



# Unrivalled Sealing

Our specialty graphites  
for sealing technology

**SIGRAFLEX®**

Graphite Materials & Systems



# 250

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## **SIGRAFLEX® HOCHDRUCK** Leak tight – even under high pressure

The SIGRAFLEX HOCHDRUCK gasket is rated to 250 bar<sup>1)</sup>. It thereby meets high demands for sealability, making gaskets extremely safe and reliable. Our unique technology makes this possible, creating a high-strength, adhesive-free layer bond. The gasket is also available in a PRO version [TA Luft compliant] or made with SIGRAFLEX APX2 foil for high-temperature processes. Intelligent solutions from SGL Carbon – unrivalled sealing.

<sup>1)</sup> 250 bar = 3625 psi



bar

# Our specialty graphites for sealing technology

Enjoy the benefits of our outstanding material properties and of our quality products for a wide range of sealing applications.

## Your benefits

Greater process reliability, significantly longer service life of equipment, minimization of emissions and downtimes with the ensuing lower operating costs.

Take advantage of our expertise in application technology. We would be pleased to support you in optimizing your processes and developing specific solutions to meet your needs.

## TA Luft [Technical Guidelines on Air Quality Control]

We also provide support in complying with the latest clean air regulations and emission regulations such as TA Luft.

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## Typical applications

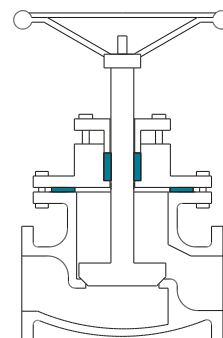
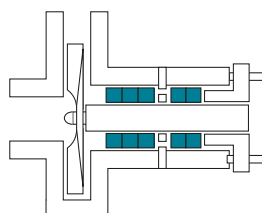
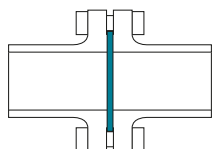
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## Products of SGL Carbon

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## Materials used by SGL Carbon

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### Flanges, joints, connectors

- EN/ANSI flanges
- Flanges and joints
- Pipelines
- Mixers and vessels
- Heat exchangers
- Flat gaskets
- Non-metallic flat gaskets
- Kammprofile, corrugated and spiral wound gaskets

- Graphite foils
- Unreinforced and reinforced graphite laminated sheets

- SIGRAFLEX® flexible graphite

### Rotating equipment

- Process pumps
- Stuffing boxes
- Braided packings
- Flat gaskets
- Packing rings (die-forming rings)

- Graphite foils
- Textile carbon and graphite packing yarns
- Foil yarns
- Unreinforced and reinforced graphite laminated sheets

- SIGRAFLEX® flexible graphite
- SIGRAFLEX® yarns

### Static equipment

- Valves
- Fittings
- Valve housings
- Stuffing boxes
- Flat gaskets
- Braided packings
- Packing rings (die-forming rings)

- Textile carbon and graphite packing yarns
- Foil yarns
- Graphite foils
- Unreinforced and reinforced graphite laminated sheets

- SIGRAFLEX® flexible graphite
- SIGRAFLEX® yarns

Other solutions, products and materials from SGL Carbon for related fields:

- Solutions for highly corrosive applications: Systems, HCl syntheses, plate heat, block heat and shell and tube heat exchangers, columns, column internals, vessels, reactors, quenchers, pumps, bellows, piping, rupture disks made of the materials DIABON®, POLYFLURON®, SICABON® and SIGRABOND®.
- Specialty graphites for mechanical engineering: for axial face seals, seal rings and bearings of SIGRAFINE® die-molded and isostatic carbons and graphites.

More information: [www.sglcarbon.com/downloads](http://www.sglcarbon.com/downloads)

# SIGRAFLEX®

The solutions described in our SIGRAFLEX portfolio are as wide ranging as our customers' demands on sealing materials.



SIGRAFLEX ECONOMY sheet, graphite rayon yarn and Z foil

**Safety provided by quality**

SIGRAFLEX flexible graphite and yarn products are characterized by their high standard of quality. The proven quality of our materials considerably enhances process reliability.

**Resistance and long-term stability**

Products made of SIGRAFLEX are chemically resistant against the vast majority of media, and largely against radiation too. Furthermore, our graphite foils and sheets boast sealing properties with long-term stability of temperatures up to approx. 550 °C (1022 °F) which, depending on type of installation, is far above other materials.

**Compliance with legal requirements**

Thanks to their material quality, gaskets made from SIGRAFLEX products easily comply with legally established values for emissions. We also provide many products which meet the stringent demands of such regulations as the Technical Instructions on Air Quality Control (TA Luft) [see table page 17].

**Reduced maintenance costs**

The long service life of our material leads to a significant reduction in maintenance costs, thereby increasing the cost effectiveness of equipment.

**Quality features**

When manufacturing SIGRAFLEX foil, we use only high quality natural graphite, which is expanded in a thermal process and is without binders or fillers. The result:

**Outstanding sealing properties**

- Low permeability to gases and liquids
- No cold or warm flow up to maximum permissible gasket pressure
- Smooth temperature change behavior

**Stability**

- High resistance to chemical media and radiation
- Absence of binders means no ageing or embrittlement
- High residual stress
- Long-term stability of compressibility and recovery over a wide temperature range

**Range of use from – 250 °C [– 418 °F] to approx. 3000 °C [5432 °F]**

- Depending on installation and operating conditions
- To approx. 800 °C (1472 °F) in an inert atmosphere (limits imposed by metal reinforcement to be observed)
- In air to approx. 400 °C (752 °F) to 600 °C (1112 °F)\*

**Anisotropic properties**

- Properties highly anisotropic particularly in respect of electrical and thermal conductivity

**User benefits**

- Flexibility, softness
- No health risks and environmentally friendly




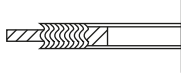
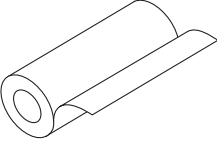

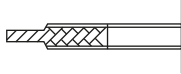

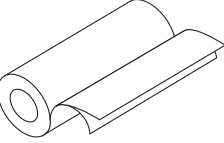


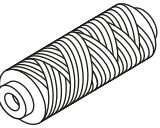



You will find certificates, licenses and test reports for our products in the Download Center of our website: [www.sigraflex.com/downloads](http://www.sigraflex.com/downloads)

