



ChemResist
ROTATIONAL-LINING

MANY YEARS OF EXPERIENCE WITH ChemResist

Rudolf Gutbrod GmbH set standards early on as one of the leading fluoropolymer processors in Europe. Customer orientation is given a major priority at Rudolf Gutbrod GmbH. Many years of practical experience, consistent development of new technologies and a cooperation marked by flexibility, open-mindedness and commitment are also just as important for Rudolf Gutbrod GmbH.

Rudolf Gutbrod GmbH is a pioneer in lining technology with its innovative and economic product "ChemResist Rotational Sinter Lining". Quite often the conventional lining and coating technologies available in the market do not fulfil the many requirements placed on them. ChemResist



The interplay between our know-how, modern facilities and equipment and our motivated and qualified employees creates a perfect quality, which satisfies the highest requirements.

puts a new emphasis in this case using a process and computer-controlled lining technology according to the rotational sinter lining process. This procedure creates a seamless lining with virtually uniform coating thickness.

High-quality partially and fully fluorinated materials, such as ETFE und PFA, and the high performance polymers PE, PP and PA, are used by ChemResist. ETFE and PE are also available as electrically conducting versions. ChemResist can also supply with FDA-conform certification upon request. This also applies to electrically conductive specifications.

Partly and fully fluorinated polymers offer universal and permanent resistance to acids, alkalis, solvents and chlorides. ChemResist possesses an extremely smooth and anti-adhesive surface and thus prevents bacterial adherence or growth. In the manufacture of highly pure products (chip industry, high purity grade chemicals) ChemResist prevents impaired quality from foreign substances or dissolved metallic ions.

If special parts are to be lined, ChemResist possesses distinct advantages both from an economic as well as a qualitative point of view. The process can be adapted flexibly to the circumstances or requirements (preparation of tooling is not



required). Even rigid construction specifications can be solved economically with ChemResist. Mechanical preliminary work, as well as the use of adhesives, can be avoided. Chemical resistance and high temperature resilience remain unaffected. The permanent and homogeneous lamination to the substrate means new and interesting perspectives in use under vacuum. ChemResist opens up new and versatile options for surface protection in almost all areas of industry to the user and the planning engineer.

ROTATIONAL SINTER LINING APPLICATIONS HAVE BEEN USED SUCCESSFULLY FOR 25 YEARS

Chemical and pharmaceutical industry

Reactors and column plates, pipe-work, reduction adapters, vessels, tanks, valves, cylinders, filters, pump casings, vibration filters, centrifuge casings, filters, galvanizing baths, etc.

Foodstuffs industry

Hoppers, pipe-work, vessels, etc.

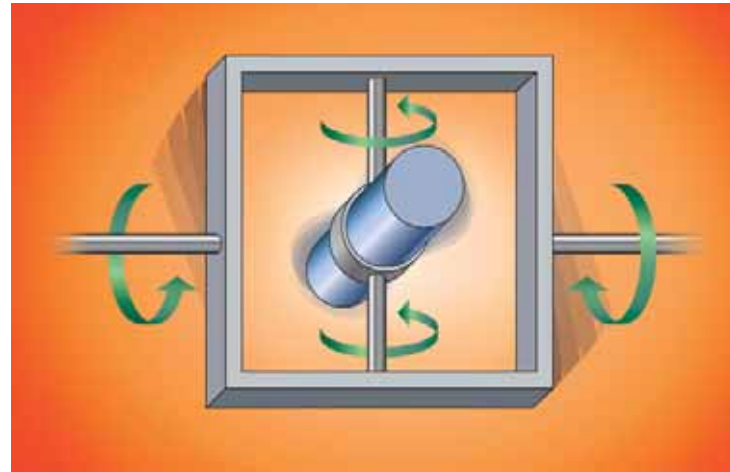
Semi-conductor technology

Pure water tanks, vessels for highly purified chemicals, exhaust air ventilation systems, solar energy, semi-conductor technology, etc.



HOW DOES ROTATIONAL SINTER LINING WORK?

