Schunk Carbon Technology: Always at your side

Schunk Carbon Technology focuses on development, manufacture and application of carbon and ceramic solutions. It combines innovative spirit and technological expertise with exceptional customer service to provide a range of products and services unique to the market. In Schunk Carbon Technology, you have a partner who can offer all the technological possibilities of an international company and implement ideas custom-tailored to your needs, both for high-volume industrial markets and for highly specialized niche markets.

Technical Ceramics – Unique Solutions

Temperature resistant, media resistant, non-wearing, extremely hard and bullet-resistant – no other material combines as many valuable features for industrial use as technical ceramics from Schunk Carbon Technology.

Our high-precision, state-of-the-art manufacturing processes provide high-end ceramic solutions for a broad range of applications. Nobody serves you better than we do. Innovative production processes, such as flexible 3-D printing with IntrinSiC, make new and economical applications possible and enable the manufacture of large components, shape diversity, small batches and prototyping.

As a specialist for ceramic materials and components made of silicon carbide (SiC) and aluminum oxide (Al₂O₃), we provide materials and components for thermal processing technology, furnace and system construction and process engineering. Thanks to its outstanding features, our SiC is also used in ballistic protection.

Premium solutions for high temperature applications. Technical ceramics from Schunk Carbon Technology set standards for the use of burner systems for direct and indirect heating, kiln furnitures and furnace and system construction. Thanks to their exceptional oxidation and corrosion resistance, resilience through changes in temperature, and dimensional stability, our premium solutions guarantee economical, energy-efficient and reliable production processes.
**Burner Technology**

Schunk Carbon Technology belongs to the pioneers and market leading ceramic manufacturers with more than 30 years experiences in the development and manufacturing of Technical SiC-ceramics.

The company provides a wide product portfolio consisting of RBSiC (silicon-infiltrated, reaction-bonded silicon carbide) and NSiC (silicon nitride-bonded silicon carbide) which serve as full ceramic heating systems for both Indirect Heating (i.e. Radiant-Flame Tubes, Recuperative Burners) as well as Direct Heating (industrial- and household burners).

Schunk Carbon Technology provides a substantial contribution for the realization of energy saving and low-emission burner systems for industrial kilns.

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### Nomenclature

<table>
<thead>
<tr>
<th>CarSiK</th>
<th>CarSiK-NG</th>
<th>IntrinSiC®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nomenclature</td>
<td>RBSiC</td>
<td>NSiC</td>
</tr>
</tbody>
</table>

### Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>CarSiK</th>
<th>CarSiK-NG</th>
<th>IntrinSiC®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (g/cm³)</td>
<td>3.09</td>
<td>2.85</td>
<td>3.07</td>
</tr>
<tr>
<td>Apparent porosity (Vol. %)</td>
<td>0</td>
<td>&lt;1</td>
<td>0</td>
</tr>
<tr>
<td>Modulus of rupture (MPa)</td>
<td>280</td>
<td>200</td>
<td>210</td>
</tr>
<tr>
<td>Modulus of elasticity (GPa)</td>
<td>360</td>
<td>220</td>
<td>360</td>
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<tr>
<td>Thermal expansion coefficient (L/°C)</td>
<td>4.9 x 10⁴</td>
<td>4.8 x 10⁴</td>
<td>4.9 x 10⁴</td>
</tr>
<tr>
<td>Thermal conductivity (W/mK)</td>
<td>160</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Specific heat (J/kgK)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT</td>
<td>600</td>
<td>750</td>
<td>600</td>
</tr>
<tr>
<td>1200°C</td>
<td>1200</td>
<td>1100</td>
<td>1200</td>
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<tr>
<td>Limit of application (°C)</td>
<td>1380</td>
<td>1470</td>
<td>1380</td>
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<tr>
<td>Chemical composition (wt. %)</td>
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<tr>
<td>SiC</td>
<td>88</td>
<td>65</td>
<td>87</td>
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<tr>
<td>Si (free)</td>
<td>11</td>
<td>-</td>
<td>13</td>
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<tr>
<td>Si₅N₆ + Si₂N₅</td>
<td>-</td>
<td>27</td>
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</tr>
<tr>
<td>Oxides</td>
<td>-</td>
<td>balance</td>
<td>-</td>
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</tbody>
</table>

