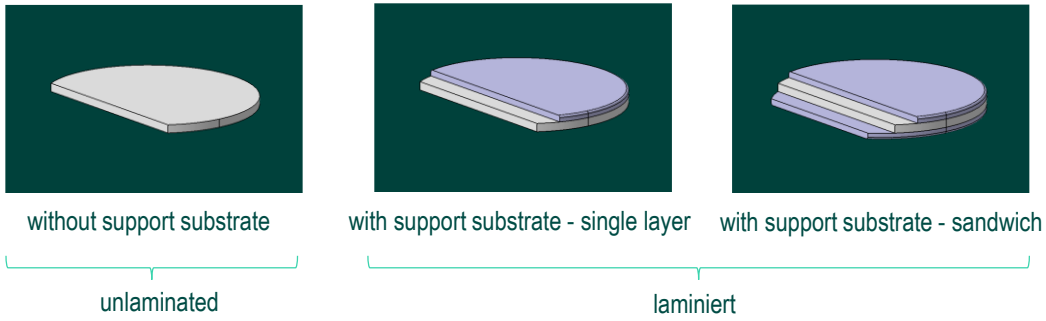
They consist of a waterproof and dustproof, but air-permeable membrane and are essential for regulated air exchange in enclosures

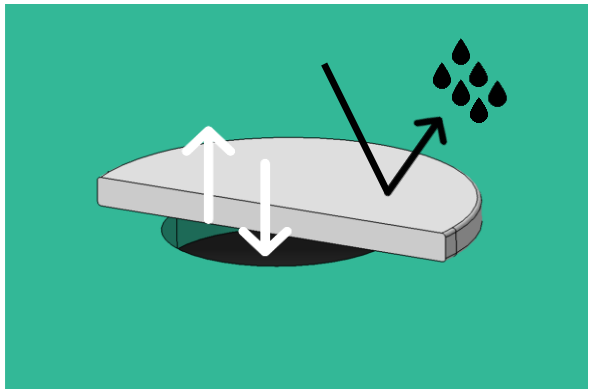


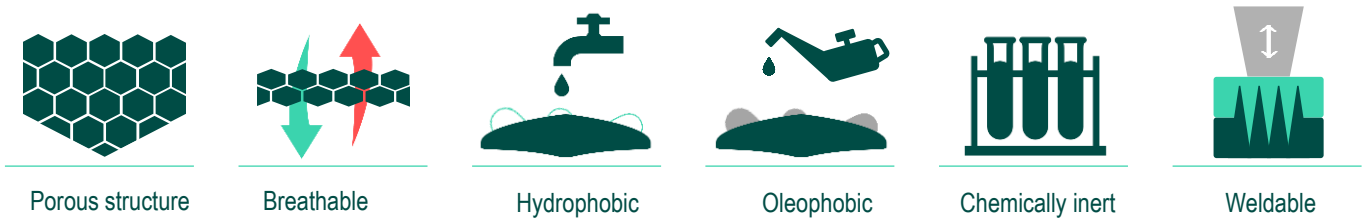
Bildquelle: ingenieur.de / Foto: IAMT, KIT

Structure and function of DAE*

- The membrane prevents dirt, water, oil and other foreign substances from entering the housing. In closed enclosures, considerable fluctuations in internal pressure occur due to differences in temperature or altitude.
- On the other hand, the membrane is also permeable to air. This ensures optimum pressure regulation.







* Pressure equalization element

Component guidelines and design

The actual design is influenced by the specific conditions such as housing shape, material and the required tolerances as well as the operating conditions.

Component guidelines and design

REQUIREMENTS

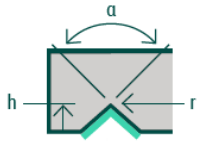
Material component	- Thermoplastics (PA, PC, PBT, PP) - High-temperature thermoplastics (PPA, PSU, PPS) are difficult or impossible to weld - High glass fiber content over 30% significantly worse - Combinations important
Material Membrane	- PTFE / ePTFE / ETFE, PET/PP nonwoven - single-layer / multi-layer - support material
Welding surface	- Welding surface must be dry and clean - free from contamination such as dust, grease, oils, release agents and other chemicals - smooth, burr-free and free from indentations, flow lines, sprouting and similar - surface roughness Rz ≤ 10 µm, max. Rz 25 µm for PBT and PA
Wall thickness	- Wall thickness should be ≥ 2 mm - Differences in thickness in the area of the welding surface must be avoided - Radius of approx. 0.1 mm prevents damage to the membrane

