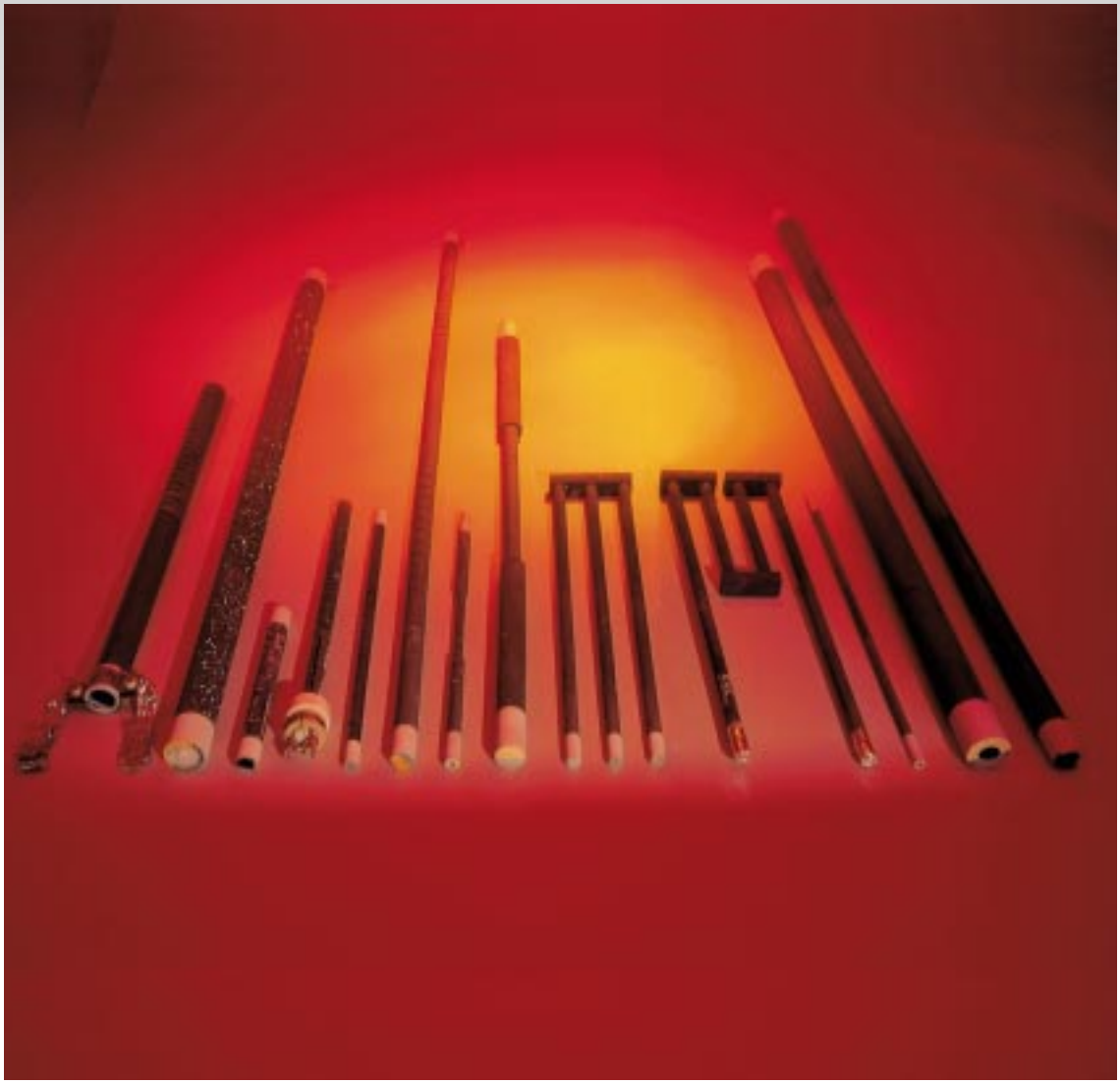
KANTHAL

Silicon Carbide

Electric heating elements



KANTHAL®

Kanthal silicon carbide

Electric furnace heating with Kanthal silicon carbide elements is economical, dependable, clean, quiet and safe. There are no fuel storage problems, no worries about fuel availability and no noxious exhaust products to be ducted away.

Kanthal-equipped furnaces are versatile. They handle a wide range of products and atmospheres efficiently, and temperatures can be controlled as closely as you like.

Kanthal elements are part of a complete system and are simple to install.

Kanthal elements give you silicon carbide resistance heating at its best.

Freedom in furnace design

Kanthal silicon carbide heating elements are rigid throughout the range of operating temperatures so they can be installed horizontally or vertically without any additional supports. The single ended connection types allow even greater flexibility in furnace design. They can be installed through side walls or roof, or project up through the hearth or used to heat furnaces that are too wide or too long to span with conventional elements.
The elements are easy to install and to connect to the power supply.

Production reliability

Installed and operated according to our recommendations, Kanthal silicon carbide heating elements can provide a long service life of several years, contributing to a long and trouble-free furnace operation. When an element needs to be replaced, it can be done whilst the furnace is at full operating temperature, without stopping production.

Excellent hot strength and dimensional stability

Kanthal silicon carbide exists only as a solid, has no liquid phase, and, as a result, will not plastically deform at any temperature.
Unlike other electrical elements, Kanthal silicon carbide elements do not bend or sag, but remain stable throughout their temperature range.

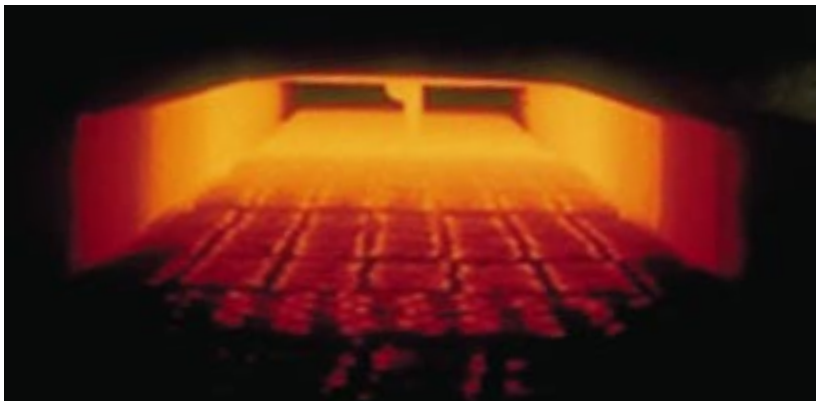
High power potential

The elements can be loaded at up to 30 W/cm^2 (3 - 12 W/cm^2 in most cases), resulting in a very high power density in a limited space and fast heating up. This feature is very important in applications demanding a high power concentration, for instance aluminium melting and holding furnaces.