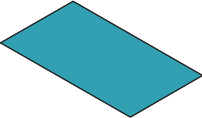

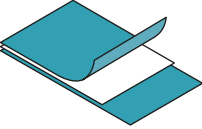
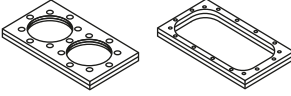
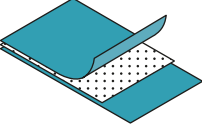

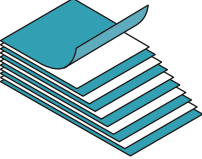
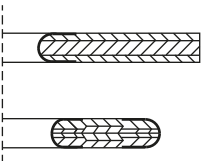
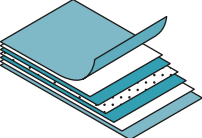
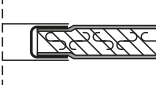
\* We are pleased to make specific recommendations.

# Processing of SIGRAFLEX® foils, sheets, and yarns

Using various methods, our SIGRAFLEX semi-finished products can be processed into a wide range of seals and other products.

| Semi-finished product   | Processing technique    | End product   |
|---|-------------------------|---|
| <b>Foil tapes</b>   |                         |   |
|    | Winding and pressing    | <br>Packing rings                                  |
|   | Corrugating             | <br>Corrugated tape                                |
|   | Winding                 | <br>Spiral wound graphite gaskets                  |
| Cutting/cutting-off   |                         |   |
| <b>SIGRAFLEX foils</b>  |                         |   |
|    | Punching                | <br>Gaskets                                      |
|   | Punching and bonding    | <br>Graphite outer layers for Kamprofile gaskets |
|   | Cutting and punching    | <br>Electrodes<br>Heating elements<br>Linings    |
| Coating   |                         |   |
| <b>SIGRAFLEX self-adhesive foil with release paper</b>  |                         |   |
| <br>[example, other coatings also available] | Punching                | <br>Self-adhesive gaskets                        |
|   | Cutting and corrugating | <br>Sealing tapes, self-adhesive                 |
| <b>Packing yarns</b>  |                         |   |
|    | Braiding                | <br>Braided packing                              |



| Material type   | Processing technique   | End product  |
|---|--|--|
| <p><b>Unreinforced sheets</b><br/> <b>SIGRAFLEX BASIS</b><br/> <b>SIGRAFLEX STANDARD</b><br/> <b>SIGRAFLEX B</b></p>   | <p>Punching<br/> Cutting<br/> Scarf cutting<br/> Bonding</p> |  <p>Simple gaskets</p> <p>Smooth stainless steel ring gaskets with graphite outer layers</p> <p>Corrugated stainless-steel ring gaskets with graphite outer layers</p>  |
| <p><b>Reinforced sheets</b><br/> <b>SIGRAFLEX ECONOMY</b><br/> <b>SIGRAFLEX BSSC</b><br/> <b>SIGRAFLEX with other reinforcements</b><br/> (e.g. nickel, Hastelloy, wire mesh, polyester foil)</p>  | <p>Punching<br/> Cutting<br/> Scarf cutting</p>              |  <p>Gaskets for pumps and fittings</p>  |
| <p><b>SIGRAFLEX UNIVERSAL</b><br/> <b>SIGRAFLEX UNIVERSAL PRO</b><br/> <b>SIGRAFLEX BTCSS</b><br/> <b>SIGRASEAL</b></p>    | <p>Punching<br/> Cutting<br/> Scarf cutting</p>              |  <p>Pipework gaskets</p> <p>UNIVERSAL PRO:<br/>for TA Luft applications</p>  |
| <p><b>SIGRAFLEX HOCHDRUCK</b><br/> <b>SIGRAFLEX HOCHDRUCK PRO</b><br/> <b>SIGRAFLEX APX2 HOCHDRUCK</b></p>   | <p>Punching<br/> Cutting<br/> Scarf cutting</p>              |  <p>Typical seal cross-sections</p> <p>High-quality gaskets e.g. with metal eyelets for various applications</p> <p>HOCHDRUCK PRO:<br/>for TA Luft applications</p> <p>APX2 HOCHDRUCK:<br/>for high-temperature applications</p> |
| <p><b>SIGRAFLEX MF</b></p>   | <p>Punching<br/> Cutting</p>                                 |  <p>Superior-quality gaskets with s/s inner eyelets for maximum safety, outstanding anti-stick behavior in flange, and sealability</p>  |

# SIGRAFLEX® graphite foils

We manufacture a broad range of SIGRAFLEX foil types for different applications. They feature high reliability, even under extreme operating conditions.





# SIGRAFLEX® graphite foils with oxidation resistance

SIGRAFLEX foils made of expanded natural graphite are distinguished by their high-temperature resistance. They are the first choice in sealing applications for long-term use at high-temperatures.

## Extremely low weight loss

Compared to other industrial graphite foils, our types SIGRAFLEX APX2, BP, AP, APX and E exhibit remarkable oxidation resistance. Their typical weight loss (in TGA test in air at 670 °C [1238 °F] for four hours) is at 2% per hour and less, while conventional industry foils lose up to 40%. The lower the weight loss, the better and more extensive is the performance of the material – making our SIGRAFLEX APX2 foil, which, in the same test parameters, typically only loses 0.6% of its weight per hour, the unrivalled “Best in Class”.

## Fulfilling specifications

When it comes to corrosion protection, SGL Carbon offers the widest-ranging portfolio on the market. With their low sulfur and halogen content, our foils fulfill user specifications and are genuine high performers in system protection.