Rotational sinter lining is carried out by filling ultra-pure thermoplastic granulate (with good flowing properties) into the hollow body, pipe or vessel to be lined. The object holder is heated and turned bi-axially so that a uniform layer thickness of molten granulate is applied seamlessly to the inner surface of the component.



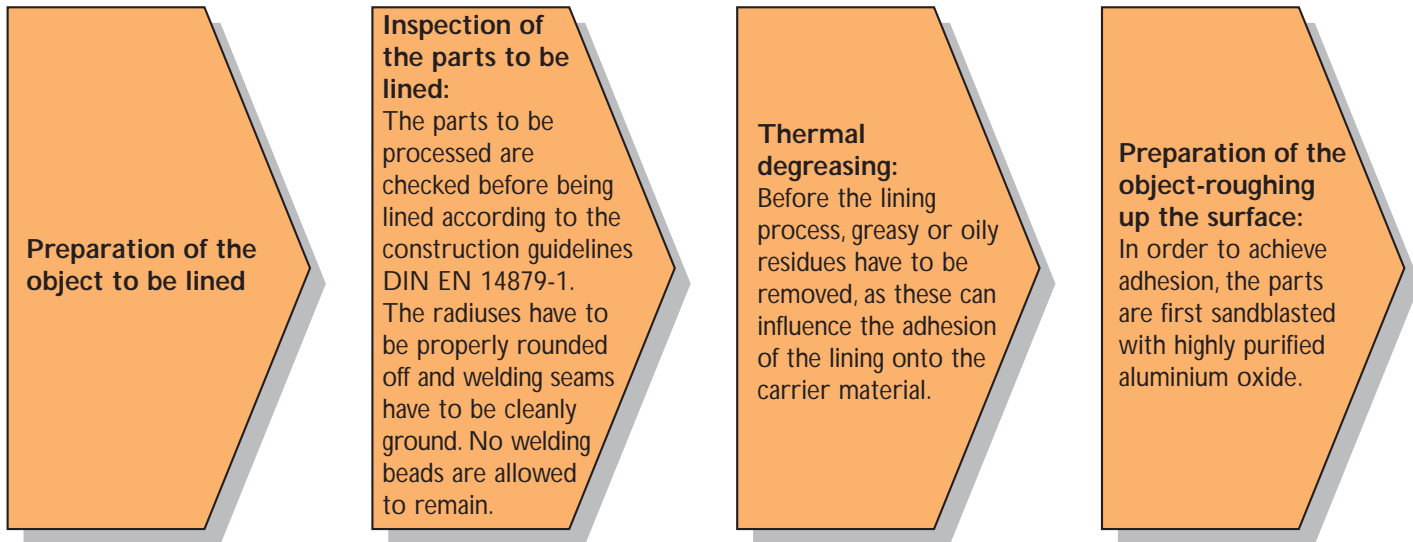
SATISFIED CUSTOMERS WHO TRUST IN GUTBROD

AllessaChemie
BASF Ludwigshafen
BASF PharmaChemikalien
BASF Rudolstadt
BASF Schwarzheide
Bayer CropScience
Bayer HealthCare
Bayer MaterialScience
Bayer Schering
Bayer Technology Services
Biochemie
Boehringer Ingelheim
Boehringer Mannheim

Cabot
Clariant
DSM
Dynamit Nobel
DyStar
Evonik
Fluorchemie Dohna
Imtech
Ineos
Infineon
KataLeuna
Kemira
Kronos Titan

Lanxess
Merck
PCK
Robert Bosch GmbH
Sachtleben Chemie
Siegle + Epple
Siltronic
Solvay
Stockhausen
Tectrion
Uhde
Vinnolit
Wacker Chemie Burghausen

PROCESS SEQUENCE



DECISIVE ADVANTAGES OF ChemResist WITH THE MATERIALS ETFE,

Layer thicknesses up to 7 mm are possible

In conventional coating of components, the layer thickness is limited to approx. 1 mm. With the Gutbrod "ChemResist" system, wall thicknesses of up to 7 mm can be achieved.

Seamless lining

Complex and difficult parts or geometries do not represent a problem for ChemResist. All surfaces of the work-piece are reliably lined with specific biaxial movements. The result is a perfect and homogeneous lining without seams and welding points.