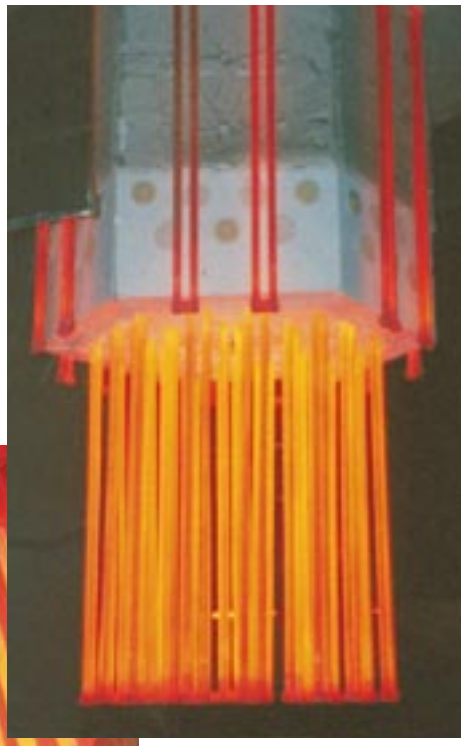
Temperature flexibility

Furnaces heated by Kanthal silicon carbide elements can operate over a temperature range from 600 - 1600 °C, making them very versatile and economical.

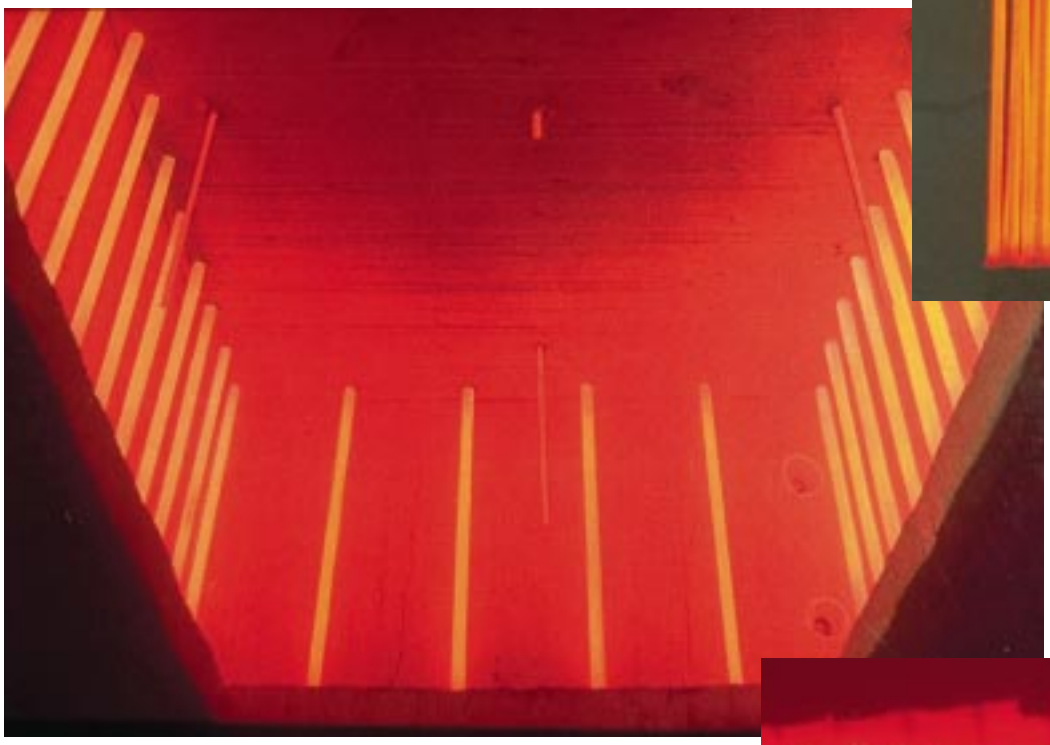
– heating at its best



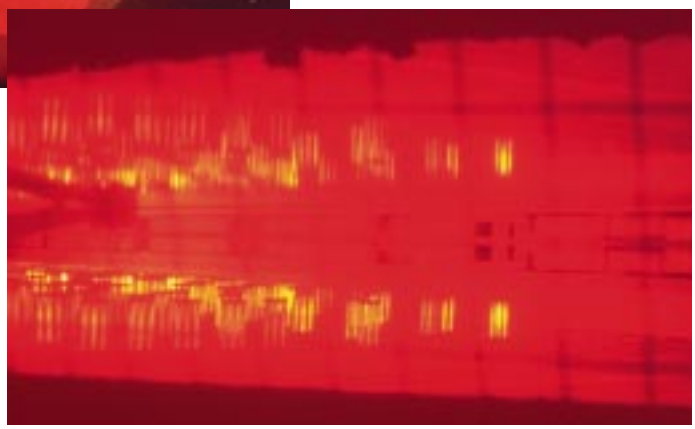
Ferrite Sintering Furnace



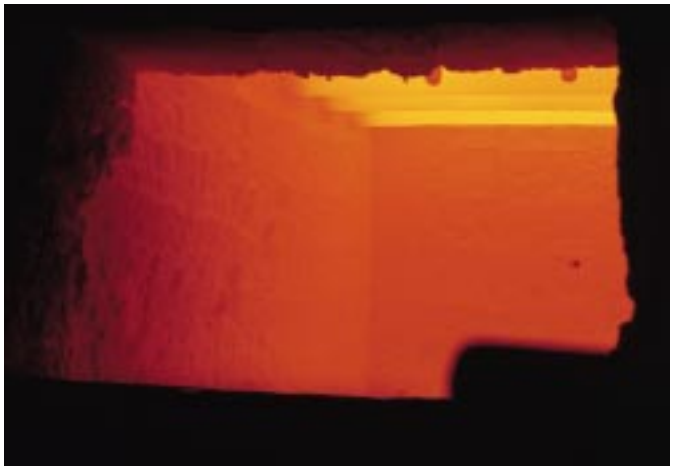
Ladle Pre-Heater



Elevator Furnace



Float Glass Tank



General Heat Treatment Furnace

Heating elements for every

A concise description of Kanthals' broad range of silicon carbide heating elements is provided on the following 3 pages.