## Material data of our SIGRAFLEX® oxidation resistant graphite foils

| Typical properties                                      | Unit              | APX2        | BP          | AP          | APX          | E            |
|---|-------------------|-------------|-------------|-------------|--------------|--------------|
| Thickness   | mm                | 0.25 – 1.52 | 0.25 – 3.05 | 0.25 – 2.0  | 0.35 – 1.0   | 0.35 – 1.0   |
|   | in                | 0.01 – 0.06 | 0.01 – 0.12 | 0.01 – 0.08 | 0.014 – 0.04 | 0.014 – 0.04 |
| Purity  | %                 | ≥ 98        | ≥ 98        | ≥ 98        | ≥ 98         | ≥ 99         |
| Ash content   | %                 | ≤ 2         | ≤ 2         | ≤ 2         | ≤ 2          | ≤ 1          |
| Density   | g/cm <sup>3</sup> | 1.0 – 1.12  | 0.7 – 1.43  | 1.0 – 1.12  | 0.7 – 1.3    | 0.7 – 1.3    |
| Sulfur content  | ppm               | < 300       | < 300       | < 300       | < 300        | < 300        |
| Chloride content  | ppm               | ≤ 25        | ≤ 50        | ≤ 50        | ≤ 25         | ≤ 10         |
| Weight loss in air at 670 °C/1238 °F (TGA) <sup>1</sup> | %/h               | ≤ 1         | ≤ 2         | ≤ 2         | ≤ 3          | < 4          |

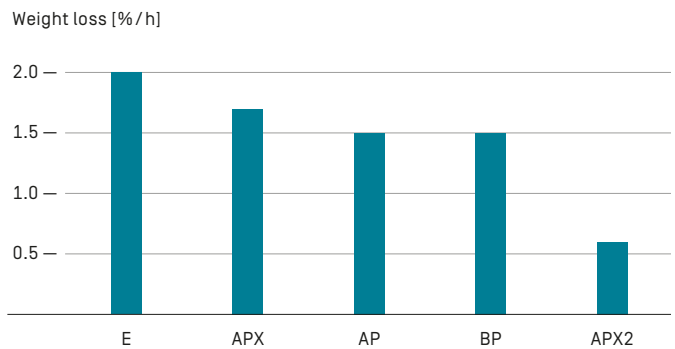
<sup>1</sup> Values for material thickness ≥ 0.5 mm and density ≥ 1.0 g/cm<sup>3</sup>



↑ Die-formed packing ring made of SIGRAFLEX tapes for use in stuffing boxes.

## Relative weight loss of SIGRAFLEX foils: APX2 is “Best in Class”

Typical relative weight loss of SIGRAFLEX foils in air at 670 °C/1238 °F



# SIGRAFLEX® industrial quality foils

Our SIGRAFLEX industrial quality foils boast outstanding sealing properties.

### Elastic, malleable, and reliable

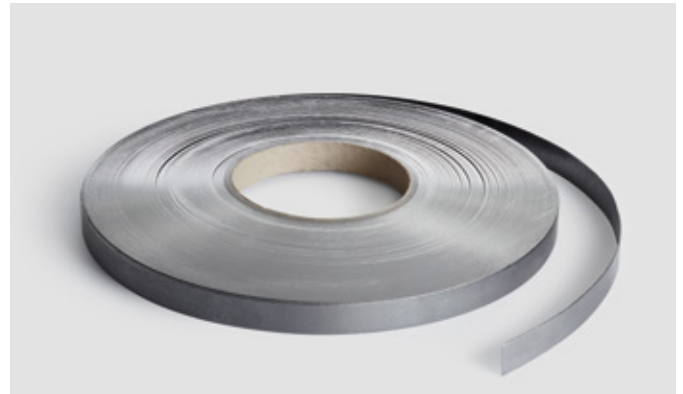
SIGRAFLEX foil is compressible and easy to shape. It fits well against the surface to be sealed, even on uneven surfaces, a clear advantage over other sealing materials.

### Easy to process

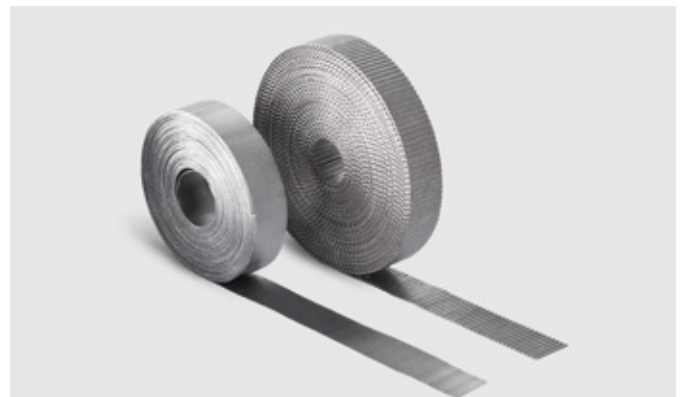
In addition to its outstanding workability, SIGRAFLEX foils are particularly easy to cut, to press and to punch, for example in tapes, corrugated tapes and packing rings.

### Material data of our SIGRAFLEX® graphite foils in industrial quality

| Typical properties | Unit              | C            | B           |
|--------------------|-------------------|--------------|-------------|
| Thickness          | mm                | 0.35 – 3.0   | 0.25 – 3.0  |
|                    | in                | 0.014 – 0.12 | 0.01 – 0.12 |
| Purity             | %                 | ≥ 98         | ≥ 98        |
| Ash content        | %                 | ≤ 2          | ≤ 2         |
| Density            | g/cm <sup>3</sup> | 0.7 – 1.3    | 0.7 – 1.4   |
| Sulfur content     | ppm               | < 300        | < 500       |
| Chloride content   | ppm               | ≤ 25         | ≤ 50        |



↑ SIGRAFLEX foil can be cut into tapes.



↑ SIGRAFLEX foil tapes can be made into corrugated tapes.



↑ As a highly effective gasket material, SIGRAFLEX foil can also be pressed into packing rings.

## SIGRAFLEX® high-purity graphite foils

### High-purity natural graphite

SIGRAFLEX flexible foils are manufactured without the use of adhesives and binders. We use high-purity natural graphite flakes as our base material. This minimizes contamination which significantly reduces the leakage rate, as well as the thermal and corrosion resistance of graphite gaskets and steel flanges.

### Protection from corrosion

Thanks to its very high-purity – ash content below 0.15 %, chloride and fluoride of maximum 10 ppm and sulfur content below 300 ppm – SIGRAFLEX foils make a significant contribution to protecting adjoining components from corrosion. This increases the operating reliability and the entire service life of equipment. Our products contribute significantly to cutting costs in static and dynamic sealing connections, piping, pumps, fittings, and vessels.

Our high-purity foils are especially suited to extreme requirements, such as sensitive processes in power plants.

↓ Kammprofile gaskets with soft facing material of SIGRAFLEX graphite foil.