* *The values quoted above were determined on test specimens and cannot generally be applied to all shapes.*

### Microstructure

- **RBSiC**: Silicon-infiltrated, reaction-bonded SiC
- **CarSiK**: Dark phase: SiC, Light phase: free Si
- **NSiC**: Light phase: SiC
- **IntrinSiC®**: Dark phase: Si₅N₆/Si₂N₅, Black phase: pores

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* The values quoted above were determined on test specimens and cannot generally be applied to all shapes.
Indirect Heating

The process of Indirect heating, using Radiant- and Flame Tubes, transfers heat by radiation. Moreover, the combustion gases are not permitted to come into contact with the ware being fired.

Silicon-infiltrated, reaction-bonded silicon carbide (RBSiC) made by Schunk Carbon Technology fully satisfies the extreme demands made on ceramics for complex constructional elements for Indirect Heating. There has been significant technological progress over the past few years due to the use of the superior ceramic grade (RBSiC) which allows the System-OEM’s to move technical boundaries in regards to long time quality performance and thermal performance.

One important advantage offered by RBSiC is the increase in the specific radiation capacity (Net Heating Efficiency) at high kiln temperatures. For example, assuming a Radiant Tube of identical dimensions operating at 1.100 °C, RBSiC achieves a Net Heating Efficiency in kW/m² of more than double compared to CrNi steel.

In the area of Indirect Heating, products made from Schunk Carbon Technology cover a wide spectrum of temperature and service conditions in particular in the market segments:

- **Steel Industry and Heat-Treatment**
  - Carburization- and Tempering Furnaces
  - Annealing Furnaces
  - Galvanizing Lines
  - Forging Furnaces
  - Tube Furnaces

- **Chemical Industry**
  - Rotary Kilns

- **Ceramic Industry**
  - Indirect heated Furnaces
The advantages of RBSiC made of Schunk Carbon Technology can be summarized as follows:

- **Outstanding Thermal Shock Resistance**
- **Stability of shape up to maximum operating temperature of 1,380°C (superior creep-resistance, no bending of tubes in service resulting in significantly reduced maintenance)**
- **Horizontal or Vertical Cantilever installations are feasible**
- **Homogeneous temperature distribution combined with high radiation-power**
- **Outstanding Oxidation- and Corrosion Resistance**
- **High degree of reliability and economy in service (Optimum Efficiency)**

CarSIK Radiant- and Flame Tubes as well as Recuperative Burners made of RBSiC have been used successfully in a wide range of heat treatment processes by almost all System-OEM’s worldwide for many decades. From prototype up to high volume manufacturing.

For purposes of energy conservation, as an alternative to a central recuperation, the combustion gases can be transferred through a Recuperative Burner – incorporated in the Radiant Tube - which functions on a countercurrent basis. The high degree of preheating on the combustion air which results from this principle of operation ensures optimal efficiency. Particular in the technical implementation of optimized surface geometries with the goal of improving efficiency of Recuperative Burners, Schunk Carbon Technology has strong core-competences using various forming processes to achieve many different shape requirements.

Schunk Carbon Technology underlined its Technology Leadership by a further quantum leap in ceramics - with IntrinSiC®.

**IntrinSiC®** is the superior innovation for the production of large, complex, monolithic constructional elements made of Silicon-infiltrated, reaction-bonded silicon carbide (RB-SiC). Based on this innovation it became possible for the first time to efficiently provide large prints of a certain complexity via 3D-printing, accompanied by a diamond-like hardness. A worldwide novelty.

IntrinSiC® combines excellent material properties of RBSiC with process-related advantages of the 3D-printing, providing a new dimension of constructive design potentials. Even large and complex monolithic structures with undercut and cavities can be formed in just one single manufacturing step.

With that outstanding manufacturing process it became feasible to adapt steel-designed geometries (i.e. from Recuperative Burners) with fins on the outside and inside.