In many cases, the reason to choose one element type in preference to another is not always completely clear at first sight. However, each element type possesses certain unique characteristics which tends to favour their use in specific installations and where certain operating conditions apply.

Further technical information about each element type can be provided on request.

Our technical service engineers have many years of first hand application experience and a deep knowledge of our products being utilised in many varied application areas throughout the world. We will gladly help you to select the most suitable product to suit your specific application.

Hot Rod

Hot Rod heating elements are manufactured in one piece from high purity alpha silicon carbide grains sintered at temperatures in excess of 2500 °C to form equal diameter recrystallised rods or thick walled tubes according to the diameter. The cold ends are formed by impregnating with high conductivity silicon. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections. The one piece construction ensures reliable and trouble free operation.

Hot Rods work well in aggressive atmospheres and are highly resistant to chemical attack. Special glazing and coating treatments can improve the life in difficult atmospheres.

Hot Rods perform well in both continuous and intermittent operation but above 1300 °C continuous operation is recommended for a maximum service life.

The maximum recommended element temperature is 1625 °C.

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Hot Rod	9.5 - 44	2000	3000
Type U, SCU, W	16 - 44	2000	2500

Hot Rod

Hot Rod Type U

Hot Rod Type SCU

Hot Rod Type W

Crusilite

Crusilite heating elements are made in one piece from thin walled tubes of Beta silicon carbide. A spiral is cut in each tube to form the hot zone. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections. Crusilite elements can be used at furnace temperatures up to 1600 °C, but operate in most industrial and laboratory furnaces at temperatures up to 1500 °C.

Crusilite X

Crusilite DS

application and heating need

Crusilite is suitable for both continuous and intermittent operation and will withstand very rapid heating and cooling cycles, severe thermal shock and high electrical loading.

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Crusilite X	10 - 35	1000	1600
DS	14 - 35	500	800
MF	45 - 75	500	1000
DM	45 - 108	300	600

Crusilite MF

Crusilite DM

Globar LL

Globar LL heating elements are manufactured from high purity alpha silicon carbide grains sintered at temperatures in excess of 2500 °C to form equal diameter recrystallised rods or thick walled tubes according to the diameter. The elements are made in three sections; a central hot zone heating section and two low resistance cold ends which are jointed and bonded to the hot zone by a high temperature firing process. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections.
Globar LL is suitable for heating operations up to 1540 °C with an air atmosphere, and has a precisely defined hot zone and cold end terminals of specially low resistance material.

Globar LL

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Globar LL	7.9 - 54	2500	3300

Globar SG, SGR.

Globar SG and SGR heating elements are manufactured in one piece in the form of thick-walled tube, that is machined with a helical cut, to form the hot zone section. They are made of a specially dense material that offers superior resistance to oxidation and chemical attack at high temperatures. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections.
SG and SGR elements can be used both in continuous and intermittent operation, and at operating temperatures up to 1650 °C.

Globar SG

Globar SGR

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Globar SG	12.7 - 54	1350	2200
SGR	12.7 - 54	650	1250

Globar DTEF

Globar DTEF is a three section heating element having a central heating zone with larger diameter cold end terminals. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections. The material and properties are basically the same as for Globar LL. This element type (commonly referred to as a dumbbell type) is the forerunner to today's more preferred equal diameter types and is usually only supplied as spare parts for existing furnaces.

Globar DTEF

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Globar DTEF	6 - 30 (hot zone)	1500	2300

Silit ED, ED-U and ED-3

Silit ED type heating elements are manufactured in one piece from high purity alpha silicon carbide. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections. The one piece construction ensures reliable and trouble free operation. Silit ED is designed for element temperatures up to 1625 °C and can be used both continuously and intermittently. The Silit ED element is capable of accepting a high surface loading and is ideally suited to applications demanding this feature.

Silit ED

Silit ED-U

Silit ED-3

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Silit ED	7.9 - 54	2500	3300
EDU	12.7 - 44	2000	2500
ED-3	19 - 44	2000	2500

Silit VE AND VE-3

Silit VE is a three section heating element having a central heating zone with larger diameter cold end terminals. The outer extremities of the cold ends are aluminised to form a low resistance contact surface for the electrical connections. The material and properties are basically the same as for Silit ED. Also available as the VE-3, 3-leg type element. This element type (commonly referred to as a dumbbell type) is the forerunner to today's more preferred equal diameter types and is usually only supplied as spare parts for existing furnaces.

Silit VE

Silit VE-3

	Diameter range mm	Max. hot zone length mm	Max. overall length mm
Silit VE	8 - 30 (hot zone)	1500	2300
VE-3	18 (hot zone)	600	982

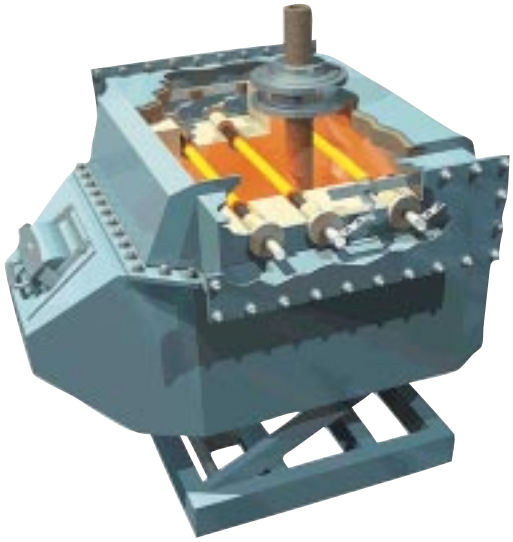
Applications

Kanthal silicon carbide elements are used in a wide variety of furnace applications, from small laboratory furnaces to large industrial heating processes, in different atmospheres and temperature ranges. The elements allow great freedom in furnace design which combined with simple installation and a long operating life, makes them the preferred choice in many applications including; the glass, ceramics, electronics and metals industries, and also for research and development.