Reduced residual tension

As no pressure is required during the lining process, considerably less tension remains in the workpiece.

Optimally adhering coating

ChemResist requires no adhesive, and no joints are produced either. The permanent and homogeneous lamination to the substrate means new and interesting perspectives in use under vacuum. For special applications in the high temperature range, a very thin primer may be used.



Rotational sinter lining:

The components are fixed into a clamping device and filled with the appropriate material. The lining temperature and rotational speed are individually set.

Finishing:

Mechanical processing of the sealed surface.

Inspection and quality control:

The components are inspected visually for appearance, layer thickness, pore impermeability and, if necessary, electrical conductivity, and an inspection certificate 3.1 according to DIN EN 10204 is issued. All test procedures are documented.

Packaging and shipment

PFA, PE, PP AND PA

Small lot sizes are also economical

It is also possible to complete small lot sizes economically using the technical rotation technology, even if there is a broad spectrum of complex forms and sizes.

Cost-effective despite quality improvement

The steel construction can be planned considerably more cost-effectively. By reducing the flange connectors (and thereby the number of potential leakage points), quality can be increased considerably.

Long-term safety

Homogeneous and permanent lamination to the substrate is achieved without the danger of collapsing with larger diameters. No safety risk through impact and longitudinal expansion, even at minus temperatures.

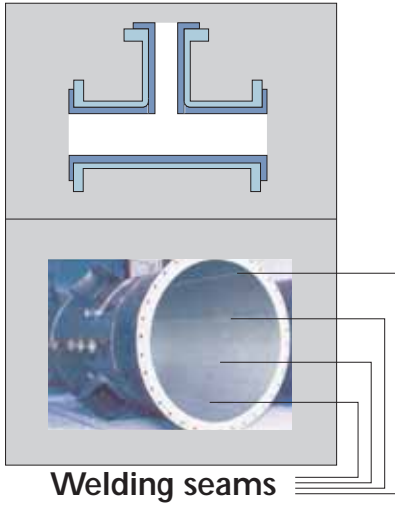
Quality assurance in every dimension

ChemResist permits components to be lined regardless of the geometry up to a size of 2,600 mm in length, a diameter of up to 2,400 mm and a total weight of 2,200 kg, without rigid requirements on the construction itself.

The process sequence with entry and processing data is documented in detail.



COMPARISON WITH CONVENTIONAL COATING AND LINING PROCESSES



Electrostatic spray coating

ECTFE, PFA, FEP, ETFE
Primer
Metal

- Thickness: approx. 1mm
- Primer principle
- Several heating phases required

Loose lining

PTFE, PFA
Welding seam
Metal

- Thickness: from 2 mm
- Ventilation holes are necessary
- Only simple forms are possible
- For complicated parts (tanks) loose linings have to be welded

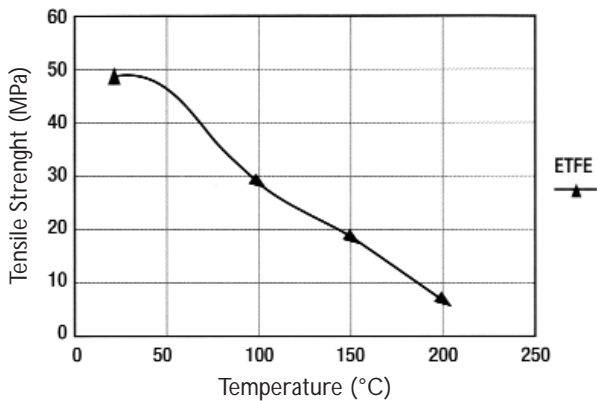
Conventional lining

PTFE, PFA, ECTFE
Adhesive
Welding seam
Metal

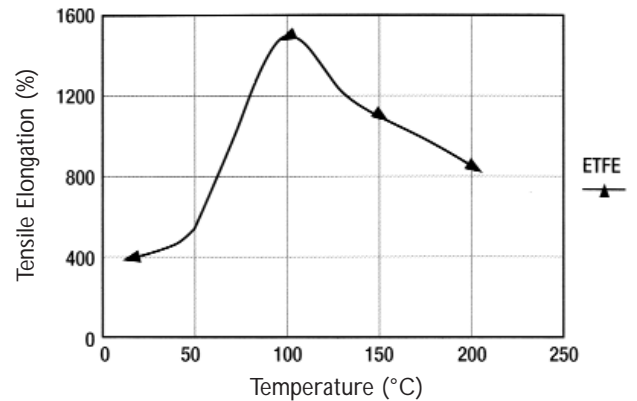
- Reduced temperature resistance due to the use of adhesives
- Subsequent welding of joints is necessary.