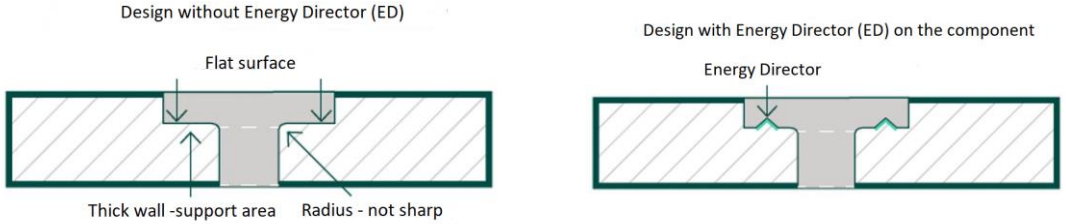
Component guidelines and design

REQUIREMENTS

Energy director (ED)

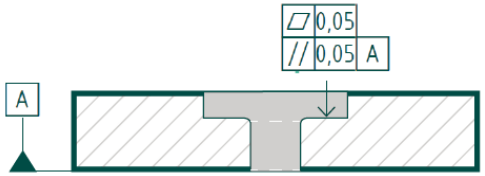
- Diameter of ED smaller than diameter of membrane, difference ~3 mm
- Height of ED h = 0.3 - 0.7 mm
- Angle of cone α = 60° - 90°
- Radius at tip r = 0.1 - 0.5 mm





Geometry

- Flatness ≤ 0.05 mm
- Welding surface plane-parallel ≤ 0.05 mm to the contact surface in the workpiece holder



ADVANTAGE

The advantage of PTFE pressure compensation elements over standard self-adhesive DAEs:

Thanks to their material, the membranes can be welded directly to their destination using ultrasonic or thermal contact methods. This improves the chemical and thermal resistance of the membrane compared to traditional bonding.

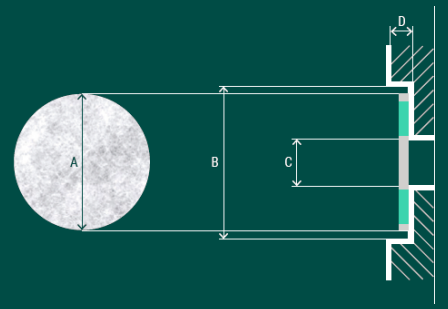
IMPORTANT

A: The outer diameter of the diaphragm, determines the dimensions of B and C

B: The diameter of the welding chamber should be at least 0.30-1.0 mm larger than A.

C: The diameter of the through-hole is determined by the specific conditions. C should be at least 1 mm smaller than the inner diameter of the probe.

D: The indentation should always be at least 0.5mm.



Positioning and welding geometry

For complex and sensitive electronic components inside plastic or metal housings, it must be ensured that ventilation takes place in order to guarantee pressure equalization. At the same time, the housing must be sealed against the ingress of media such as water and oil.

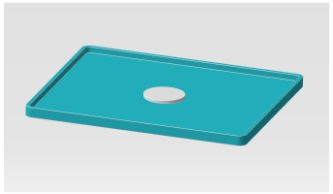
Bildquelle: Schreiner-Group

Membrane positioning

Membranes can be welded onto the housing from the outside or the inside. However, welding from the inside usually has advantages: The membrane is better protected against external influences or damage and the quality of the IP protection is guaranteed.

If external welding is nevertheless required, ensure that the membrane is fitted in areas that reduce external influences.

