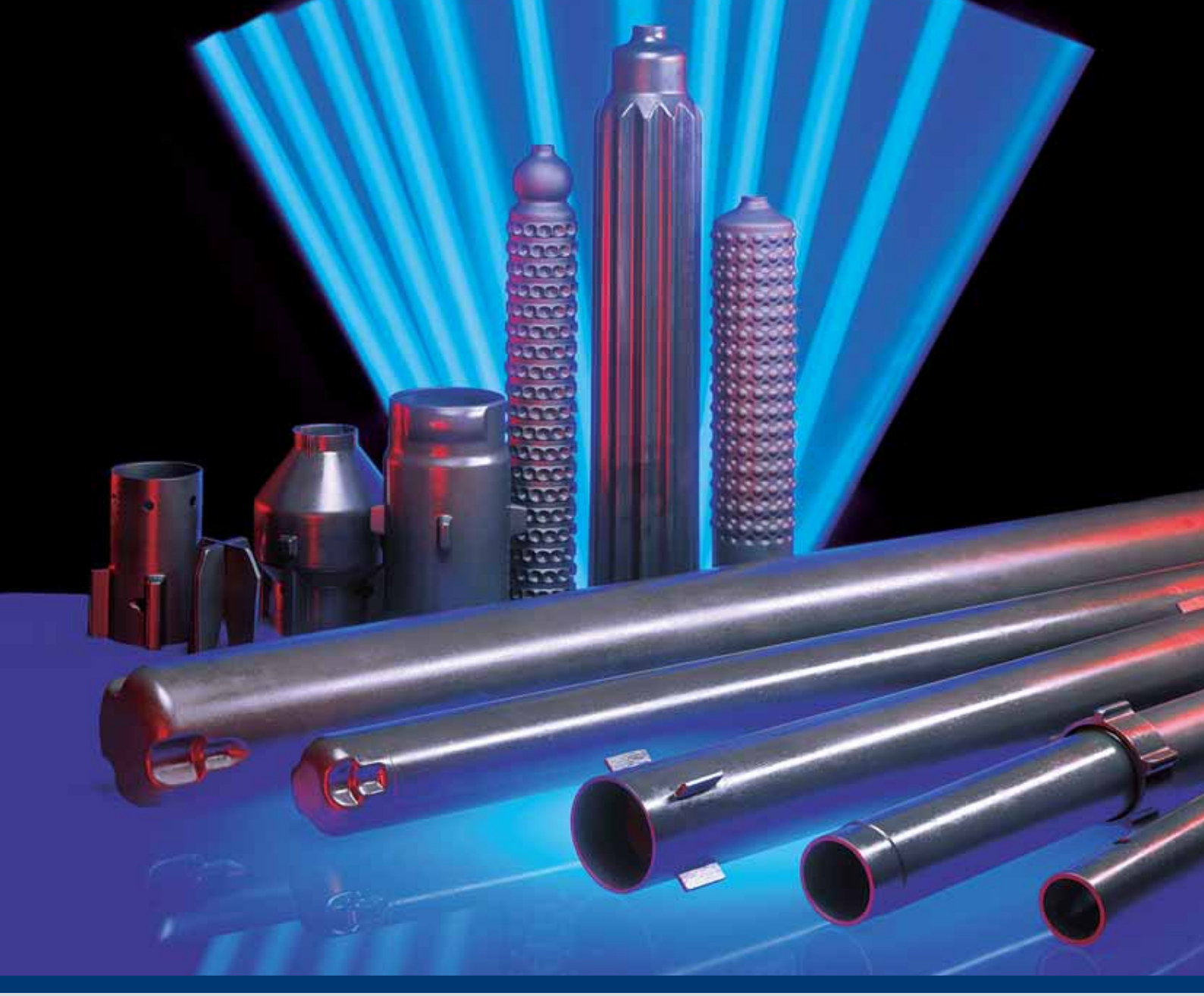


Burners – Indirect Heating
Complex, Complete, Competent

Advantages

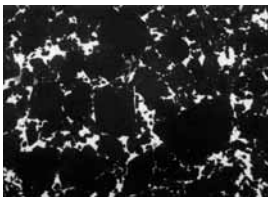
- No porosity, therefore excellent oxidation and corrosion resistance
- Very good thermal shock resistance
- Gas tight
- Stability of shape up to maximum operating temperature (high degree of creep resistance, no bending of tubes in service meaning much reduced maintenance)
- Very good thermal conductivity (increased radiative heat transfer)
- High degree of reliability and economy in service
- Low mass
- Optimum efficiency