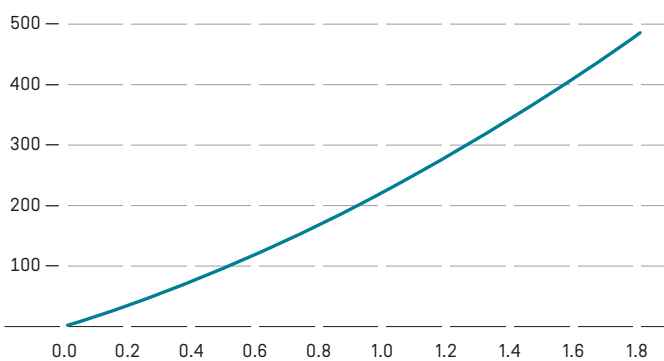
### Material data of our high-purity SIGRAFLEX® graphite foils

| Typical properties | Unit              | N           | Z            | ZX         | S           | UHP         |
|--------------------|-------------------|-------------|--------------|------------|-------------|-------------|
| Thickness          | mm                | 0.25 – 1.52 | 0.15 – 3.0   | 0.37       | 0.25 – 1.52 | 0.5 – 3.0   |
|                    | in                | 0.01 – 0.06 | 0.006 – 0.12 | 0.015      | 0.01 – 0.06 | 0.02 – 0.12 |
| Purity             | %                 | ≥ 99.5      | ≥ 99.85      | approx. 98 | > 99        | ≥ 99.99     |
| Ash content        | %                 | ≤ 0.5       | ≤ 0.15       | approx. 2  | < 1         | ≤ 0.01      |
| Density            | g/cm <sup>3</sup> | 0.7 – 1.12  | 0.7 – 1.3    | 0.95       | 1.12        | 1.12        |
| Sulfur content     | ppm               | < 300       | < 300        | < 300      | < 300       | < 30        |
| Chloride content   | ppm               | ≤ 50        | ≤ 10         | ≤ 20       | ≤ 10        | ≤ 1         |

### The thermal conductivity of SIGRAFLEX foils is strongly direction dependent (anisotropy) and can thus be regulated.

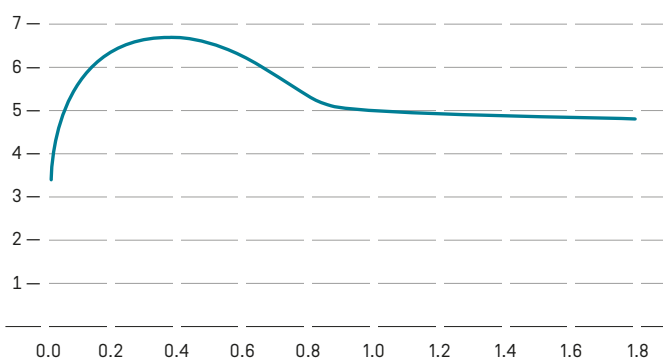
Thermal conductivity of SIGRAFLEX foils as a function of density (at room temperature),  
left: parallel to surface, right: perpendicular to surface

Thermal conductivity [Wm<sup>-1</sup>K<sup>-1</sup>]



Density [g/cm<sup>3</sup>]

Thermal conductivity [Wm<sup>-1</sup>K<sup>-1</sup>]



Density [g/cm<sup>3</sup>]

# SIGRAFLEX® graphite sheets

Each type of our SIGRAFLEX graphite sheets provide an appropriate solution for the demands made by our customers.





**The wealth of possibilities**

Unreinforced or reinforced, with or without impregnation:  
The portfolio of SIGRAFLEX graphite sheets provides a variety of solutions to all needs.

Adhesive-free, high performing sheets for extreme sealing and safety requirements, adhesive-bonded grades for standard gasket stress and many specific variants – whichever the situation, we have the SIGRAFLEX graphite sheet for your individual application.

**We provide support with all TA Luft issues**

If your equipment has to meet the requirements of the “Technical Instructions on Air Quality Control” (TA Luft), our wide variety of reinforced and impregnated SIGRAFLEX graphite sheets provide the optimum sealing material.

And that’s not all: we would be pleased to support you on site, and together develop a sustainable solution tailored to your needs. Please just ask us.

**Application-specific suitability of our SIGRAFLEX® graphite sheets**

| Scope of application      |  | STANDARD | ECONOMY | UNIVERSAL | UNIVERSAL PRO | SELECT | HOCHDRUCK | HOCHDRUCK PRO | APX2 HOCHDRUCK | MF | EMAIL | SIGRASEAL | BSSC | BTCSS |
|---------------------------|--|----------|---------|-----------|---------------|--------|-----------|---------------|----------------|----|-------|-----------|------|-------|
| Gaskets                   | Kammprofile and corrugated gaskets   | ○        |         |           |               |        |           |               |                |    |       |           |      |       |
|                           | PTFE envelope gaskets  |          |         |           |               |        |           |               |                |    | ●     |           |      |       |
|                           | Gaskets for pumps and valve bodies   | ○        | ●       | ○         | ○             |        | ●         | ●             | ●              |    |       | ○         | ●    | ○     |
|                           | One-piece gaskets up to 1500 mm (59.1") diameter   |          |         | ●         | ●             |        | ●         | ●             | ●              |    | ●     | ●         | ●    | ●     |
| Flange design             | Flanges with sealing strips  | ○        | ●       | ●         | ●             | ●      | ●         | ●             | ●              | ●  |       | ●         | ●    | ●     |
|                           | Flanges with grooves and springs design/ sealed joints under high stress   |          |         |           |               |        | ●         | ○             | ●              |    |       |           |      |       |
|                           | Unstable flanges with low gasket stress  |          | ●       |           |               |        |           |               |                |    | ●     |           |      |       |
|                           | Vessel and equipment flanges   | ○        |         | ●         | ●             |        | ●         | ●             | ●              | ●  |       | ○         | ●    | ●     |
|                           | Emergency repairs and complex dimensions   | ●        | ○       |           |               |        | ●         | ●             | ●              |    |       |           | ●    |       |
| Operations under pressure | Low internal pressure up to 40 bar   | ●        | ●       |           |               |        |           |               |                |    |       |           | ●    |       |
|                           | Internal pressures from vacuum up to 100 bar   |          |         | ●         | ●             | ●      |           |               |                |    |       | ○         |      | ○     |
|                           | Internal pressures from vacuum up to 250 bar   |          |         |           |               |        | ●         | ●             | ●              |    |       |           |      |       |
| Operating temperatures    | -200 °C to 300 °C [-328 °F to 572 °F]  | ●        | ●       | ●         | ●             | ●      | ●         | ●             | ●              | ●  |       | ●         | ●    | ●     |
|                           | -200 °C to ~550 °C [-328 °F to ~1022 °F] <sup>1)</sup>   | ●        | ●       | ●         | ●             | ●      | ●         | ●             | ●              |    |       | ○         | ●    | ●     |
| Impermeability            | Maximum requirements according to the emission protection regulation “Technical Guidelines on Air Quality Control” (TA Luft) |          |         |           |               | ●      | ●         | ○             | ●              |    | ●     |           |      |       |

<sup>1)</sup> In consideration of chemical resistance. We will be glad to provide specific recommendations for operational temperatures of over 450 °C [842 °F].