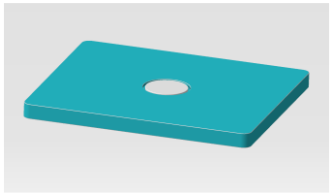
INSTALLATION



recommended

Installation on the inside of the housing

– Protection against mechanical stress

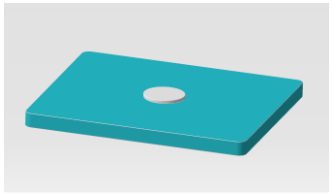


possible

Installation on the outside of the housing with recess

– Protection against mechanical stress

– Greater resistance to demanding tests



not recommended

Installation on the outside of the housing without recess

– Risk of inaccurate application

– Unprotected against mechanical stress

– Membrane and weld seam are vulnerable to harmful media

ARRANGEMENT

recommended

Side wall / vertical arrangement

- Prevents fluid build-up on the membrane

– Liquids flowing past clean the membrane

possible

Floor-side, internal arrangement

– Pressure can remain trapped until the water has evaporated

not recommended

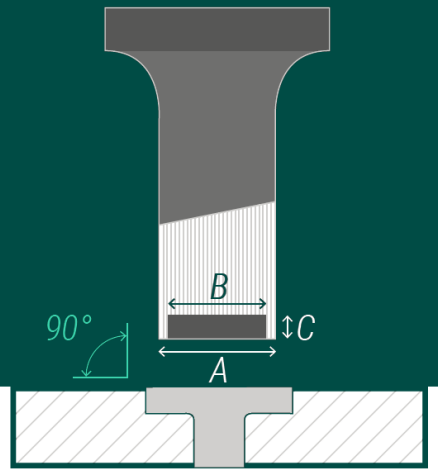
Overhead arrangement

– Liquids can accumulate and hinder gas exchange

Welding geometries

DESIGN WITHOUT ED

- increased risk of damaging the membrane during the welding process
- higher requirements for plane parallelism
- ED must be machined onto the sonotrode (welding contour)
- thickness of the welding ring (contour) should be at least 1.0 mm.
- possible sonotrode wear

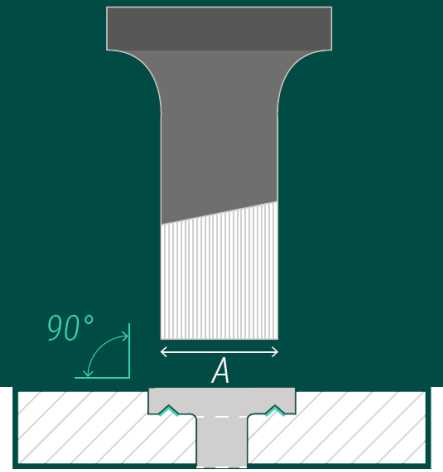


SONOTRODE

- usually made of a titanium alloy, with the punch-seal unit made of steel
- Outer diameter of the welding surface ≤ the diaphragm diameter
- Probe edges with a radius of at least 0.1 mm to prevent damage to the membrane
- Vacuum bore for membrane placement

DESIGN WITH ED

- Easier process set-up thanks to defined melting mass
- Larger process window for welding
- Only a smooth sonotrode welding surface is required, clean welding pattern
- Additional separating contour possible, sharp-edged and ground
- Less wear on the sonotrode
- Manufactured to meet the specifications for MS punch seal unit

