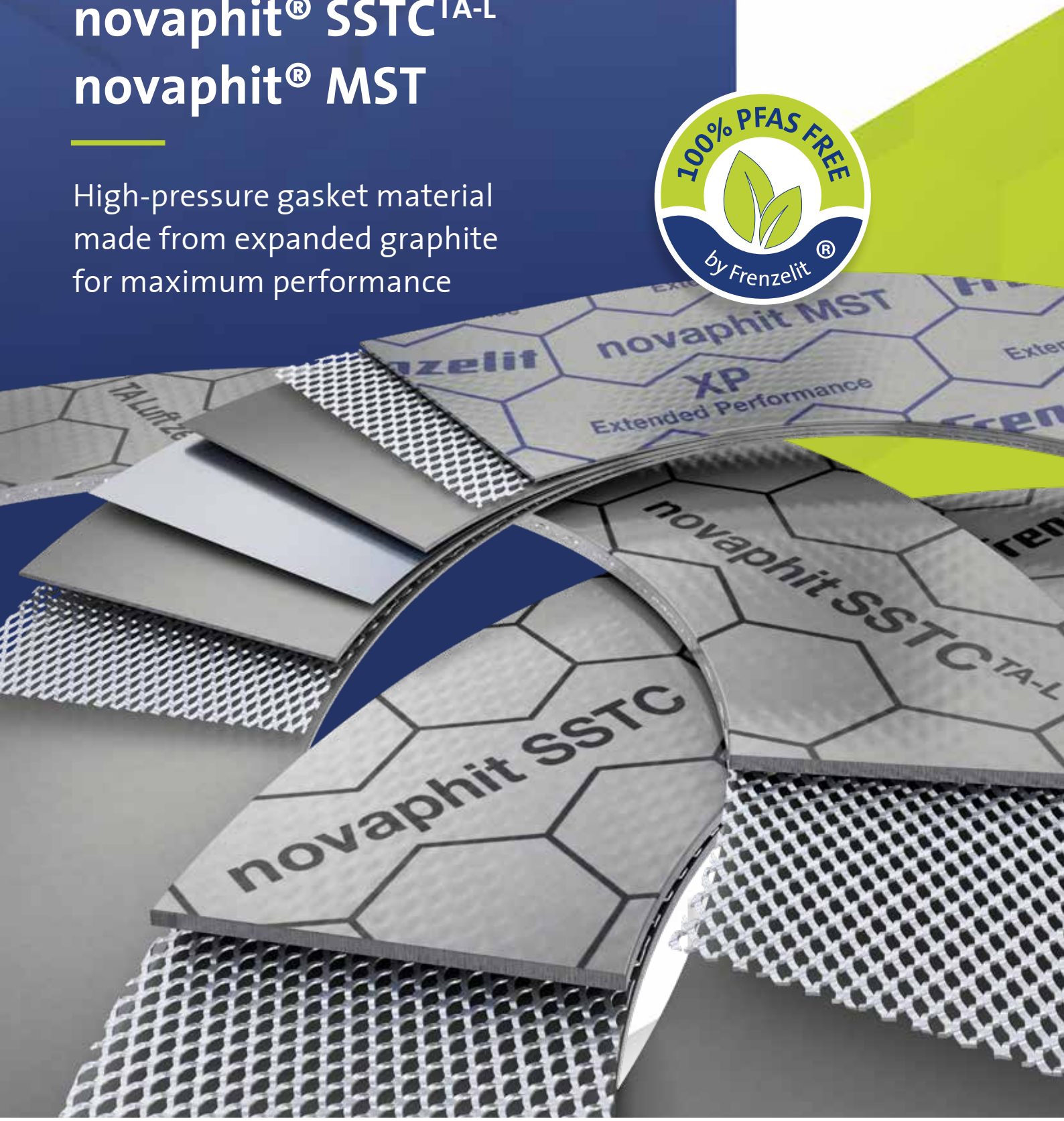
Frenzelit

novaphit® SSTC
novaphit® SSTC^{TA-L}
novaphit® MST

High-pressure gasket material
made from expanded graphite
for maximum performance

100% PFAS FREE
by Frenzelit ®



GASKETS
GASKETS

INSULATION
INSULATION

EXPANSION JOINTS
EXPANSION JOINTS

www.frenzelit.com

WHY USE GRAPHITE AS A GASKET MATERIAL?
Excellent performance and maximum process reliability

novaphit® SSTC | novaphit® SSTC^{TA-L} | novaphit® MST

[mm] | 1.0 | 1.5 | 1.6 | 2.0 | 3.0 | 4.0*

[°C] | –200 to 550

The novaphit® product family comprises a range of flat gasket materials made from high-quality expanded graphite. novaphit® gaskets are reliable and durable even at the outer application limits.