Examples of some typical furnaces where Kanthal silicon carbide elements are the natural choice, are shown below.

Aluminium Die Casting

Furnace temp	800-1000 °C
Furnace power	10-50 kW
Element types	Silit ED and ED-U Hot Rod and Type U Globar LL



Typical low pressure die casting machine with elements mounted across the roof of the furnace, sometimes in metallic Kanthal APM or ceramic radiant tubes to protect from mechanical breakage and facilitate pressure sealing.

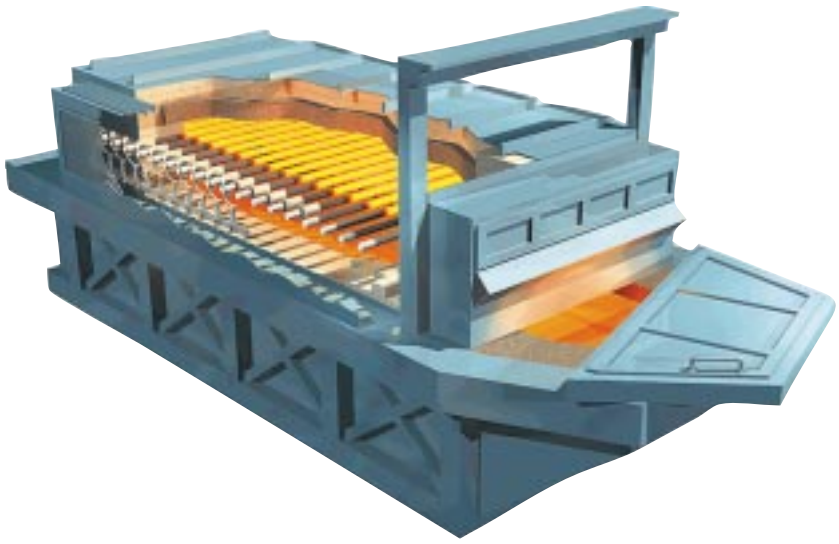
Products Produced Automotive components e.g. aluminium car wheels and cylinder heads; architectural fittings electrical motor and pump castings.

Aluminium Melting & Holding Furnace

Furnace temp	800 -1200 °C
Furnace power	100 - 500 kW
Element types	Silit ED and ED-U Hot Rod and Type U Globar LL and SG

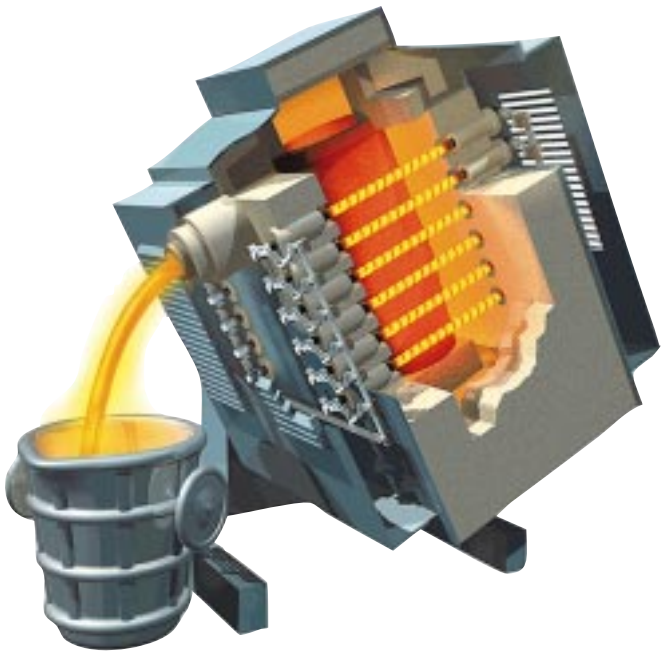
Kanthal silicon carbide heating elements offer a high power concentration for rapid melting and are simply installed across the width of the furnace. Elements are easily replaced, when required, without reducing the furnace temperature.

Products Produced Aluminium extrusions and castings.



Crucible Furnace For Non Ferrous Metals

Furnace temp	600-1500 °C
Furnace power	20-200 kW
Element types	Globar SG Crusilite type X Silit ED Globar LL Hot Rod