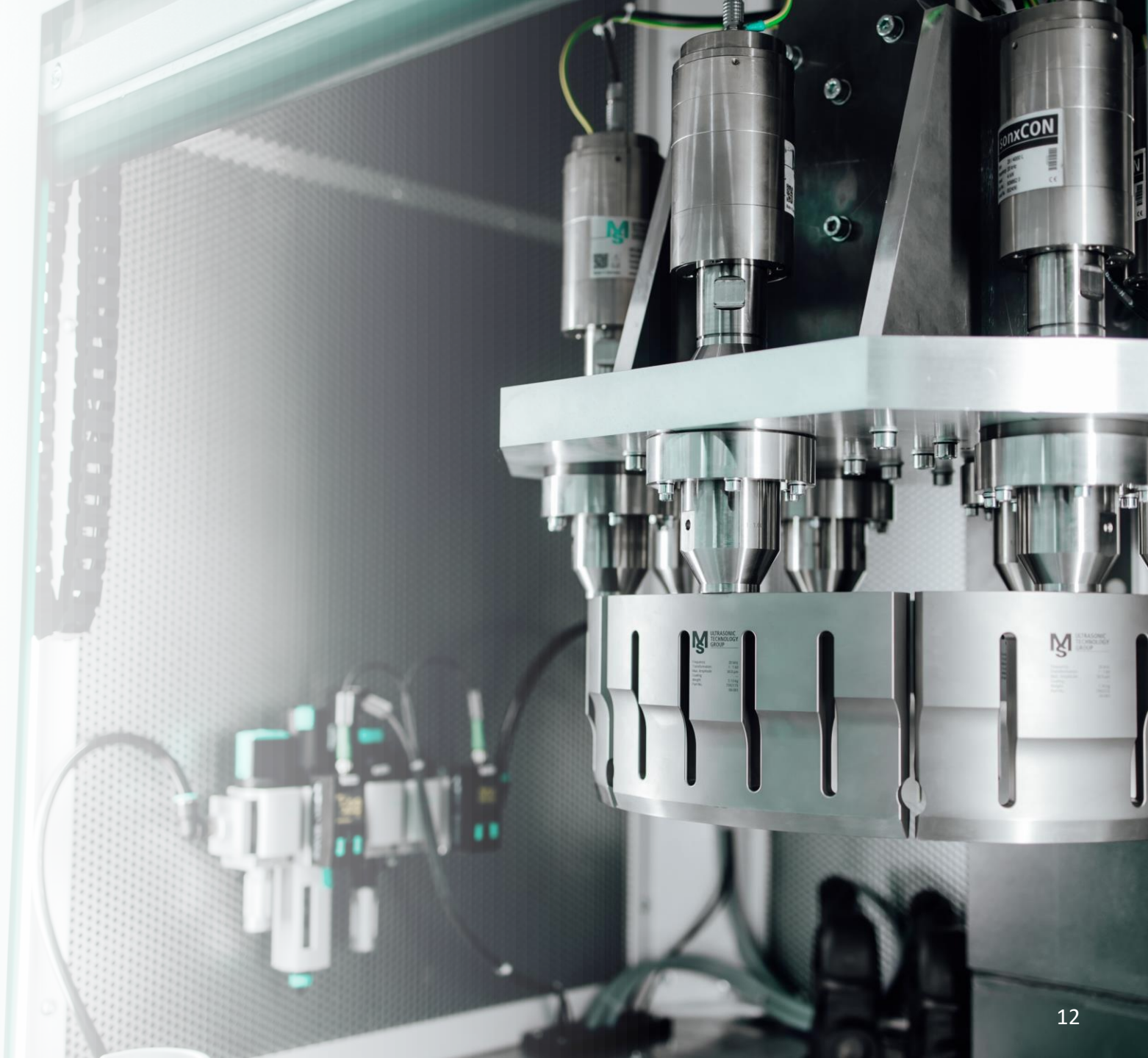


Welding process

The longitudinal welding of membranes and non-woven materials is an interlocking of both joining partners.

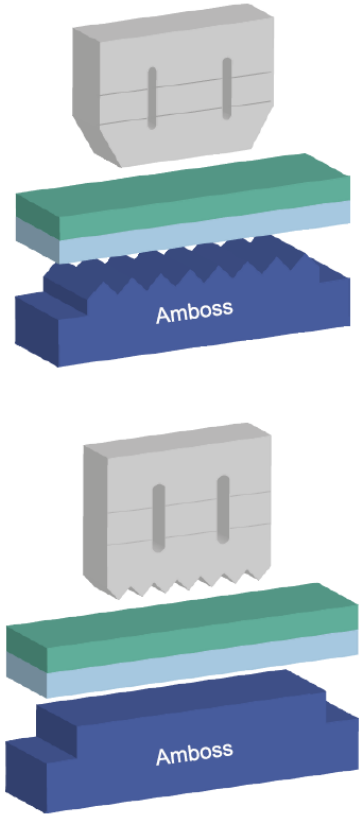
Due to the higher melting point of the membrane, only the housing material melts using ultrasound and penetrates the pores of the membrane.

Torsional welding applies the welding energy radially. This is particularly gentle on sensitive components and unlocks new application possibilities.



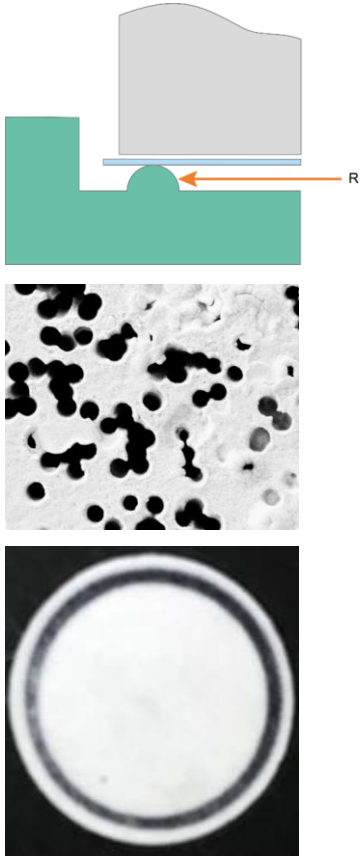
Welding process - longitudinal

VERKRALLEN



Applications:
- Membrane
- Non-woven fabric, filters, insulating mats

Please note :
- Energy focusing via anvil geometry, via sonotrode contour or in combination
- Partial ED on the injection molded part
- Sonotrode contours, roughened, truncated pyramid contour, special contours for welding membranes