○ Suitable ● Recommended

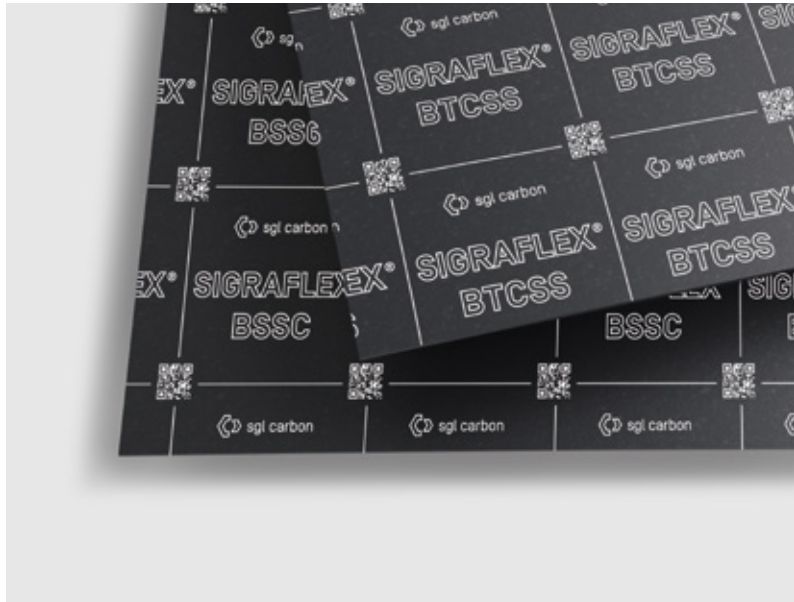
**In the interest of your safety**

Our reinforced SIGRAFLEX graphite sheets are highly corrosion resistant. This considerably reduces the maintenance costs of equipment and extends its service life. Above all, the use of premium SIGRAFLEX materials significantly enhances seal safety for employees and the environment – a high priority when operating equipment.

**Comprehensive knowledge of applications**

Our broad portfolio of reinforced graphite sheets makes it possible to find suitable materials for the specific requirements of all types of equipment. It allows to select variants with especially low halogen and sulfur content, as well as materials with a compressibility of 30 to 50% to prevent from forming gaps in the sealing joint.

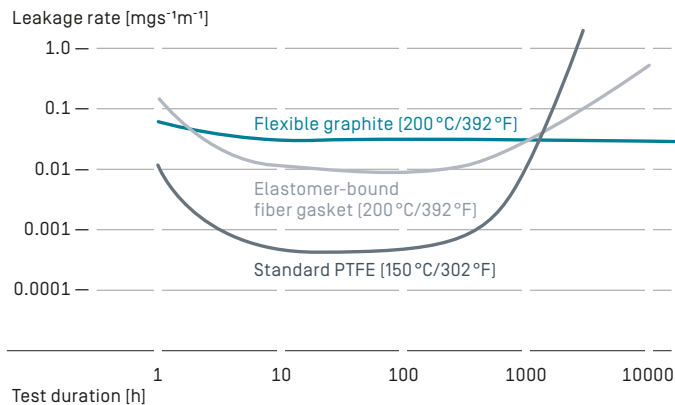
Our products have been developed with an in-depth understanding of how they will be used. Let us advise you – together we will work out the best solution for your specific requirements.



↑ SIGRAFLEX BTCSS and BSSC sheets. BSSC grade sheets are bonded sheets reinforced with stainless steel. BTCSS is an adhesive-free sheet consisting of two layers of graphite foil and a perforated-steel insert.

**Over 10000 hours and beyond stable leakage rate**

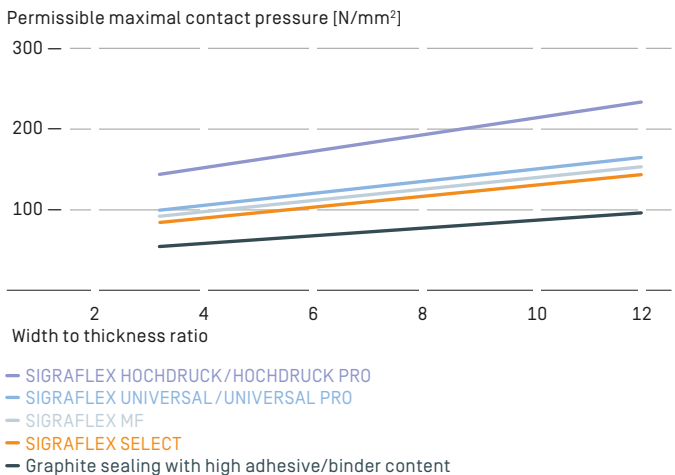
Change in leakage rates of various sealing materials in long-term trials, measured on a DN 40 PN 40 flange in accordance with DIN 28090-1 and -2



Due to the warm flow characteristics of PTFE, the test temperature for this material was set at only 150 °C (302 °F)

**Superior load capacity: adhesive-free reinforced graphite sheets**

Max. permissible contact pressure for gaskets made of reinforced SIGRAFLEX graphite sheets with a thickness of 2 mm [0.08"] at 300 °C/572 °F (acc. to DIN 28090-1)



- SIGRAFLEX HOCHDRUCK/HOCHDRUCK PRO
- SIGRAFLEX UNIVERSAL/UNIVERSAL PRO
- SIGRAFLEX MF
- SIGRAFLEX SELECT
- Graphite sealing with high adhesive/binder content