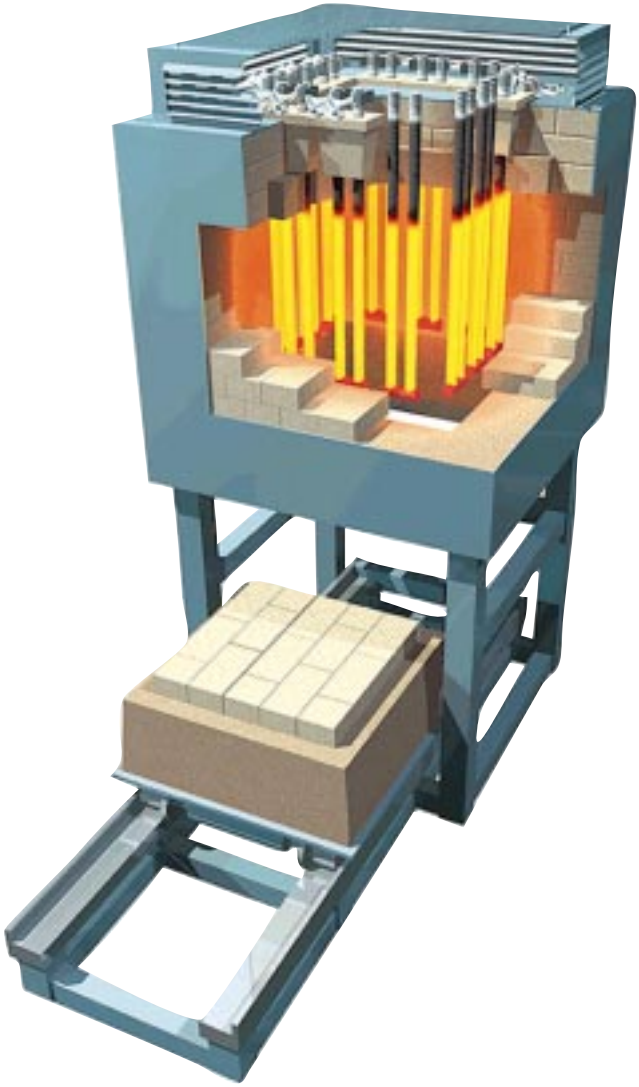


Static or tilting crucible furnaces are used for melting and holding of non-ferrous metals and alloys (e.g. Copper, Aluminium, Brass, Bronze, etc.). Elements are placed around the crucible on two or four sides, and their high power concentration facilitates rapid melting.

Products Produced Marine, automotive, architectural and general purpose castings.

Elevator Furnace

Furnace temp	1000-1600 °C
Furnace power	4-150 kW
Element types	Silit ED and ED-U Hot Rod and Type U Globar LL, SG and SGR Crusilite Type X and DS



Elements can be installed vertically (as shown) for ease of electrical connections, or if preferred, horizontally, on two or four walls, to allow the furnace height to be divided into separate control zones.

Products Produced Engineering ceramics (e.g. alumina, zirconia etc.). Electronics materials (e.g. ferrites, fluorescent powders, ceramic capacitors, electronic substrates, piezoelectric materials, etc.)

Laboratory Furnace

Furnace temp	1000-1600 °C
Furnace power	1-24 kW
Element types	Crusilite (all Types) Globar Types SG and SGR Hot Rod and Type U Silit ED and ED-U

Kanthal silicon carbide heating elements offer rapid heating and cooling in low thermal mass, general purpose and specialised laboratory furnaces for use up to 1600 °C.
Power supply equipment is normally simple and inexpensive and transformers are not usually required.
Element life is superior to that of metallic elements especially at the higher temperatures.

Products Produced Small scale batches of metals, glass, ceramics and composite materials.

Rotary Hearth Furnace

Furnace temp	1000-1500 °C
Furnace power	35-800 kW
Element types	Silit ED-U and ED-3 Hot Rod Type U & W

Elements are usually installed vertically, as shown, with all electrical connections easily accessible at the top of the furnace. Where the furnace chamber is wide and low, it may be preferable to use horizontal elements across the furnace roof.

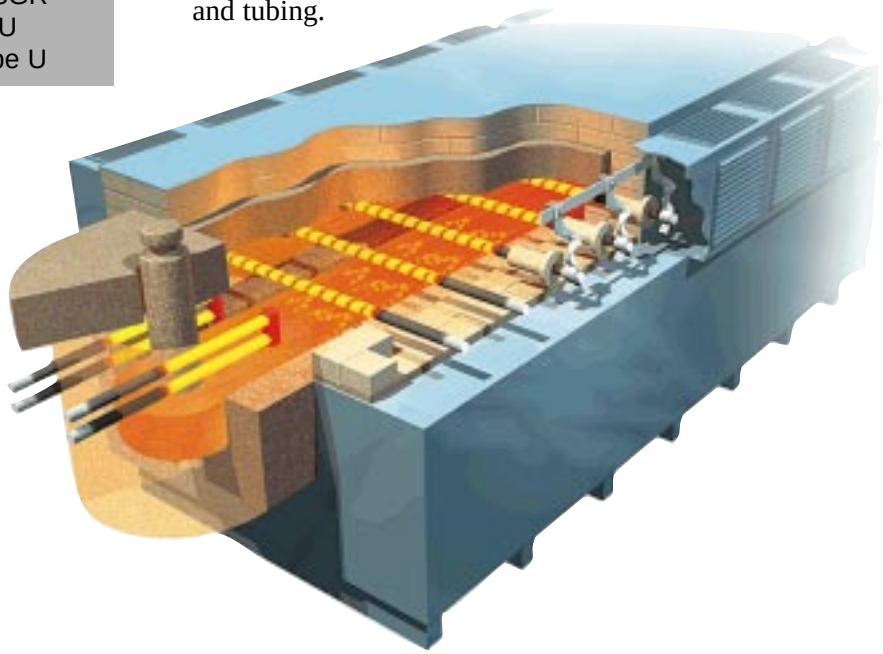
Products Produced Forgings and pressings for aerospace, automotive and general engineering use. Engineering ceramics (e.g. alumina, zirconia etc.). Electronics materials (e.g. ferrites, fluorescent powders, ceramic capacitors, electronic substrates, piezoelectric materials, etc.)