Technical Data

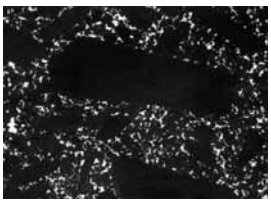
		CarSIK-G	CarSIK-GG
Bulk density	(g/cm³)	3.09	3.15
Apparent porosity	(Vol. %)	0	0
Modulus of rupture	(MPa)	280	280
Weibull modulus		10	10
Compressive strengths	(MPa)	1,000	1,000
Modulus of elasticity	(GPa)	360	360
Vickers hardness	(MPa)	SiC 2,5000 Si 9,000	SiC 25,000 Si 9,000
Thermal expansion coefficient	20°–1,000 °C (1/°C)	$4,9 \times 10^{-6}$	$4,9 \times 10^{-6}$
Thermal conductivity (W/mK)	100 °C	160	160
	1,200 °C	24	24
Specific heat (J/kgK)	RT	600	600
	1,300 °C	1,200	1,200
Limit of application [Melting point silicon (°C)]	(°C)	1,380 [1,380]	1,500 [1,380]
Chemical composition (wt. %)	SIC	88	92
	Free SI	11	7

Microstructure

CarSIK-G



CarSIK-GG

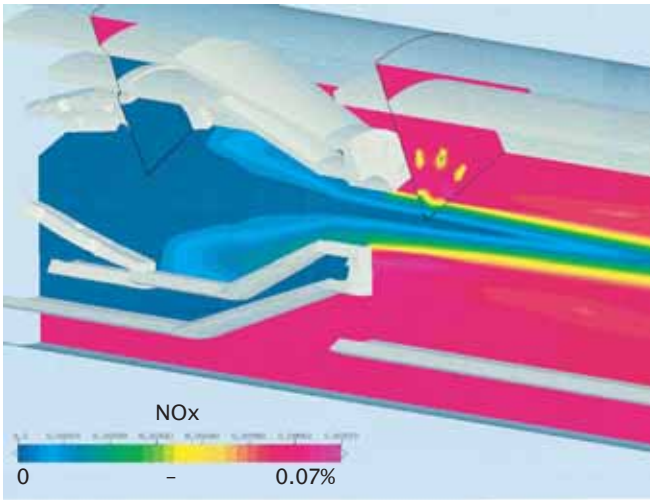


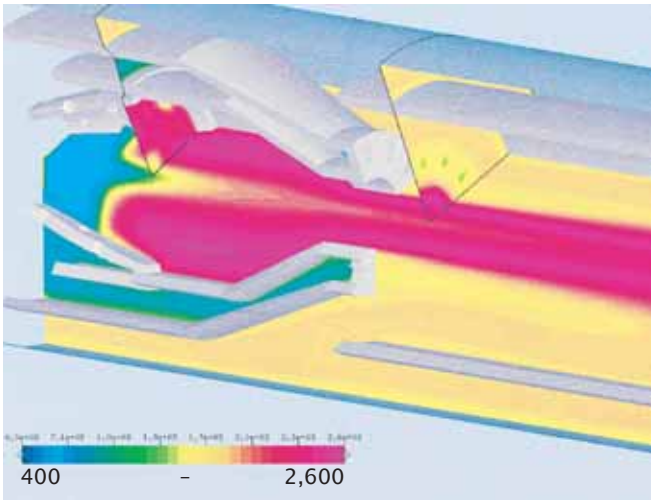
Dark phase = SiC
Light phase = free Si

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

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.
Our **CarSIK** grade therefore fully satisfies the extreme demands made on material for radiant tube applications.
For reasons of energy conservation, as an alternative to a central recuperature, 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 of the combustion air which results from this principle of operation ensures optimum efficiency.
There has been significant technological progress over the past few years due to the use of silicon-infiltrated, reaction-bonded SiC(RBSiC). One important advantage offered by this material is the increase in the specific radiation capacity at high kiln temperatures. For example, assuming a radiant tube of identical dimensions operating at 1,100 °C, RBSiC achieves a heat transfer of more than double that of CrNi steel (please refer to the diagram of WS-Wärmeprozeßtechnik GmbH shown below). In the area of indirect heating, **CarSIK** products cover a wide spectrum of temperature and service conditions.
When compared with high-alloy steels, these products exhibit no deformation in service, thereby making the components free of any maintenance.

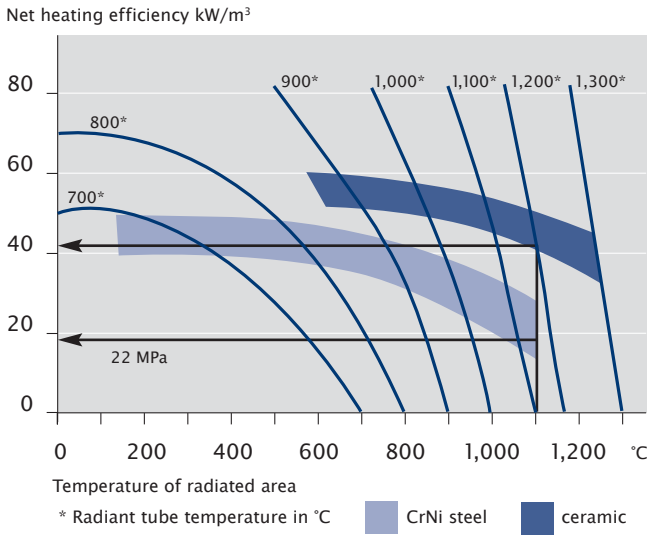




Numerical representation of the NOx and temperature distribution in a ceramic radiant tube (Ruhrgas AG)

References

For Radiation



ALD Aichelin (Continous tempering furnace)

CarSIK radiant and flame tubes have been used successfully in conjunction with recuperative burners in a wide range of heat treatment processes by almost all system constructors worldwide for many years.
An increasing degree of automation is making greater demands on the ceramic burner components. Through direct communication with constructors and end users, Schunk Ingenieurkeramik GmbH can develop specific solutions for each individual customer up to the production stage.