## Material data of our SIGRAFLEX® reinforced adhesive- and binder-free graphite sheet

| Typical properties                       | Unit | HOCHDRUCK PRO<br>2-9 inserts | APX2 HOCHDRUCK<br>1-5 inserts | MF<br>3-7 inserts | UNIVERSAL PRO<br>1-2 inserts | SELECT <sup>1</sup><br>2 inserts |
|--|------|------------------------------|-------------------------------|-------------------|------------------------------|----------------------------------|
| Metal reinforcement:                     | mm   | 0.05                         | 0.05                          | 0.05              |                              | 0.05                             |
| Stainless steel sheet 316 (L)            | in   | 0.002                        | 0.002                         | 0.002             |                              | 0.002                            |
| Metal reinforcement:                     | mm   |                              |                               | 0.1               | 0.1                          |                                  |
| Perforated stainless steel sheet 316 (L) | in   |                              |                               | 0.004             | 0.004                        |                                  |
| Thickness                                | mm   | 1.0 – 4.0                    | 1.0 – 3.0                     | 2.0 / 3.0         | 1.6 / 2.0 / 3.0              | 1.6                              |
|  | in   | 0.04 – 0.16                  | 0.04 – 0.12                   | 0.08 / 0.12       | 0.06 / 0.08 / 0.12           | 0.06                             |
| Width                                    | mm   | 1000 / 1500                  | 1500                          | 1000              | 1000 / 1500                  |                                  |
|  | in   | 39.4 / 59.1                  | 59.1                          | 39.4              | 39.4 / 59.1                  |                                  |
| Length                                   | mm   | 1000 / 1500                  | 1500                          | 1000              | 1000 / 1500                  |                                  |
|  | in   | 39.4 / 59.1                  | 59.1                          | 39.4              | 39.4 / 59.1                  |                                  |
| Purity                                   | %    | ≥ 99.85                      | ≥ 98                          | ≥ 99.85           | ≥ 98                         | ≥ 98                             |
| Ash content                              | %    | ≤ 0.15                       | ≤ 2.0                         | ≤ 0.15            | ≤ 2.0                        | ≤ 2.0                            |
| Chloride content                         | ppm  | ≤ 10                         | ≤ 25                          | ≤ 10              | ≤ 25                         | ≤ 25                             |

<sup>1</sup> Sold in gasket form.

## Material data of our SIGRAFLEX® reinforced bonded graphite sheets

| Typical properties                       | Unit | ECONOMY <sup>1</sup><br>1-2 inserts | BSSC<br>1 insert | BTCSS<br>1 insert | BMV          |
|--|------|-------------------------------------|------------------|-------------------|--------------|
| Metal reinforcement:                     | mm   | 0.05                                | 0.05             |                   |              |
| Stainless steel sheet 316 (L)            | in   | 0.002                               | 0.002            |                   |              |
| Metal reinforcement:                     | mm   |                                     |                  | 0.1               |              |
| Perforated stainless steel sheet 316 (L) | in   |                                     |                  | 0.004             |              |
| Polyester film                           | mm   |                                     |                  |                   | 0.127        |
|  | in   |                                     |                  |                   | 0.005        |
| Bonded/adhesive-free                     |      | bonded                              | bonded           | adhesive-free     | bonded       |
|  | mm   | 0.55 – 3.0                          | 0.76 – 3.05      | 0.76 – 3.05       | 0.38 – 3.05  |
| Thickness                                | in   | 0.022 – 0.118                       | 0.03 – 0.12      | 0.03 – 0.12       | 0.015 – 0.12 |
|  | mm   | 1000                                | 1016 / 1524      | 1016 / 1524       | 1016 / 1524  |
| Width                                    | in   | 39.4                                | 40 / 60          | 40 / 60           | 40 / 60      |
|  | mm   | 1000                                | 1016 / 1524      | 1016 / 1524       | 1016 / 1524  |
| Length                                   | in   | 39.4                                | 40 / 60          | 40 / 60           | 40 / 60      |
|  | %    | ≥ 98                                | ≥ 98             | ≥ 98              | ≥ 98         |
| Purity                                   | %    | ≥ 98                                | ≥ 98             | ≥ 98              | ≥ 98         |
| Ash content                              | %    | ≤ 2                                 | ≤ 2              | ≤ 2               | ≤ 2          |
| Chloride content                         | ppm  | ≤ 25                                | ≤ 50             | ≤ 50              | ≤ 50         |

<sup>1</sup> Also available in rolls up to 1mm (0.04") thick.

# Successful together

We do not just manufacture products, but also provide intelligent solutions with sustainable benefits for our customers.

Close collaboration and an understanding of specific requirements allow us to develop forward-looking solutions and respond to specific needs.

This has given rise to most of our innovation – such as the new SIGRAFLEX CLEAN gasket.





## Nothing sticks

Downtime is an extreme cost factor in any piece of equipment, so incidental maintenance must be kept to a minimum. After years of use, flat gaskets often stick to flanges. So when it is the occasion to replace them it takes additional time and effort to do so. There is also the risk of damaging the flange.

We offer high-quality solutions for special sealing requirements – including reduced adhesion. Our SIGRAFLEX MF sheet also meets the very highest demands in terms of separating behavior. And our impregnated SIGRAFLEX sheets have been used by many well-known chemical companies for years because their anti-stick properties are better than comparable products in the industry.

The importance of controlling maintenance costs has prompted us to develop a material with excellent separating properties for standard sealing applications:

### **SIGRAFLEX® CLEAN**

This new material with its special surface finish exhibits no adhesive behavior from room temperature to 300 °C (572 °F). The gasket separates from flanges with ease, no need to clean the flange. This also greatly reduces the risk of damaging the flange. Users save time and money whenever gaskets are replaced.

# SIGRAFLEX<sup>®</sup> carbon and graphite yarns

Thanks to the variability of the pre-cursor materials, carbon and coating content, our SIGRAFLEX packings yarns provide specific solutions for a large number of applications.



### Broad spectrum for different requirements

We offer a wide variety of options in the manufacture of our SIGRAFLEX packing yarns, and can optimally design final yarn properties: pre-cursor material, carbon content, number of plies and filaments, twisting, coating, and weight. This results in a comprehensive portfolio fulfilling the wide variety of demands of our customers.