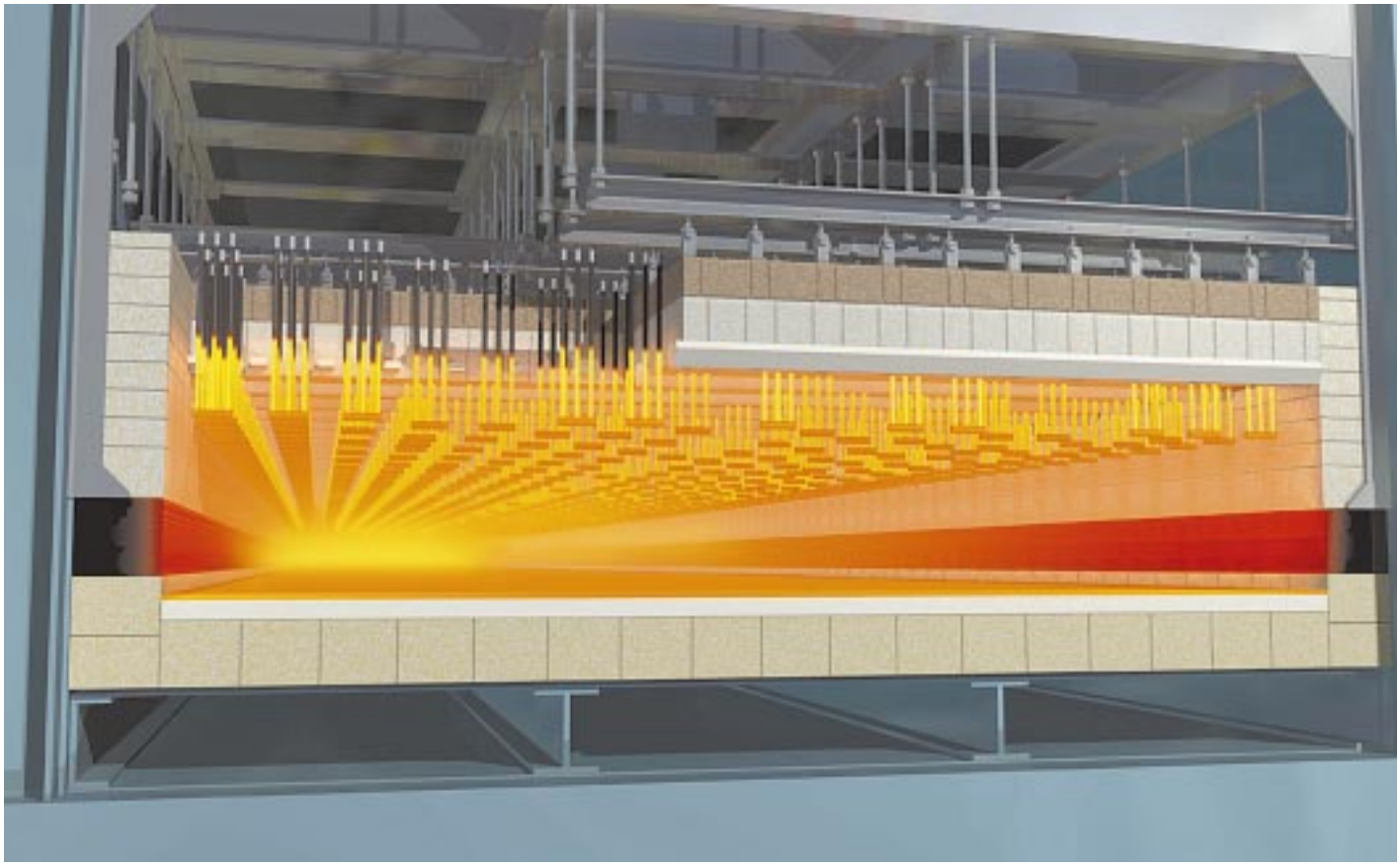
Glass Feeder

Furnace temp	1000-1550 °C
Furnace power	50-1000 kW
Element types	Crusilite Types X and DS Globar SG and SGR Silit ED and ED-U Hot Rod and Type U

Elements are normally installed across the width of the forehearth to allow a low and compact roof design for precise temperature control and high thermal efficiency.
Kanthal twin hot zone elements have also been developed to improve glass quality by reducing temperature variations across the width of the channel.
Kanthal Type U elements provide the high power concentration required for the feeder bowl.
Elements can be replaced easily, if required, without loss of production.

Products Produced
Soda lime glass: bottles, jars, tableware and fibre-glass insulation. Borosilicate glass: heat resistant cookware and laboratory ware. Lead crystal glass: tableware and art ware. Optical glass lenses, fibres and tubing.





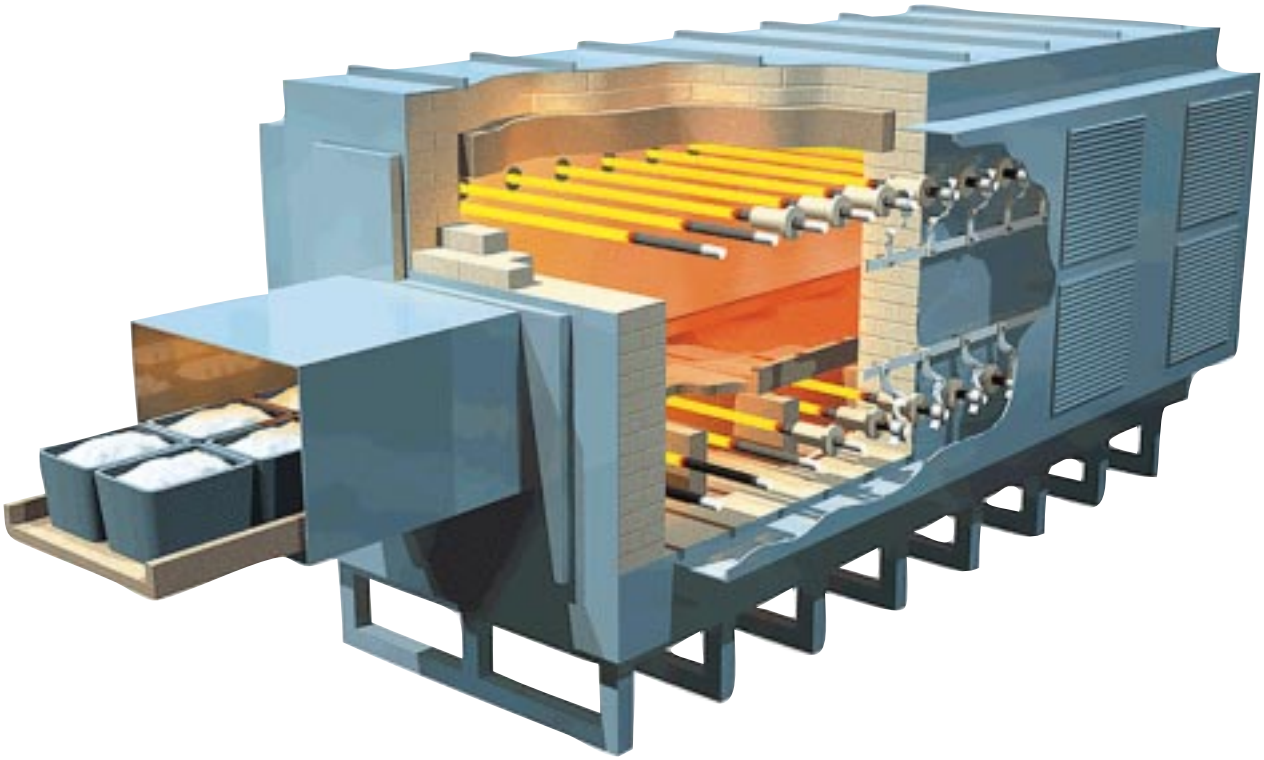
Continuous Furnace

Furnace temp	800-1600 °C
Furnace power	30-1000 kW
Element types	Silit ED and ED-U Hot Rod and Type U Globar LL and SG

Kanthal silicon carbide heating elements provide the reliability and long life that are fundamental to the successful operation of any continuous furnace.