Bildquelle: Oxyphen

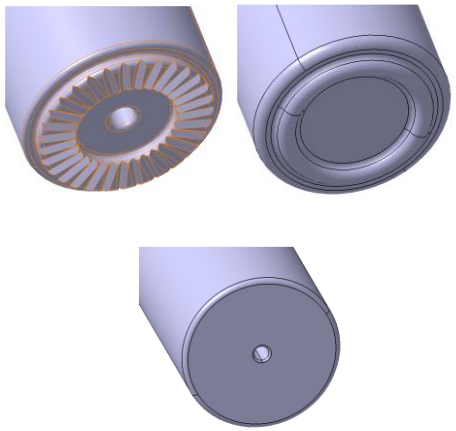
Welding process - longitudinal

WELDING

Membrane is positioned in the component as a stamped part

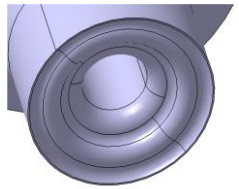
manually or by vacuum

Sonotrode welds membrane to component



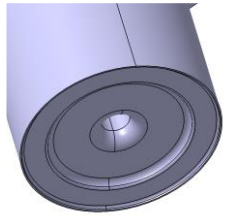
CUTTING & WELDING

the membrane is cut out of the solid material using a knife profile; cut and welded to the component at the same time

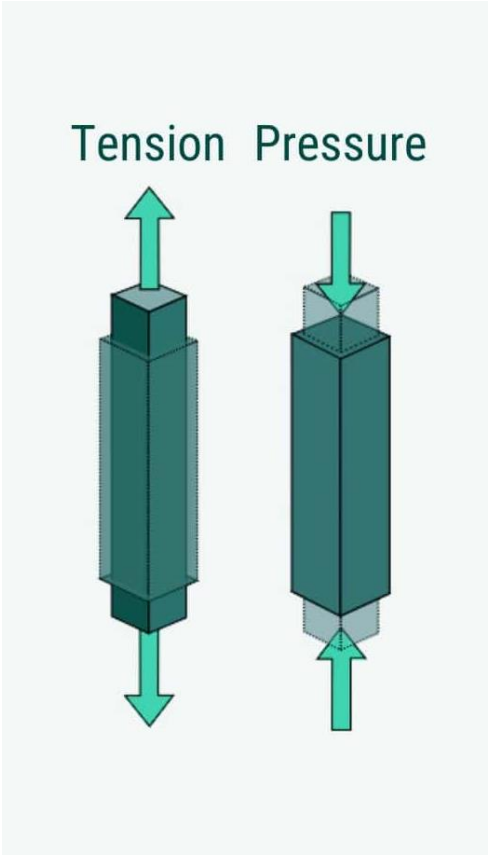


DIE PUNCH & WELDING

The membrane is first punched from strip material and positioned on the component using a vacuum, where it is welded using the same welding tool



FEM



Welding process - torsional

WELDING

Membrane is positioned in the component as a stamped part

manually or by vacuum

Sonotrode welds membrane to component

Part-friendly process

Reduced stress in the components

CUTTING & WELDING

the membrane is cut out of the solid material using a knife profile; cut and welded to the component at the same time

Higher strength due to compaction of the weld seam

Interchangeable contour screw-in end details

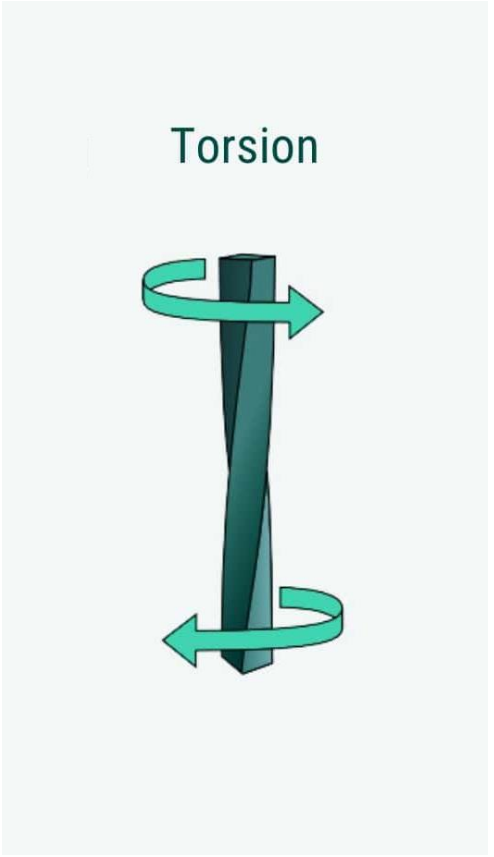
DIE PUNCH & WELDING

The membrane is first punched from strip material and positioned on the component using a vacuum, where it is welded using the same welding tool

Use on standard series machine

Longitudinal and torsional on the same machine

FEM



Schweißverfahren - torsional

SCHWEIßEN

Was macht das torsionale Schweißen so besonders?