### Advantages of SIGRAFLEX yarns

Our customers benefit from the use of packings made of high quality and high-purity yarns from SGL Carbon. They offer a unique combination of tightness and heat dissipation, excellent high-temperature and chemical resistance, as well as reduced contamination of processes due to the high purity of the yarns.

### High-performing graphite yarns for braided packing

We offer yarns made of different base materials, depending on your requirements:

- Rayon: Soft, compliant yarn that is stable at high temperatures.
- Graphite foil: Over knitted flexible graphite yarn suitable for high temperatures, oxidation and corrosive environments.
- PAN: Our graphitized PAN yarns stand out due to their excellent oxidation resistance. When specially coated, they also meet the latest Shell specification MESC SPE 85/204.

### We support you

The quality and state of the yarn used is crucial to the properties of braided packing, in addition to an adequate manufacturing method. We are glad to help you select the ideal variant for your specific application. Please just ask.

## Application-specific suitability and product characteristics of our SIGRAFLEX® carbon and graphite yarns

|                               |  | Pre-cursor material |                           |              |                             |                |                                 |
|-------------------------------|--|---------------------|---------------------------|--------------|-----------------------------|----------------|---------------------------------|
| Application                   |  | PAN Carbon          | PAN stretch broken Carbon | PAN Graphite | PAN stretch-broken Graphite | Rayon Graphite | Flexible graphite <sup>1)</sup> |
| Military applications         |  |                     |                           |              |                             | ●              |                                 |
| Power plants                  |  | ●                   | ●                         | ●            | ●                           | ●              | ●                               |
| Nuclear power plants          |  |                     |                           |              |                             | ●              | ●                               |
| Refineries                    |  |                     |                           | ●            | ●                           |                | ●                               |
| Petrochemical installations   |  |                     |                           | ●            | ●                           | ●              | ●                               |
| Chemical plants               |  | ●                   | ●                         | ●            | ●                           |                | ●                               |
| Paper and cellulose industry  |  | ●                   | ●                         | ●            | ●                           | ●              |                                 |
| High-speed pumps              |  |                     |                           | ●            |                             | ●              |                                 |
| Steam applications            |  | ●                   |                           | ●            | ●                           | ●              | ●                               |
| Valve packing                 |  | ●                   | ●                         | ●            | ●                           |                | ●                               |
| Piston-pump packing           |  | ●                   | ●                         | ●            |                             |                | ●                               |
| Temperature >2000 °C (non-ox) |  |                     |                           |              |                             |                | ●                               |

| Product characteristics      | Unit | Carbon       | Carbon | Graphite  | Graphite | Graphite | Graphite     |
|------------------------------|------|--------------|--------|-----------|----------|----------|--------------|
| Type                         |      | Carbon       | Carbon | Graphite  | Graphite | Graphite | Graphite     |
| Carbon content <sup>2)</sup> | %    | ≥ 94         | ≥ 94   | ≥ 99      | ≥ 99     | ≥ 99.9   | ≥ 98 - 99.85 |
| Temperature <sup>3)</sup>    | °C   | < 400        | < 400  | < 500     | < 500    | < 450    | < 580        |
|                              | °F   | < 752        | < 752  | < 932     | < 932    | < 842    | < 1076       |
| pH range <sup>4)</sup>       |      | 2 - 12       | 2 - 12 | 1 - 14    | 1 - 14   | 1 - 14   | 0 - 14       |
| Tensile strength             |      | very high    | high   | very high | high     | moderate | low          |
| Twisting                     |      | S, Z, ribbon | S, Z   | S, Z      | S, Z     | S, Z     |              |

<sup>1)</sup> Data of wire-reinforced foil yarn unless otherwise indicated. <sup>2)</sup> Base yarn without coating/reinforcement.

<sup>3)</sup> Approximate peak values for yarns without coating for operating temperatures near the indicated peak values, service life can be limited by chemical resistance, equipment temperature, operating conditions and design. Please refer to our technical information on temperature resistance. Please consult us for use at temperature ranges near the limit values. <sup>4)</sup> Operating conditions, depending on medium.

# SIGRAFLEX® reinforced foil yarns

## Material data of our SIGRAFLEX® APX2 foil yarn reinforced with Inconel®<sup>1)</sup> 601 with a diameter of 100 µm

| Typical properties                                      | Test methods           | Unit    | SIGRAFLEX APX2 yarn |
|---|------------------------|---------|---------------------|
| Base material   |                        |         | SIGRAFLEX APX2 foil |
| Carbon content <sup>2)</sup>                            | ASTM D5373             | %       | ≥ 98                |
| Ash content <sup>2)</sup>                               | ASTM C561              | %       | ≤ 2                 |
| Sulfur content <sup>2)</sup>                            | ASTM D4239             | ppm     | < 300               |
| Chloride content <sup>2)</sup>                          | ASTM D4327             | ppm     | ≤ 25                |
| Fluoride content <sup>2)</sup>                          | ASTM D4327             | ppm     | ≤ 10                |
| Halogen content <sup>2)</sup>                           | ASTM D4327             | ppm     | ≤ 70                |
| Weight  | ASTM D1907             | g/m     | 3 or 5              |
| Tensile strength  | ASTM D2256             | kg (lb) | 8 (18)              |
| Weight loss from air [at 670 °C/ 1238 °F] <sup>2)</sup> | ASTM D7582<br>LECO TGA | %/h     | ≤ 1                 |

Other yarn types on request. Please contact us.

<sup>1)</sup> Inconel® is a registered trademark of Special Metals Corporation.

<sup>2)</sup> Only graphite

### New developments in demand

We have responded to customer requests for high-temperature resistant and high-purity braided packing yarns with outstanding mechanical properties by developing a new yarn based on the SIGRAFLEX foil already established in the sealing market.

### Maximum protection from oxidation

This has resulted in the best foil yarn on the market with regard to oxidation resistance. The flexible expanded natural graphite yarn SIGRAFLEX APX2, made of SIGRAFLEX APX2 foil with Inconel®<sup>1)</sup> wire reinforcement.

The foil is made of premium expanded natural graphite and provides maximum protection from oxidation [see page 12].

### A higher bar

Our SIGRAFLEX APX2 yarn combines a number of unique properties including low friction, high flexibility, and excellent chemical resistance. Also the yarn is produced without a carrier fiber and is without binders or adhesives, it does not become brittle over time. Just like SIGRAFLEX APX2 foil the yarn exhibits high thermal conductivity so frictional generated heat can be easily transferred.