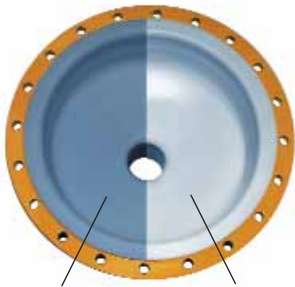
Effect of Temperature on Tensile Strength



Effect of Temperature on Tensile Elongation



PERFECT SOLUTIONS WITH ChemResist ROTATIONAL SINTER LINING



Standard ETFE

Ultra-pure ETFE; for pharmaceuticals, semi-conductor and special chemicals

ETFE, PFA and PE
Rotational sinter lining

ETFE, PFA and PE
Metal

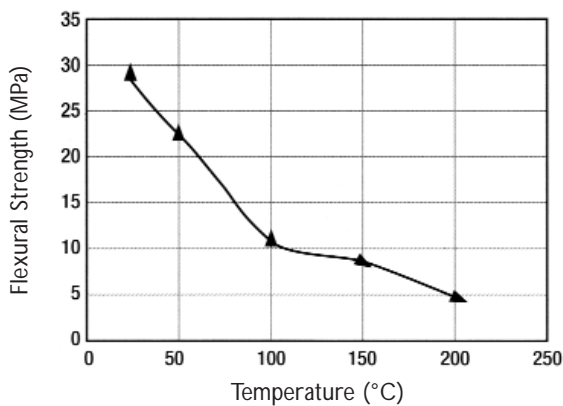
- Thickness: 2 - 7 mm
- Direct laminate with metal
- Only one heating phase
- Seamless lining

ChemResist ROTATIONAL-LINING

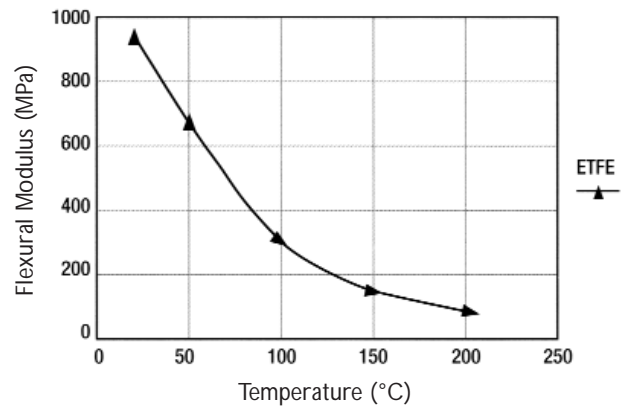
Seamless lining –
No welding seams –
No adhesives