ADVANTAGES:

- Insensitive to changing loads
- Maximum adaptability to flange unevenness
- High flexibility when sealing surfaces are unfavorable/ faulty
- Virtually no hot creep
- Universal chemical resistance
- Maximum sealing performance in the flange
- Can be used at internal pressure levels of up to 250 bar

Following the phase-out of asbestos, initially, there were no technically reliable solutions available for gasket applications in higher temperature ranges. Rubber-bonded gasket materials have a natural maximum temperature limit. There was a particular need for better solutions for media that are hot, dangerous and have creep properties, such as steam or heat transfer oils. This was the reason for the tremendous success of gaskets made from expanded graphite.

Consistent product quality thanks to process control system

Frenzelit is involved throughout the manufacturing process of the novaphit® product family, from the procurement of the graphite raw material to the finished gasket. All the parameters that affect quality are monitored via a process control system.
This ensures consistent maintenance of the highest product quality. Process reliability in manufacturing results in dependable gasket connections for users, thereby ensuring reliable processing operations in their facilities.

Sealing system design

Frenzelit produces the data needed to calculate the design parameters for gasket applications in its own laboratory. A large number of different tests that are relevant to gasket materials are carried out in-house on an ongoing basis. The tests range from media resistance tests to mechanical/thermal tests and the determination of gasket parameters on state-of-the-art AMTEC test rigs. Both the quality assurance department and the development department take frequent advantage of these laboratory services. Customer-specific tests are also performed to ensure user tasks are completed as efficiently as possible.

The production process from the mine to the finished product

* Thickness 4.0 mm only available with novaphit® MST

HIGH-QUALITY GRAPHITE GASKETS
made from expanded graphite

novaphit® gaskets made from expanded pure graphite are suitable for high chemical, thermal and mechanical stresses. They do their job reliably even when there are extreme fluctuations in conditions. Incidentally, novaphit® gaskets do not contain any binders.

There can be dramatic differences in graphite quality. Below you will find an explanation of how expanded graphite is made and what quality criteria need to be met.

Where does graphite come from?

Graphite is obtained in both open-cast and underground mines. The choice of the mine determines the subsequent quality level. The grinding and cleaning operations that follow are just as important.

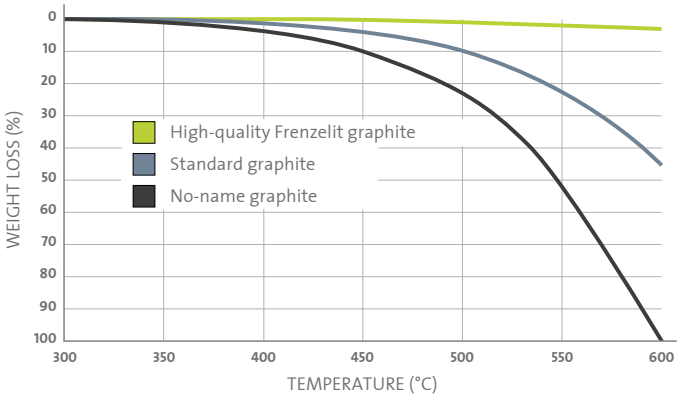
What happens in the expanding process?

The ground raw graphite is expanded in a thermal process, in which the volume of the (flake) graphite is expanded many times over. A flexible and soft graphite foil (made from expanded graphite) is produced from a “brittle” graphite powder.

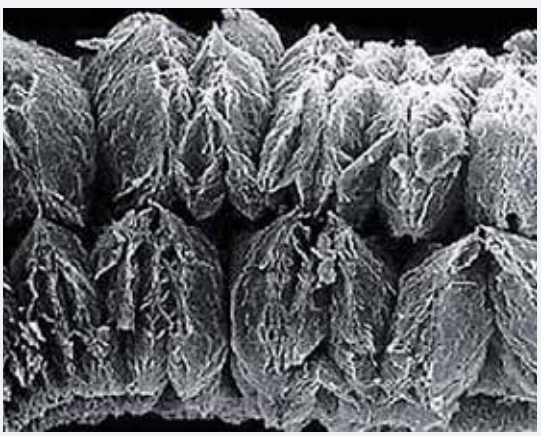
Oxidation resistance: the most important quality feature of graphite gaskets

The efficiency of the graphite is defined essentially by its oxidation resistance. The common assumption that graphite quality is determined solely by a specific degree of purity is inaccurate. On the contrary: It is essential to precisely determine the oxidation properties of graphite, because even graphite foils of the highest purity level may not be resistant enough to oxidation. Thanks to careful selection of the raw graphite and 100% incoming goods inspections confirming this property along with many others, only high-quality graphite is used in the novaphit® SSTC, novaphit® SSTC^{TA-L} and novaphit® MST production process.