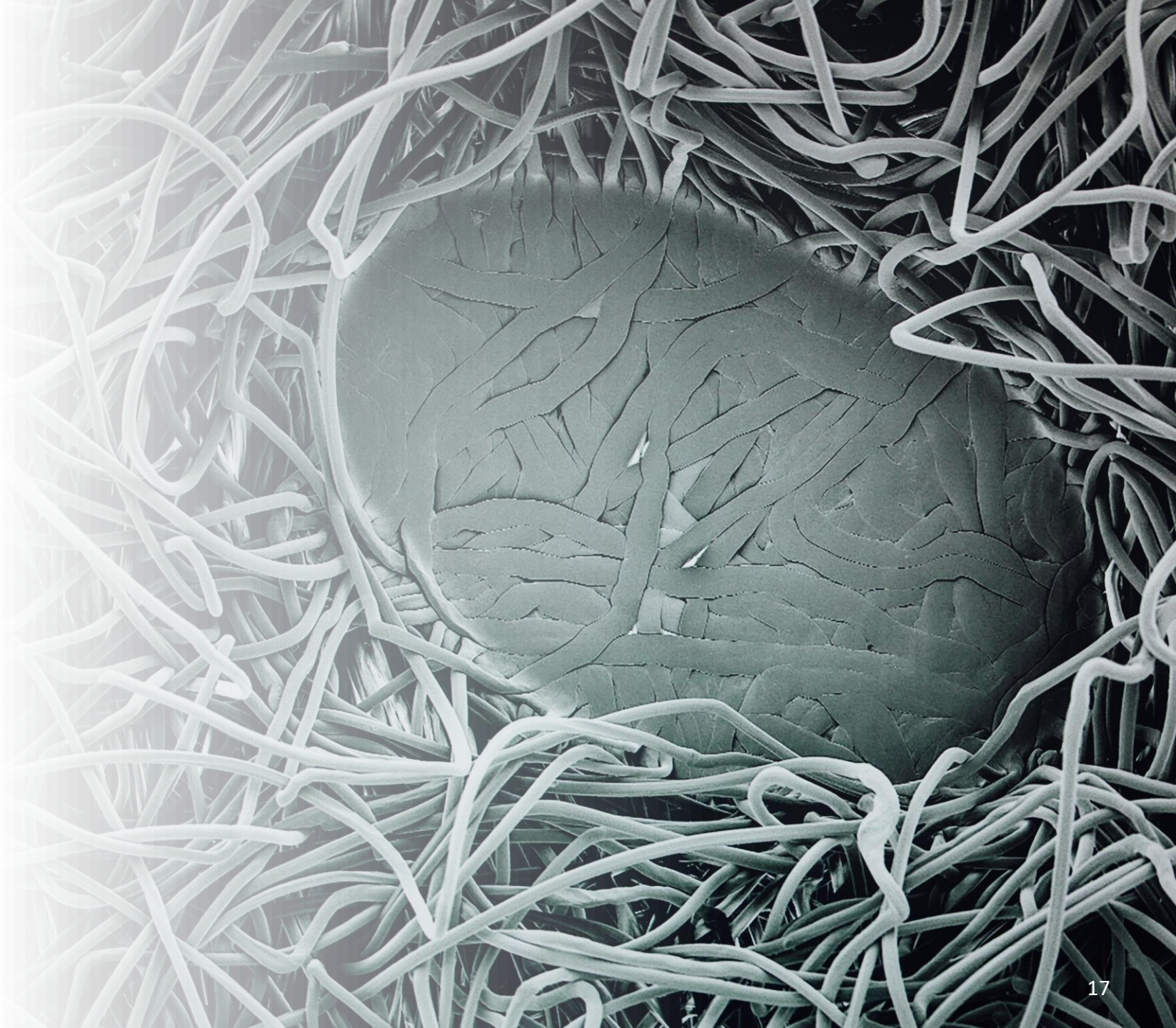
Die Torsionsbewegung bringt die Schweißenergie radial ein. Das ist besonders schonend für empfindliche Bauteile und eröffnet neue Anwendungsmöglichkeiten.

Was sind die Vorteile und Einsatzgebiete?

+ ideal für dünnwandige Bauteile, die zum Durchbrennen neigen
+ minimale Schallübertragung auf das Trägerbauteil
+ geeignet für Materialien mit unterschiedlichen Schmelzpunkten
+ geringer longitudinaler Energieeintrag
+ Membrane schwingen weniger mit und bleiben intakt
+ Delamination wird minimiert
+ schlanke Bauweise unserer Komponenten

Welding process

During the welding process, the results must be checked and recorded regularly so that the relevant parameters can be corrected at any time if the temperature and humidity of the environment change and the processing location is different.