Effect of Temperature on Flexural Strength



Effect of Temperature on Flexural Modulus

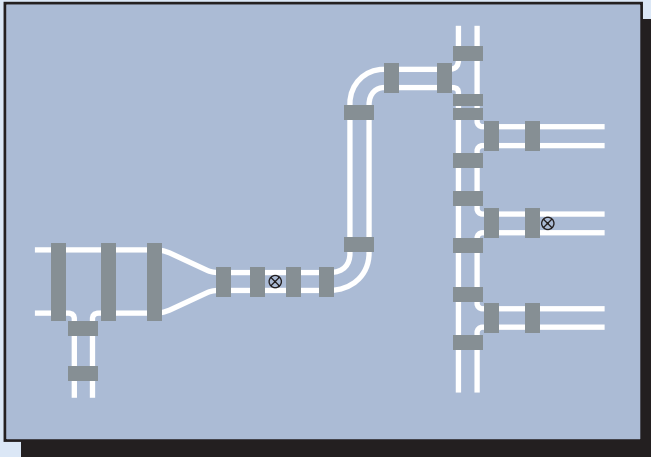


ChemResist
ROTATIONAL-LINING

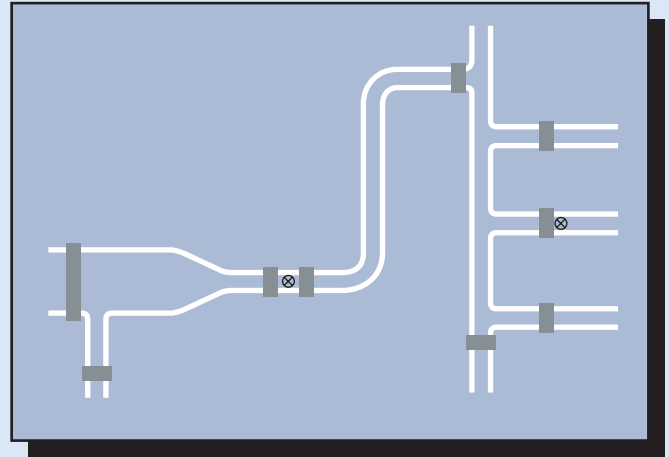
ETFE, PFA, PE, PP AND PA HAVE MANY EXCELLENT PROPERTIES

- Exceptional, universal chemical resistance at high temperatures (ETFE, PFA)
- Purity
- No tension cracking
- Electrical conductivity (ETFE, PE)
- Repairable
- Solvent resistance
- Easy to clean, thanks to anti-adhesive surface (ETFE, PFA, PA)
- FDA-conformity (ETFE, PFA, PE)
- Non flammable (ETFE, PFA)
- Resistant to cold
- More robust
- Approved according to the Code of Practice Air (ETFE, PFA, ECTFE)

Reduction of costs • Reduction of leakage points • Reduction of weight



Conventional lining/coating



ChemResist Rotational Sinter Lining

COMPETENT IN ALL ASPECTS ...

In order to survive in today's competitive environment we offer our customers not only perfect lining solutions, but also completely integrated concepts.

Optimal results emerge right from the start. You can count on our full-service consultancy competence from the very beginning.