### Over knitted wire reinforcement

The over knitted wire reinforcement is Inconel 601 which provides the added tensile suitable for braiding. The wire also possesses excellent high temperature behaviour and is suitably lubricated with no detriment to the high temperature performance and purity of the yarn. The yarn is also compliant with the latest Shell MESC SPE 85/204 standard.

### Broad portfolio of foil yarns

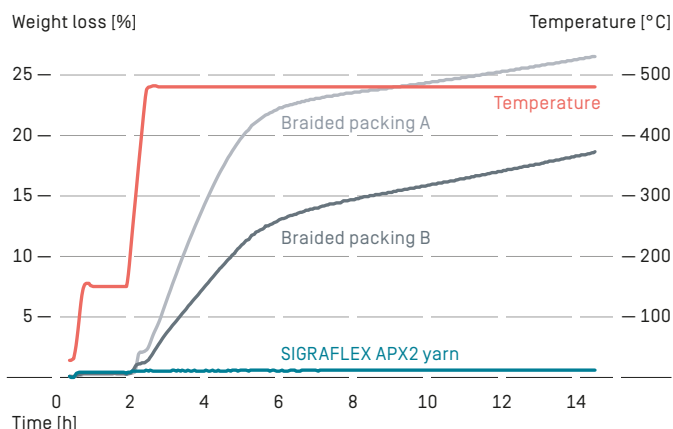
SGL Carbon has other foil based yarns with the same type of reinforcement including SIGRAFLEX Z foil yarn with an ash content of less than 0.15% for applications where a higher degree of purity is required.



↑ SIGRAFLEX APX2 yarn provides maximum protection against oxidation.

### Lowest weight loss with APX2 foil yarn

Behaviour of different packings/yarns in TGA-dimensions at 482 °C [900 °F]





# SIGRAFLEX® oxidation-resistant yarn

## Unrivalled combination of properties

Our new SIGRAFLEX OXR yarn is unique in many respects. It has been specifically developed for high-temperature applications, and combines the advantages of graphitized textile yarns based on polyacrylonitrile with those of a proprietary coating to enhance its temperature resistance.

## For high-temperature applications

The yarn is manufactured with a coating based on proven SIGRAFLEX APX2 technology. Thanks to the considerably improved oxidation resistance, it can be used in high-temperature applications. It furthermore fulfills the requirements of packing manufacturers for low friction and high thermal conductivity.

## High-purity – meets Shell specification

The purity of the yarn is excellent as well: with regard to carbon content it stands at  $\geq 99.5\%$ . The yarn also exhibits low sulfur, fluorine and chlorine content.

This is a decisive advantage for our customers, since SIGRAFLEX OXR yarn is the only yarn product on the market that meets the requirement of Shell specification 85/204 for graphite.

## Yarns for unmet needs

The new yarn products from SGL Carbon close the existing market gap in the field of packing yarns that are high in purity as well as resistant to high-temperatures.

Are you interested in trying out our yarn products? Please contact us.

## Material data of our SIGRAFLEX® OXR yarn<sup>1</sup>

| Typical properties                                      | Test methods           | Units             | Graphitized twisted stretch-broken yarn |
|---|------------------------|-------------------|---|
| Base material   |                        |                   | PAN                                     |
| Coating   |                        |                   | proprietary                             |
| Carbon content <sup>21</sup>                            | ASTM D5373             | %                 | $\geq 99.5$                             |
| Ash content <sup>21</sup>                               | ASTM C561              | %                 | $\leq 0.15$                             |
| Sulfur content <sup>21</sup>                            | ASTM D4239             | ppm               | $\leq 100$                              |
| Chloride content <sup>21</sup>                          | ASTM D4327             | ppm               | $\leq 25$                               |
| Fluoride content <sup>21</sup>                          | ASTM D4327             | ppm               | $\leq 10$                               |
| Halogen content <sup>21</sup>                           | ASTM D4327             | ppm               | $\leq 100$                              |
| Moisture content  | ASTM C562              | %                 | $\leq 0.1$                              |
| Density   | ASTM D3800             | g/cm <sup>3</sup> | 1.67                                    |
| Weight  | ASTM D1907             | g/m               | 1.07                                    |
| Tensile strength  | ASTM D2256             | kg                | 45                                      |
| Coating content   | ASTM D537              | %                 | 15                                      |
| Twisting  | ASTM D1423             | TPM               | 45                                      |
| Available twistings                                     |                        |                   | S, Z                                    |
| Weight loss from air [at 670 °C/ 1238 °F] <sup>21</sup> | ASTM D7582<br>LECO TGA | %                 | < 2                                     |

<sup>11</sup> non-binding and temporary

<sup>21</sup> Equipment that fulfills Shell specification MESC SPE85/204 [current version]

↓ SIGRAFLEX OXR yarn, our textile-graphite packing yarn with special coating, developed for use in high-temperature applications.



# Smart Solutions

Be it materials, components or production processes, we focus our thinking and actions on the customer and keep an eye on the big picture. Our solutions already anticipate the future today.

The following examples show a selection of our unique product range.

## Mobility

- Lightweight components and structural parts based on fiber-reinforced composites for automotive and aerospace manufacture
- Graphite anode material for lithium-ion batteries in electric vehicles
- Carbon-ceramic brake disks for sports cars and luxury sedans

## Energy

- High-temperature solutions based on specialty graphites and fiber materials for the photovoltaic industry
- Carbon fiber materials for rotor blades
- Gas diffusion layers for fuel cells
- Systems for more efficient heat exchange and heat recovery
- Carbon fibers for pressurized gas containers

## Digitization

- Carbon, graphite, and CFC components for polysilicon and monocrystal pulling in the semiconductor industry
- High precision, coated graphite carriers for the production of LEDs

→ State-of-the-art green production with the world's largest isostatic press



# SGL Carbon

We are leaders in the development and manufacture of products based on carbon, graphite, carbon fibers, and fiber-reinforced composites. In partnership with our customers, we develop intelligent, trendsetting, and sustainable solutions that deliver a clear benefit.

With our in-depth material, engineering, and application know-how, we make a substantial contribution to the major future topics mobility, energy, and digitization.



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