Welding process

WELDING PROCESS

Due to the higher melting point of the membrane, only the housing material melts and penetrates the pores of the membrane, which itself remains intact :

– Short cycle times
– Strong, durable bond
– Parameter control and documentation

Process monitoring in the machine

– Splice inspection
– Material handling
– Vacuum
– Punching quality of the membrane

WELDING PARAMETERS

– Amplitude: 10 - 35 µm, Torsion > 25 µm
– Welding time: 80 – 500 ms
– Welding force: ≤ 200 N
– Holding time: 200 – 500 ms
–Holding force: 20 – 150 N

Additional process parameters

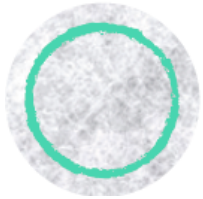
– Cutting gap of the die
– Weldable membrane side
– Winding of the roll material

Welding process

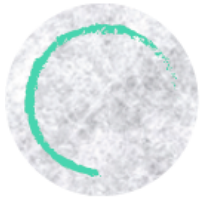
WELDING IMAGE

The housing should be supported in the workpiece holder directly under the welding surface.

The sonotrode must hit the component directly at a 90° angle.

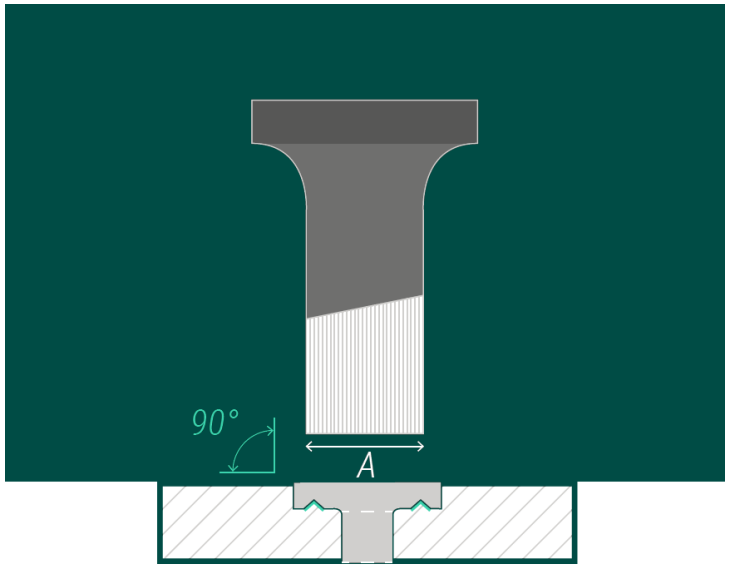


Good weld pattern, recognizable by :
– Uniform welding
– No interruptions or melting outside the membrane



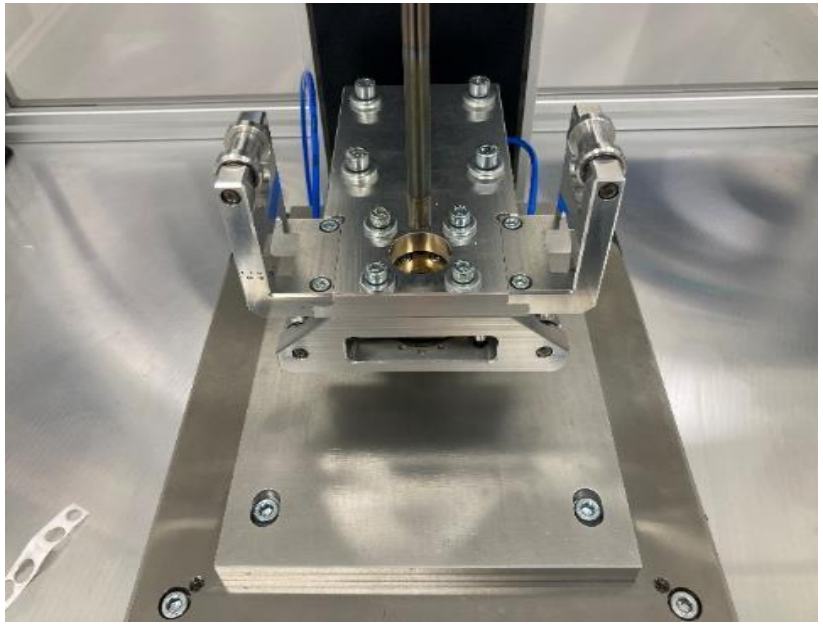
Poor weld pattern, due to irregular welding:
– Uneven welding surface, inadequate encoder
– Sonotrode / workpiece holder not aligned