Weight loss as an indication of the oxidation resistance of pure graphite foil (99%)



Flake graphite Source: Graphit Kropfmühl AG



Expanded graphite Source: Graphit Kropfmühl AG

ENVIRONMENTAL PROTECTION
thanks to maximum quality standards throughout the company

High-quality gaskets play a key role in protecting the environment. Rules like the German Clean Air Act ("TA Luft") set high standards when it comes to sealing criteria. It is particularly important that these criteria are met in applications involving media that endanger the environment and are harmful to health.

Demonstration of the high quality of novaphit® MST and novaphit® SSTC^{TA-L} (according to TA Luft) in component testing

Component testing involves leakage measurement following 48 hours of exposure to a temperature of 300 °C. The leakage limit is $1 \cdot 10^{-4}$ mbar • l / (s • m). Until now, this has been the most important criterion for determining the quality of a gasket material. Many years of practical experience with gaskets have, however, shown that the quality of the gasket material depends on other criteria, too. They include mechanical properties, long-term temperature resistance and effective sealing for long periods. It is apparent from this that excellent gasket material performance is determined by the combination of several different properties.

Focus on the entire sealing system: VDI 2290

There are more detailed regulations that are designed to ensure compliance with TA Luft standards. The quality of the overall gasket connection is influenced not only by the properties of the gasket material but also by the installation in situ. The current VDI directive 2290 is primarily based on a comprehensive approach to gasket system design. It stresses the importance of expert installation as much as the need for accurate design calculations.

Gasket design in accordance with DIN EN 1591

DIN EN 1591-1 is expressly recommended for the design and calculation of gasket systems. VDI 2290 continues to refer to use of design sealing class $L_{0.01}$. Thanks to their superior performance, novaphit® MST and novaphit® SSTC^{TA-L} make it possible to produce gasket connections in compliance with the strict criteria of TA Luft and VDI 2290. By supplying novaphit® MST and novaphit® SSTC^{TA-L}, Frenzelit has created a solid foundation for company-wide standardization while maintaining maximum quality.

XP TECHNOLOGY
Higher efficiency thanks to innovative technology

Frenzelit continuously researches innovations that improve products even when they have proved successful for decades. XP technology for novaphit® was developed as part of this process. Graphite possesses inherent properties that were previously considered unchangeable, leaving users little choice other than to accept them. The new XP technology for novaphit® is now eliminating these restrictions.

XP = eXtended Performance

Non-stick properties without any temperature restrictions

Until now, one of the standard properties of graphite has been that gasket residue almost always adheres to the sealing surface and has needed to be removed in laborious and time-consuming operations whenever gaskets needed replacing. Conventional, organically based, non-stick coatings weaken graphite properties such as sealing efficiency or stability at high temperatures – which would otherwise be quite impressive. Non-stick properties that remain stable for long periods over the entire application temperature range of the graphite cannot be achieved with these systems. This problem has been solved successfully for the first time with the innovative inorganic XP technology.

Increased oxidation resistance

Even high-quality graphite foils that incorporate oxidation inhibitors are subject to oxidation at certain temperatures. XP technology for novaphit® enables deep passivation of the graphite, which slows down the oxidation process significantly. This leads to a substantial increase in long-term resistance.

Inorganic deep passivation

XP technology for novaphit® involves purely inorganic treatment of the graphite. In this process, homogeneously distributed nanoparticles throughout the entire cross-section of the material provide compact protection for the graphite. The active substance is chemically inert and supports the excellent media resistance of the graphite.