When element replacement is ultimately required, a distinct advantage is the ability to replace elements whilst the furnace is at normal operating temperature, this preventing expensive downtime and loss of production.

Products Produced Engineering ceramics (e.g. alumina, zirconia etc.). Electronics materials (e.g. ferrites, fluorescent powders, ceramic capacitors, electronic substrates, etc.)



Float Glass Line

Furnace temp	600-1150 °C
Furnace power	2500-5000 kW
Element types	Kanthal 3-phase

The float glass process is used to manufacture flat glass for architectural and automotive uses.
Up to 1500 special Kanthal 3-phase elements are installed vertically through the roof of each bath and multi zone control is used to maintain an accurate temperature profile through the width and length of the bath, thus ensuring consistent, high quality glass production.
Kanthal is the worlds leading supplier of elements to the float glass industry.

Technical data

Electrical Characteristics

Silicon carbide is a semiconductor material, and has a much higher resistivity than metallic resistance materials. Room temperature resistivity is fairly high, and falls with increasing temperature to a minimum value at about 600-900 °C. At element temperatures above 900 °C, resistivity increases with rising temperature, as shown in Fig. 1 Resistance vs temperature - Comparison of Kanthal SiC elements.
Minute impurities in the material have a disproportionate effect on the resistance value at temperatures below 600 - 900 °C and resistance measurements taken at room temperature give no indication of the resistance at higher temperatures. Resistance measurements should always be carried out at a constant temperature, at or above 1000 °C (800 °C for Crusilite), and the value can be calculated by dividing the voltage across each element by the current passing through it.
Nominal resistance tolerances and calibrating temperatures are given in the table below.

Calibrating temperature and tolerances

Element	Calibrating temperature °C	Standard resistance tolerance %
Hot Rod	1050	+15 -20
Crusilite Type X		
(Dia. 10-14 mm)	800	±12.5
(Dia. 18-35 mm)	800	±10
Type DS	800	±15
Type DM, MF	800	+25-20
Globar LL	1070	+10 -20
DTEF	1070	±15
SG	1070	±10
SGR	1070	±20
Silit ED, ED-U, ED-3	1070	±15
Type VE, VE-3	1400	±15

(Special tolerances are applied on elements for the

Every element is fully tested and calibrated individually and the following data marked on each element:

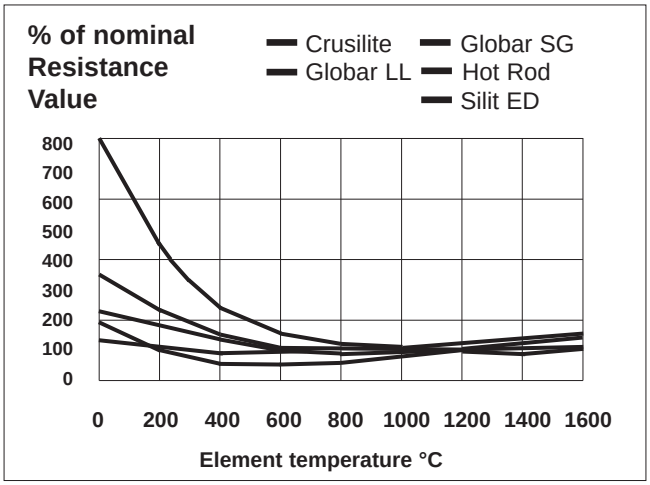
Hot Rod	Max. starting voltage	Resistance at 1050 °C
Crusilite	-	Resistance at 800 °C
Globar LL	Test current value (amp.) Calibration voltage	
Silit ED	Resistance at 1070 °C	Test current value (amp.)

The nominal resistance value of an element may be used when calculating the voltage requirements of the power supply, but account must be taken of the minimum resistance tolerance when calculating the maximum current drawn. This maximum value should then be used for the calculation of the power supply current rating.
Further assistance to determine power supply specifications can be provided on request.

Element Performance

All silicon carbide elements gradually increase in resistance during their life in operation and the rate at which this occurs is affected by the following factors:
- Element type
- Element Specific Loading (W/cm^2)
- Operating Temperature
- Process Atmosphere
- Mode of operation - continuous or intermittent
- Operating practices

Resistance vs. Temperature - Comparison of Kanthal SiC Elements Fig 1.



To optimise element life, the right type of element should be selected and the lowest specific loading consistent with the furnace design should be used.
To compensate for the gradual increase in element resistance (ageing), a variable voltage power supply is usually provided, to enable the design power to be maintained throughout the life of the elements. The power supply may consist of a variable output transformer, thyristor unit, or a combination of the two.
The type of equipment used may effect element performance and it is important that the equipment used is compatible with the elements.
Power supply recommendations will be provided on request.