| Items | | Units | ETFE tetra- fluoroethylene- ethylene- copolymer | FEP tetrafluoroethylene- hexafluoropropylene- copolymer | PCTFE polychloro- trifluoro- ethylene | PVDF polyvinylidene- fluoride | PTFE polytetra- fluoro- ethylene | ASTM No. | |
|-----------------------------------|--|---|--|--|--|--|--|--------------|------|
| Physical properties | Specific gravity | | 1.73 - 1.75 | 2.15 - 2.17 | 2.1 - 2.2 | 1.76 - 1.77 | 2.1 - 2.2 | D792 | |
| | Melting point | °C | 265 - 270 | 285 - 295 | 212 - 217 | 170 - 185 | 327 | | |
| | Melt viscosity | poise (°C) | 10 ⁴ - 10 ⁵ (300 - 330) | 10 ⁴ - 10 ⁵ (350 - 380) | 3x 10 ⁶ - 2x 10 ⁷ (270 - 300) | 3x 10 ⁶ - 2x 10 ⁷ (270 - 300) | 10 ⁴ - 10 ⁵ (300 - 300) | | |
| Mechanical properties | Tensile strength 23°C | kg/cm ² | 410 - 470 | 190 - 220 | 300 - 400 | 500 - 600 | 70 - 280 | JIS K689 | |
| | Yield strength 23°C | kg/cm ² | 190 - 220 | 130 - 150 | 400 - 450 | 400 - 600 | 120 - 160 | JIS K6891 | |
| | Elongation 23°C | % | 420 - 440 | 250 - 330 | 80 - 250 | 200 - 300 | 225 - 600 | JIS K6891 | |
| | Tensile modulus | kg/cm ² | 5 - 8x 10 ³ | 3.5x 10 ³ | 10 - 20x 10 ³ | 8 - 14x 10 ³ | 4x 10 ³ | D638 | |
| | Flexural modulus | kg/cm ² | 9 - 10x 10 ³ | 6.7x 10 ³ | 17.6x 10 ³ | 14 - 18x 10 ³ | 3.5 - 6.3x 10 ³ | D790 | |
| | Izod impact strength | ft-lb/in notch | no break | no break | 3,0 | 3.5 - 3.8 | 3.0 | D256 | |
| | Rockwell hardness | | R-50 | R-25 | R-75 - 95 | R-110 | R-18 | D785 | |
| Thermal properties | Frictional coeff. (against stainl. steel) | | 0.20 | 0.20 | 0.18 | 0.21 | 0.09 | | |
| | Linear thermal expansion coeff. | °C ⁻¹ | 9.4x 10 ⁻⁵ | 9x 10 ⁻⁵ | 10x 10 ⁻⁵ | 12 - 15x 10 ⁻⁵ | 10x 10 ⁻⁵ | D696 | |
| | Flammability | | Incombustible | Incombustible | Incombustible | Self-extinguish | Incombustible | D635 | |
| Chemical properties | Continuous Ser- vice temperature | °C | 150 | 220 | 180 | 150 | 260 | | |
| | Chemical resistance | | Excellent | Excellent | Good | Good | Excellent | D543 | |
| | Water absorp- tion 23°C | % | 0.01> | 0.01> | 0.00 | 0.34 - 0.04 | 0.01> | D570 | |
| | Permeation (O ₂) | cc.mil/ 100 in ² 24 hr • (N ₂) atm | 148 | 300 - 900 | 4 - 90 | 3.3 - 4.0 | 1050 | D1434 | |
| Electrical properties | | | 45 | 150 - 170 | 1.5 - 22 | 0.9 - 2,1 | 390 | D143 | |
| | Volume specific resistance | ohm/cm | 10 ¹⁷ | 10 ¹⁸ | 1.4x 10 ¹⁷ | 2 - 6x 10 ¹⁷ | 10 ¹⁸ | D257 | |
| | Dielectric constant tangent 23°C | | 2.4 - 2.6 | 2.1 | 2.5 - 2.8 | 3 - 11 | 2.1 | D150 | |
| | Dielectric loss tangent 23°C | 60 H ₂ | | 0.0001> | 0.0003 | 0.015 | 0.05 | 0.0001> | D150 |
| | | 10 ³ H ₂ | | 0.0005 | 0.0002 | 0.023 | 0.018 | 0.0001> | D150 |
| | | 10 ⁶ H ₂ | | 0.0032 | 0.0007 | 0.012 | 0.16 | 0.0001> | D150 |
| 10 ⁹ H ₂ | | | 0.01 | 0.0005 | 0.01 | 0.11 | 0.0004 | D150 | |
| Breakdown voltage (short time) | KV/0.1 mm film | | 12 | 12 | 12 - 13 | 9 | 8 - 10 | JIS K6891 | |
| Arc resistance | sec | | 120 | 165< | 300< | 50 - 70 | 300< | D495 | |

Typical properties of fluorinated plastics



EVEN COMPLETE SOLUTIONS

Start talking to us already in the planning phase. We shall be pleased to provide complete solutions and will take over the responsibility for your steel construction, in collaboration with our competent and certified partners.

With our own jig manufacturing (mounting objects up to 2.2 tonnes), modern means of production and facilities we produce according to state-of-the-art technology standards. Our processes and procedures are certified according to ISO 9001:2000. We shall also continue to invest in new means of production in the future.



We act with awareness for the environment in all our activities and products. We pay attention to avoiding environmental pollution and to using resources responsibly.



Rudolf Gutbrod GmbH in Swabian Dettingen/Erms sets new standards in innovative coating technology. The company is leading in Europe as a processor of fluorinated polymers.

The enterprise was founded in 1964 and is a pioneer in Germany in surface coating technology with fluoropolymers. And as a licensee of well-known raw material manufacturers to some of Europe's top addresses, as far as functional coatings with non-stick effect, low friction, chemical protection and corrosion protection are concerned. State-of-the-art technology is ensured through continuous development work.

Raw material procurement is undertaken on a worldwide basis. International and permanent exchange of ideas will ensure that the highest possible quality will be maintained in solving the different requirements of our customers also in the future.

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