ADVANTAGES AT A GLANCE:

- Non-stick properties: fast gasket replacement – tremendous time-saving potential
- Minimized risk of flange damage
- Inorganic basis guarantees long-term effectiveness and media stability – even at temperatures above 250 °C
- Increased oxidation resistance – better long-term performance
- Mass loss < 3%/h at 670 °C
- Higher plant reliability/availability

The novaphit® product family

Product name	Brief description	XP technology
novaphit® MST	Multilayer gasket with expanded and flat metal inserts for highest mechanical stability, fulfilling TA Luft requirements	standard
novaphit® SSTC^{TA-L}	With expanded metal insert, fulfilling TA Luft requirements	optional
novaphit® SSTC	With proven expanded metal insert	optional
novaphit® SSTC$^{TRD\ 401}$	The TÜV-certified solution for oval closure lid gaskets	optional
novaphit® 400	Reinforced with flat metal insert, for filigree geometries and thin gasket thicknesses	–
novaphit® VS	Pre-compressed graphite sheet without metal reinforcement	optional
novaphit® M	Graphite foil with a density of 1.0 g/cm^3	optional

XP TECHNOLOGY
facilitates gasket replacement

XP technology provides novaphit® flat gaskets with non-stick properties that have not been achieved before with graphite.

With XP technology

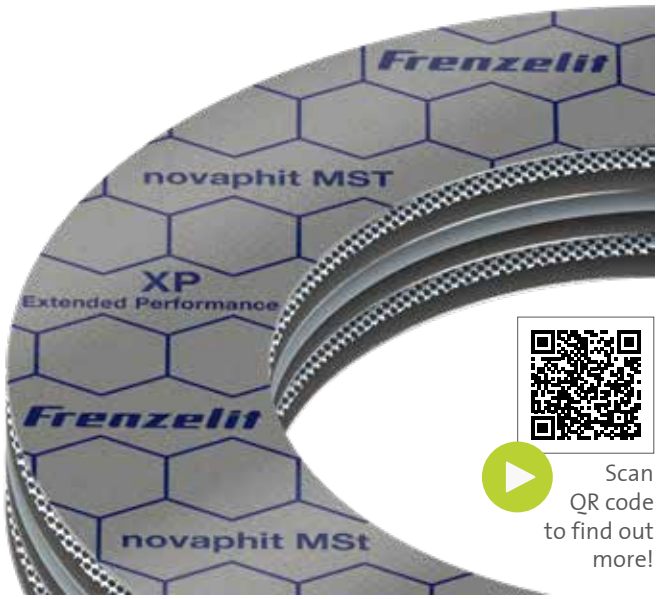
Without XP technology

The non-stick function of novaphit® with XP technology is 100% effective over the entire application temperature range of a graphite gasket. Due to the inorganic, inert basic structure of the XP technology, there are no functional restrictions with respect to chemical media resistance.

The XP technology for novaphit® materials reduces the common graphite deposits on the sealing surfaces and facilitates gasket removal and the time-consuming cleaning of the flanges. This represents an impressive improvement in the performance of graphite gaskets.

XP technology offers incredible savings. This is attributable to the simpler removal of the gaskets, the considerable simplification or elimination of flange cleaning and the associated time savings. It also protects sealing surfaces, ensuring they remain intact for longer. Tongue-and-groove flange connections are a particularly tough challenge, when residue on old gaskets requires removal.

Investigations carried out by plant operators also show that it is not unusual for leakage problems to be attributable to incomplete removal of old gasket residue. XP technology makes a major contribution to process reliability in this respect.



XP TECHNOLOGY
increases oxidation resistance

When an oxidant such as atmospheric oxygen is present, graphite gaskets are subject to oxidation at higher temperatures. Graphite turns (among other things) into CO_2 as a result. This leads to a loss of graphite mass, the consequence of which is an increase in leakage from the gasket seal, and even total failure of the gasket.

Impact of the difference in oxidation resistance

Test temperature: 670 °C/4 h, atmosphere: air

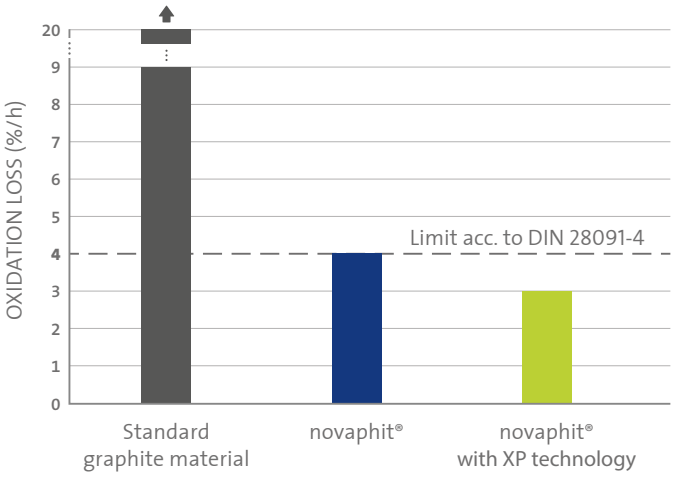
novaphit® with XP technology

Commercially available graphite gasket

The quality requirements regarding the oxidation resistance of flat graphite gaskets are specified in DIN 28091-4 to be a maximum of 4% oxidation loss per hour and a dwell time of 4 h at a temperature of 670 °C. The exacting demands of specifications from the oil processing industry have been incorporated in the DIN standard here. XP technology for novaphit® materials results in a significant improvement in the oxidation resistance of the graphite. The XP technology makes novaphit® so inert that the maximum mass loss due to oxidation is 3%/h, i.e. considerably lower than the requirements under the current standard.