**Process advantages of 3D-printing:**
- Realizing of undercuts and/or cavities
- No time-consuming manufacturing from patterns and moulds (CAD-data means part ready for manufacturing immediately)
- High degree of process-flexibility
- Fast production lead times
- Design modifications by the click of a mouse
- No time-consuming retooling of moulds
- Digitizing from existing parts by Reverse Engineering
Uniform temperature distribution at high radiation output

Products of Schunk Carbon Technology ensure an optimum level of internal exhaust gas circulation as the ceramic heart of Radiant Tubes and therefore yield a uniform temperature distribution over the maximum radiation area. RBSiC with a high degree of reliability and economy in service, makes a significant contribution to customers' productivity as an integrated part of a complete system with burners i.e. with a FLOX® or flame design.

The innovative System of WS-Wärme-Prozesstechnik GmbH ensures:

- Uniform temperature distribution at high radiation output
- Low-wear system configuration
- Simple to assemble
- Minimal maintenance requirement

[FLOX® is a protected trademark by the company WS-Wärme-Prozesstechnik GmbH]

Schunk Carbon Technology is the pioneer and leading manufacturer of RBSiC Radiant Tubes more than 30 years with tens of thousands of Radiant Tubes in operation. Single ended Radiant Tubes for gas fired and electrically heated applications are feasible as standard in sizes with a diameter ≤ 240 mm and length ≤ 3000 mm. Larger diameters, respectively longer tubes up to 4200 mm combined with smaller diameter upon request.

Outstanding Quality performance:
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Direct Heating

Process modifications have opened up a wide range of applications for ceramic burners, to such an extent that metals have been substituted in most application areas.

Within this area of ceramics, the silicon-infiltrated, reaction-bonded silicon carbide (RBSiC) deserves special mention. Due to its excellent properties, this material ensures optimum long term quality performance on these applications within the specified temperature range.

CarSiK burner tubes and constructional elements for the thermal process technology have been used successfully for decades by almost all system- and kiln OEM’s worldwide in gas- and oil-fired industrial kilns.
Household Burners

Schunk Carbon Technology belongs to the world leading manufacturers of ceramic household burner nozzles particularly in the RBSiC grade, for floor standing oil-fired central heating boilers.

The partial switch-over of the industry to sulfur reduced fuel oils caused a corrosion effect (“metal dusting”) at steel which resulted in a global switch-over to ceramics. The excellent material properties of RBSiC fulfills the high demands of long term quality performance of resources-caring and corrosion resistance in energy efficient central heating boilers.

Schunk Carbon Technology ensures a right on time delivery for large volume serial manufacturing lots with tight dimensional tolerances and consistently high quality level.

Industrial Burners

For operation in industrial kilns and combustion plants, ceramic burner nozzles are the preferred choice to ensure a high degree of efficiency in many industries, including ceramic, iron/steel, precious, non-ferrous and light metal, as well as paper and thermal after-burning industries.

Using CarSIK results in an optimum degree of efficiency combined with a high reliability of operation and economy in service from prototype up to large volume manufacturing.
Other exemplary applications

The excellent material properties of RBSiC from Schunk Carbon Technology demonstrate their high potential not only in the above stated markets. With a focus on identifying and implementing cost saving measures, Technical Ceramics enables innovative solutions.

Due to the positive wetting behavior in direct contact i.e. with zinc melting, the NSiC (silicon nitride-bonded silicon carbide) improves the efficiency of Immersion Tubes in particular for Galvanizing Lines and achieves a quality performance more than double compared to commercially available refractory grades. Exemplary in the area of paper drying. Using CarSIK constructional components in gas-fired Infrared Emitters ensure a high radiative efficiency, which results in a decreasing gas consumption while increasing the drying capacity.

Quality Commitment

Quality is in our DNA.

Our commitment and dedication to Quality is reinforced by proven internal processes flanked by intensive quality control and inspection methods within the entire line of manufacturing to ensure a constant high level of quality.

As integrated part of our policy, we are committed to continuously improving our products, processes and services to meet and exceed our customers requirements. Our company is certified according to DIN ISO 9001.

We ensure a high degree of quality in working on customer and application specific measurements prior to shipping as an integrated part of our in-house control. Apart from an optical inspection of the fired product, the material is (depending on the shape) subject to a 100% gauge- and/or 3-point load testing as well as application-specific 3D-Scanning and X-ray measurement.

Quality Commitment