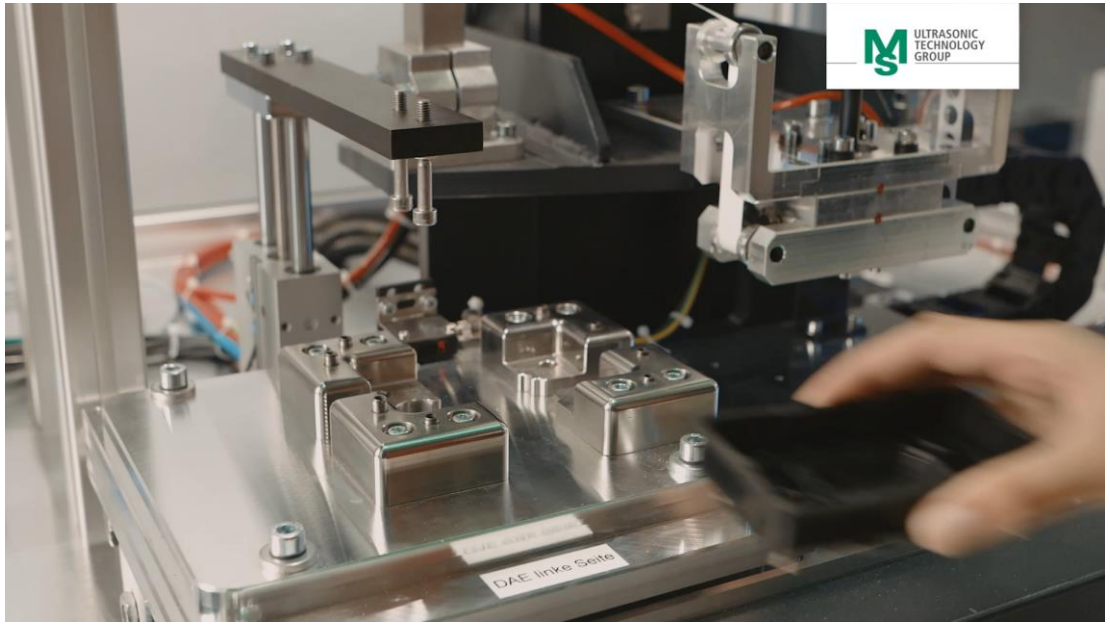
Poor weld pattern, as material expulsion inside and outside:
– Too high amplitude, force, energy
– Excess glass fiber



Welding process

Workpiece holder and sonotrode for DAE membranes (PA GF35/PTFE), punching and sealing





Special features:
- Stainless steel WA, with brass punching die, with ALIGNMENT FEATURES to prevent twisting
- Guide for diaphragm tape for punched parts
- Integrated leak test
- Steel round sonotrode, 35 kHz (URS) with cutting edge and smooth surface

Quality assurance and test procedures

Test procedures are essential for validating the welding process and monitoring the parameters as well as for static evaluations during production.

Quality assurance

QUALITY ASSURANCE BY MEANS OF TEST PROCEDURES

Optical inspection

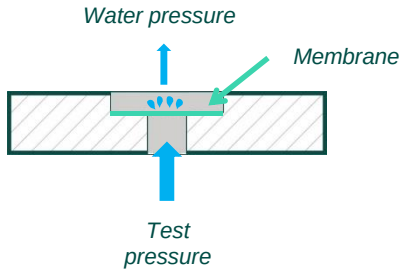
– Camera test: quick detection of defects or incorrect positioning

– Circular, symmetrical weld mark on membrane

WEP / iWEP-Test (water entry pressure)

– Membrane is pressurized with water

– Time: 0.6bar/30s or until diaphragm bursts or detaches* (based on membrane specifications)



Burst pressure test

– Membrane is pressurized with air

– Time: 0.6bar/30s or until diaphragm bursts or detaches* based on membrane specifications)

Visual Inspection – destructive check

– Removing the membrane and assessing the connection

Water Seal /Tightness (IP4x, IPx6K or IPx9K) depending on the membrane material

Punch seal unit

To save on material and production costs for plastic parts with integrated membranes :

MS sonxTOP MEMBRANE.

In total, the ultrasonic machine combines four process steps :

Tape transport with splice control, mechanical punching out of the tape material, transport of the membrane punched part to the sealing position and finally ultrasonic sealing of the punched part onto the plastic component.

ULTRASONIC TECHNOLOGY GROUP

Thank you for your time and attention.

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