The following chart shows the results of thermogravimetric analysis (TGA in accordance with DIN 28090-2) of a proven novaphit® gasket – which is already inherently oxidation-resistant – with and without XP finishing. XP technology ensures that oxidation loss does not exceed 3%/h. The increase in efficiency helps keep seals stable for longer and thus improves both process reliability and plant availability.

Mass loss due to oxidation according to DIN 28090-2, TGA at 670 °C/4 h



MATERIAL PROFILE OF novaphit® SSTC / novaphit® SSTC^{TA-L}
Advantages of the expanded metal insert used

Gasket material made from expanded graphite (purity level > 99%) with internal impregnation and an acid-resistant expanded metal insert made from chrome-nickel steel (material no. 1.4404 / AISI 316L).

Expanded metal made from acid-resistant stainless steel

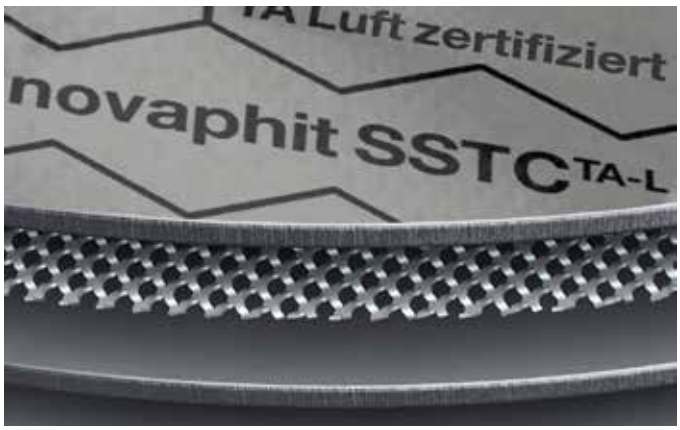
Corrosion and acid-resistant material (material no. 1.4404).

Thickness of the expanded metal insert used

Stretching the stainless steel film used (original thickness 0.15 mm) results in a three-dimensional structure with a projected height of about 0.4 mm, which in turn leads to chambering of the gasket core.

Geometry of the stainless steel insert

- Better exploitation of the surface pressure available to compress the graphite, because no "crowns" need to be levelled (bent). This speeds up gasket installation.
- No undercutting in the insert material. The graphite foil encloses the insert completely.
- Optimized surface pressure distribution when compared to other insert concepts. This is impressively demonstrated by the self-contained lines of higher surface pressure (see the Fuji Film photo of novaphit® SSTC^{TA-L} with expanded metal).
- Favorable grid geometry (diamond dimension = 3.0 mm) makes it possible to reliably produce gaskets with very narrow gasket widths.
- Easy cuttability. Handling benefits in manual and in-house finishing.

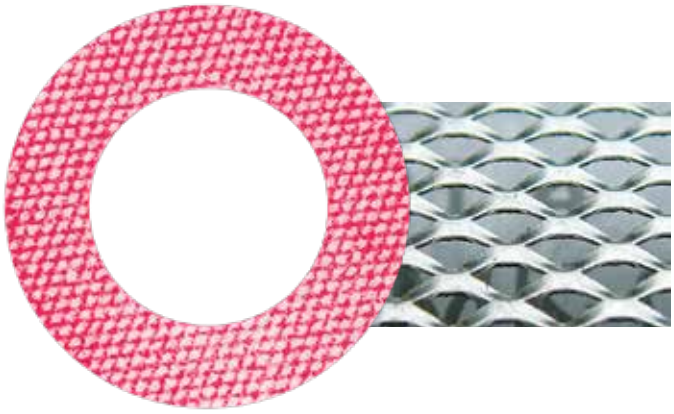


- Considerably lower risk of layer separation when bending occurs. Even in such cases, the graphite foil is pressed around the insert again completely when pressure is applied to the gasket during installation in the flange. This results in a greater tolerance in the event of improper handling.
- Repeated bending of the insert is irreversible due to strain hardening, i.e. the insert recovers and is actively involved in the sealing operation! This ensures a more secure gasket connection, particularly at higher surface pressure levels.
- Another advantage of novaphit® SSTC and novaphit® SSTC^{TA-L} in direct comparison with smooth metal inserts is their open insert design principle. This means that not only the outer graphite layer but also a considerably thicker layer is available to compensate for flange damage.