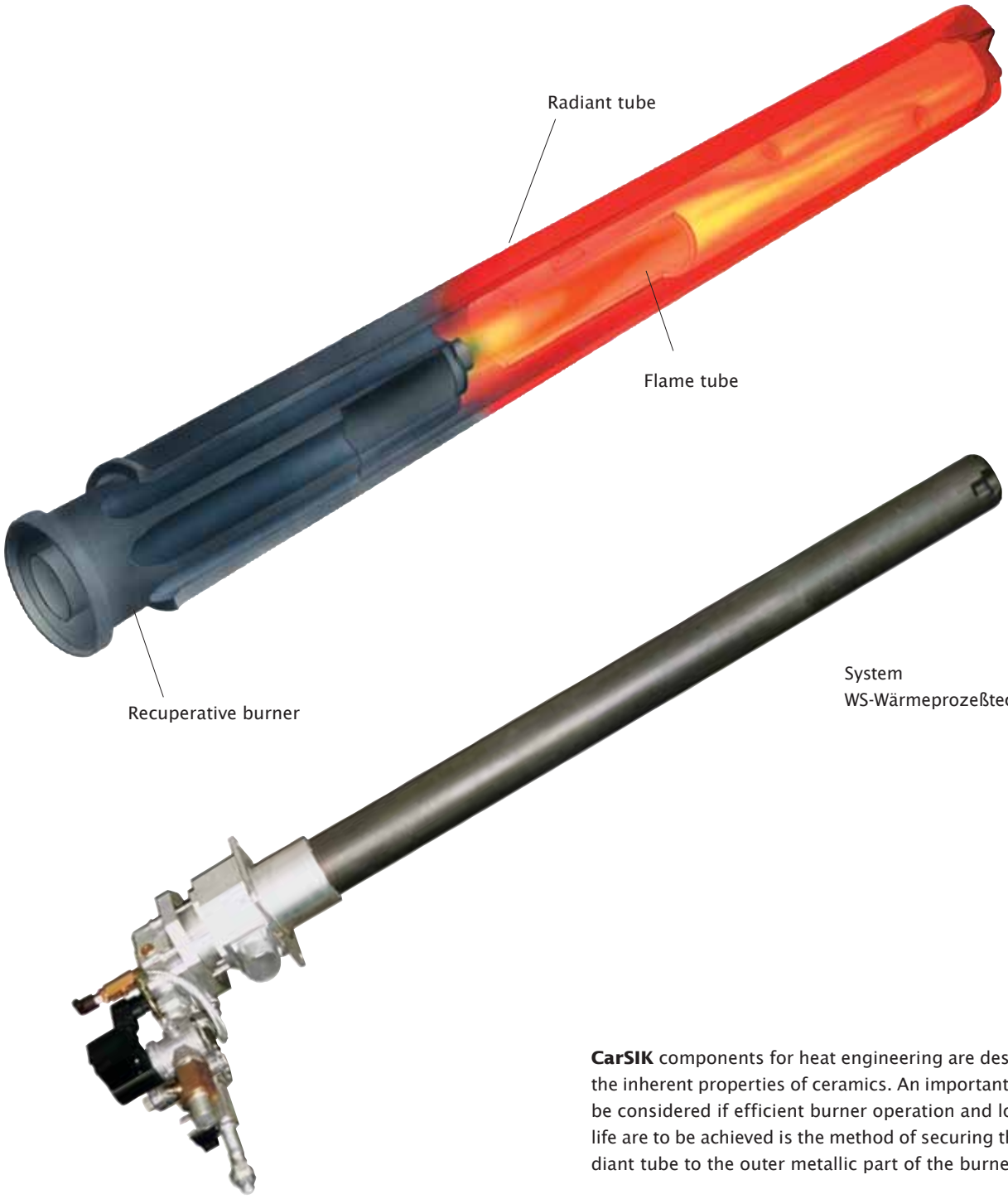
Varius forming processes are available depending on the different shape geometries required. The main process used is slip-casting, which enables production of complex shapes while at the same time keeping tight dimensional tolerances. This type of production can be adopted from prototype up to high volume manufacture.

WS-Wärmeprozeßtechnik GmbH
(Meshbelt furnace for electric sheet steel)

LBE Beheizungseinrichtungen GmbH
(Bright annealing roller hearth furnace)

Example of Installation

Full ceramic gas radiant tube



System
WS-Wärmeprozeßtechnik GmbH

CarSIK components for heat engineering are designed around the inherent properties of ceramics. An important factor also to be considered if efficient burner operation and long operation life are to be achieved is the method of securing the ceramic radiant tube to the outer metallic part of the burner.

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