Fuji Film photos

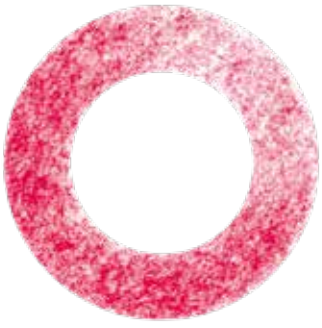
Sensitivity: Medium
Gasket thickness: 2.0 mm
Surface pressure: 30 N/mm^2

Frenzelit novaphit® SSTC^{TA-L} graphite gasket with expanded metal



Graphite gasket with tanged metal

Graphite gasket with flat metal



MATERIAL PROFILE OF novaphit® MST with XP technology
Advantages of combining expanded metal and smooth metal inserts

Multilayer gasket material made from expanded graphite (purity level 99.5%*) with several expanded metal and flat metal inserts made from stainless steel (material no. 1.4404 / AISI 316L) and intelligent internal impregnation.

XP technology as standard

novaphit® MST, the flagship of the novaphit® product family, features all advantages of the XP technology as standard.

Outstanding adaptability

The logical arrangement of the stainless steel inserts is the special feature of novaphit® MST. Graphite foils of 0.5 mm thickness alternate with 1.4404 stainless steel. The open structure of the expanded metal makes the gasket more adaptable, because the two outer graphite layers on each side can be used to compensate for flange unevenness.

A new dimension in internal impregnation performance

Systematic improvement in the effectiveness of the internal impregnation has made it possible to use graphite foils with optimized initial density. The sealing properties are simultaneously increased as a result, while adaptability is improved significantly. Gasket deformation of about 43% is achieved with surface pressure of only 20 MPa. Compared with standard multilayer laminates, which reach only about 23%, this results in 87% higher adaptability.

Excellent handling

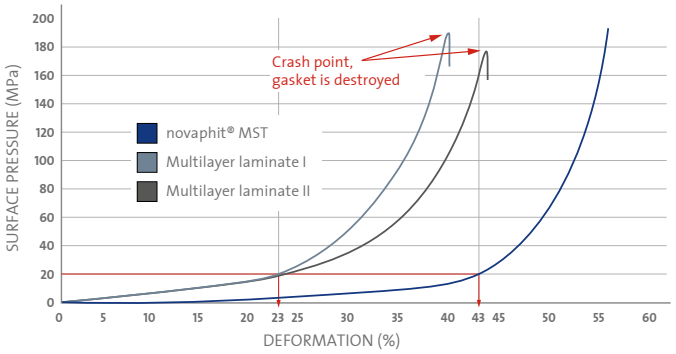
Thanks to the multilayer structure, gaskets made from novaphit® MST have extremely good dimensional stability properties and do not buckle. This can be an advantage over single-layer, reinforced graphite gaskets.

Easy processing

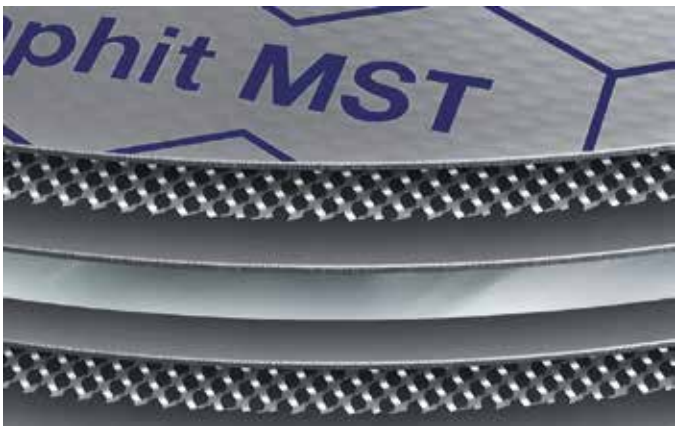
The thickness of the individual stainless steel inserts (0.05 mm) has been chosen carefully to ensure extremely reliable and easy processing via all standard methods:

- Punching
- Plotting
- Water jet cutting
- Cutting with circular saws
- Cutting with metal shears
- Cutting with scissors

Compression curve according to DIN 28090-1



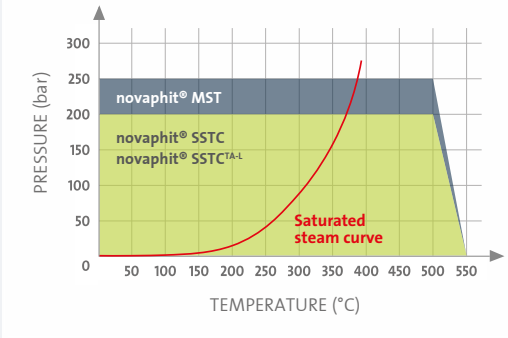
* typical value



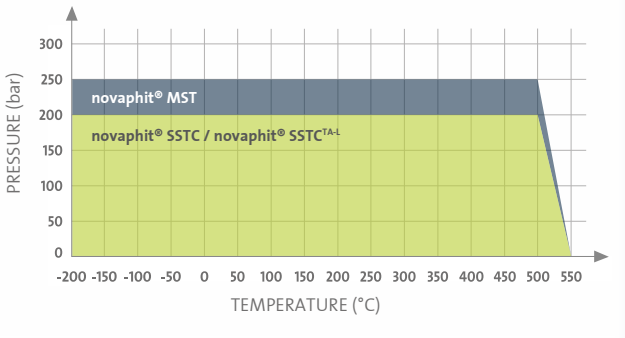
Application recommendations

Depending on pressure and temperature levels

Water/water vapor



Other media*



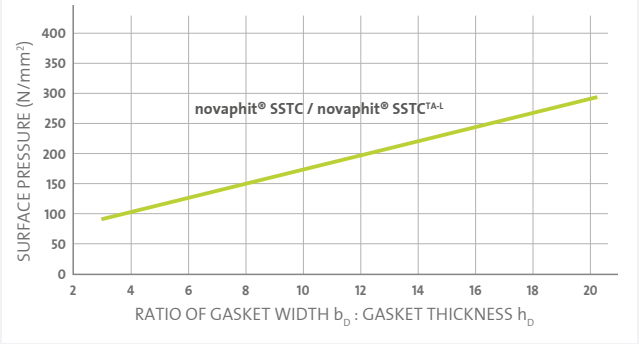
Notes on application recommendations

The temperature and pressure recommendations in the charts apply to 2.0 mm thick gaskets that are used with raised face flanges. Higher stresses are possible when thinner gaskets are used! Consequently, the details shown here should be considered cautious estimates rather than specific operational limits.

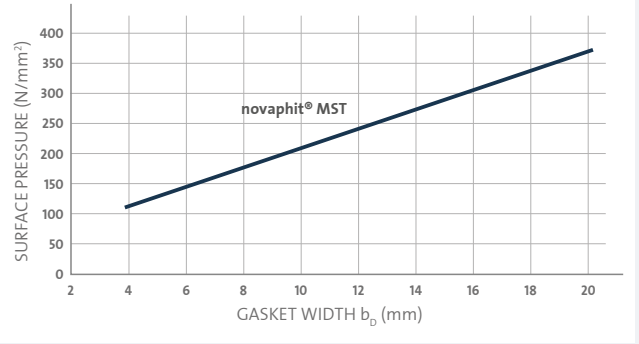
** Example for the most common other media. Precise data for individual cases can be obtained from the Frenzelit novaDISC program at www.novadisc.de or by contacting our application engineering specialists.*

Maximum surface pressure

after installation, with smooth sealing faces



The maximum surface pressure can be increased by a factor of approximately 1.5 in the case of tongue and groove flanges.



The multilayer structure of novaphit® MST ensures outstanding performance regardless of gasket thickness.

Gaskets for hydrogen applications

Sealing the medium of hydrogen is one of the most challenging tasks in the field of gaskets and seals. This is primarily due to the unique properties of the hydrogen atom. It is the smallest of all the elements in terms of atom size and atom mass.

With the "H_2-approved by Frenzelit" branding and more, Frenzelit already wants to set benchmarks in the industrial use of hydrogen with its own proprietary test method and the resulting measurement protocols. novaphit® SSTC^{TA-L} and novaphit® MST are particularly suited for these applications. Please feel free to contact our application engineering specialists with any additional questions.

PFAS FREE gasket materials

Highly effective Frenzelit product families (such as novapress® or novaphit®) can already be used as substitutes for a large number of applications that currently use PTFE. Frenzelit can confirm that many of its products do not contain regulated substances ("forever chemicals") and that regulated substances are also not used to manufacture these products. Consequently, the core range of products will not be affected by a PFAS ban.

Frenzelit now labels all corresponding products and product groups with a PFAS FREE logo.

TECHNICAL DATA
Explanations

Material data

General information				novaphit® SSTC	novaphit® SSTC^{TA-L}	novaphit® MST
Approvals and compliance				BAM, DVGW, Firesafe, GL	BAM, Blow-out VDI 2200, DVGW, Firesafe, GL, TA Luft, VP 401	BAM, Blow-out VDI 2200, DVGW, Firesafe, GL, TA Luft,
Color				graphite gray	graphite gray	graphite gray
Printing				Without XP: black honeycomb imprint With XP: blue honeycomb imprint	Without XP: black honeycomb imprint With XP: blue honeycomb imprint	blue honeycomb imprint
Treatment				Optional: XP technology	Optional: XP technology Internal impregnation TA Luft	XP technology Internal impregnation TA Luft
Material: metal insert				1.4404	1.4404	1.4404
Product data (tolerances acc. to DIN 28091-1)						
Dimensions			[mm]	1000 x 1000 1500 x 1500 2000 x 1000	1000 x 1000 1500 x 1500 2000 x 1000	1000 x 1000 1500 x 1500
Thicknesses			[mm]	1.0 / 1.5 / 2.0 / 3.0	1.0 / 1.6 / 2.0 / 3.0	1.0 / 1.5 / 2.0 / 3.0 / 4.0
Physical properties (modal values)						
Thickness			**[mm]**	**2.0**	**2.0**	**2.0**
Graphite purity		DIN 51 903	[%]	> 99	> 99	99.5
Density		DIN 28090-2	[g/cm³]	1.35	1.37	1.3
Residual stress	300 °C	DIN 52913	[N/mm²]	45	45	45
Compressibility		ASTM F 36 J	[%]	37	37	45
Recovery		ASTM F 36 J	[%]	15	17	15
Cold compressibility ε_{KSW}		DIN 28090-2	[%]	35	36	45
Cold recovery ε_{KRW}		DIN 28090-2	[%]	4	5	4
Hot creep $\varepsilon_{WSW/300}$		DIN 28090-2	[%]	2	3	3
Hot recovery $\varepsilon_{WRW/300}$		DIN 28090-2	[%]	2	4	3
Specific leakage rate		DIN 3535-6	[mg/m/s]	0.07	0.01	0.01
Oxidation value **With XP technology**	670 °C	DIN 28090-2 DIN 28090-2	[%/h] [%/h]	≤ 4 ≤ 3	≤ 4 ≤ 3	– ≤ 3
Tensile strength transverse		DIN 52910	[N/mm²]	8	8	16
Total chloride content		DIN 28090-2	[ppm]	≤ 50	≤ 50	≤ 50
Leachable chloride content		PV01605	[ppm]	≤ 20	≤ 20	≤ 20
Total fluoride content		DIN 51723	[ppm]	≤ 50	≤ 50	≤ 50

Changes to technical data reserved as part of product improvement.

Warranty disclaimer
In view of the variety of different installation and operating conditions along with application and process engineering options, the information given in this brochure can only provide approximate guidance and cannot be used as the basis for warranty claims.

OUR COMMITMENT
to people and the environment.

As a company with a rich tradition, we care about long-term success and the satisfaction of our customers. Quality is always a top priority for us – as is our commitment to the environment, society and our employees.

We also pride ourselves on always considering our customers' present and future needs, something that is apparent in our application consulting, training seminars and installation services.
A development partnership with us is an excellent opportunity for you to optimize products that are already a success – and a great way to get your new developments to the market even faster. We help you modify products or support you in implementing innovative material concepts – and create real added value for you.

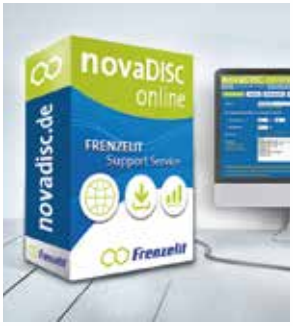
GASKET MATERIALS

- **novapress®** *approx. -100 to 200 °C*
- **novatec®** *approx. -100 to 250 °C*
- **novaflon®** *approx. -270 to 260 °C*
- **novaphit®** *approx. -270 to 550 °C*
- **novamica®** *approx. -200 to 1000 °C*

The temperature data refer to use with non-critical media.

INSULATION MATERIALS

- **isoplan®** *approx. -100 to 1100 °C*



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FZ/3/11.23/005/FA

Frenzelit
creating hightech solutions