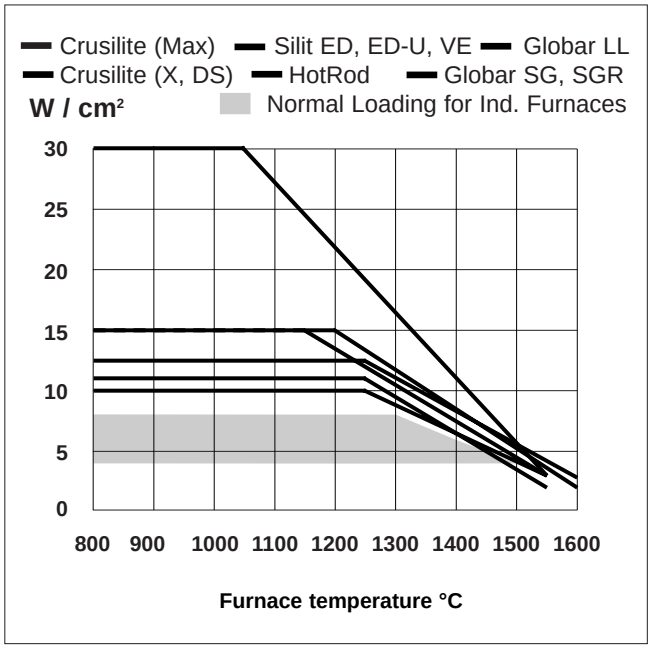
Atmospheres

Kanthal silicon carbide elements may be used in clean, dry air at element temperatures up to a maximum of 1650 °C (Globar SG), but a lower limit may often be required for use in other atmospheres as detailed in the table below.
The dew point of the atmosphere and the surface loading of the element are also factors which combine to affect element life.

Element Loading

The element temperature, and hence the ageing rate, is directly proportional to the specific loading which is expressed in W/cm^2 of the hot zone surface area. For optimum element life therefore, the lowest power loading consistent with the furnace design should be used. and this is usually in the range 3-8 W/cm^2.
Fig. 2 Maximum Permitted Element Loading, illustrates the relationship between furnace temperature and element surface loading.
The curves show maximum specific element loading for different element types operated in air. These values may be used as a guide, but for maximum element life a lower loading should be used wherever possible.
A lower loading may also be required where elements are to be operated in reducing or other process atmospheres, to maintain element temperatures within the limits, see table below.

Maximum Permitted Element Loading Fig 2.



** useful but limited life at 1450 °C*
Note that element temperatures are quoted and that these may be considerably higher than the furnace temperature. Please contact Kanthal for specific advice is required.

Maximum element temperature in furnace atmospheres, °C.

Atmosphere	Hot Rod	Globar LL	Silit	Crusilite	Globar SG	Comments
Air	1625	1540	1625	1575	1650	Must be clean and dry
Nitrogen	1350*	1350	1350*	1250	1400	
Hydrogen	1200	1200	1200	1200	1200	
Exothermic Gas Endothermic Gas	1250-1400	1250-1400	1250-1400	1000-1250	1250-1400	Very variable. Actual temp depends on exact gas composition and dew point
Hydrocarbons	1250	1250	1250	1250	1250	Periodic burn-off of carbon may be required
Vacuum	1000-1200	1000-1200	1000-1200	1000	1100-1300	Depends on degree and period of application

Wall Loading - Power Concentration

An exceptional feature of Kanthal silicon carbide heating elements is their capability to provide a very high power concentration.
Elements can be spaced at a minimum of 2 diameters between centres and 1.5 diameters between element centres and the refractory lining.
For example, it is possible to align 9 elements of 54 mm dia, per metre of furnace wall to achieve a power concentration in excess of 230 kW/m^2.

Installation

It is essential to ensure that elements are not restricted in any way and are free to move radially as well as axially in their support holes. The gap between the cold ends and their support holes should never be packed tightly with fibre, special ceramic sleeves are recommended, to locate the elements, and isolate them from the furnace casing. Flexible aluminium braid should be used for making terminal connections. Full details of available braids and terminal clips are available on request.

Matching and replacement of heating elements

It is recommended that any series-connected elements be selected within a resistance range of +/-5% of each other. Elements connected in parallel may have a wider range of +/-10%.
The elements are easy to replace, even when hot, once the electricity supply has been switched off. This means that the furnace operation can continue virtually without interruption.
If an element fails or is broken after only a short period in use, it can usually be replaced with a new element; preferably with one from the higher end of the resistance tolerance. If the elements have been in use for a considerable time however, the entire group should be replaced, otherwise an excessive load will fall on either the new or old elements, resulting in premature failure. When a group of elements has been replaced, it is essential to ensure that the voltage output of the power supply equipment is reduced to the correct level before switching on, as overloading of elements, even for a very short period, can cause irreparable damage. The old elements may be retained for later use with others which have been in use for a similar period of time.
If possible, voltage and current readings should be taken from each element before removal and the resistance value marked on the terminal to assist in matching at a later date.
It is important to reiterate that the resistance values of elements at room temperature give no indication of their resistance at operating temperature and resistance measurements should always be taken at a constant temperature, at or above 1000 °C (800 °C for Crusilite).
Different types of heating elements should never be operated in the same circuit, as variations in ageing rates can cause overloading of one type or the other depending on the method of connection.

Standard Size Range

The maximum hot zone length, overall length and diameter range for each element type is summarised in the tables on pages 4 - 6.
Standard size lists are available at your nearest Kanthal office.

Special Elements and Sizes

Special elements with non standard cold ends or hot zones, long bridges or other shapes can be supplied. Our technical service engineers will be pleased to assist you.

Accessories

A comprehensive range of accessories is available to suit all types of Kanthal elements, including aluminium braids, connecting clamps and clips, refractory lead-in sleeves etc.
Please request the Accessory Booklets.

Quality Control

All Kanthal silicon carbide elements are manufactured at our own plants. They are subject to a stringent quality control system that meets the standards of BS EN ISO 9001/9002.
The quality assurance scheme covers all aspects of product quality, including quotations, order handling and shipping, initial design of new element types, inspection of raw materials, in-process inspection and final inspection of the end products.
All hot zones are tested during production and this test is repeated on all finished elements. In addition, long term high temperature testing under typical furnace conditions, is carried out periodically in our test laboratories, to ensure that the element performance meets defined criteria.

Ordering service

Kanthal silicon carbide elements are specified as follows:
- Element type
- Diameter, mm
- Hot zone length, mm
- Overall length, mm
  (cold end length for multi-leg elements)
- Nominal resistance,
  (leg resistance for type W elements)

Straight rod or spiral elements

Type + (outer) dia./hot zone length/overall length/ nominal resistance. Example: Silit ED 25.4/455/1245/0.97 Ω

Types with thickened ends:
Silit VE, VE-3: Type + outer dia. hot zone/dia. cold end/hot zone length/cold end length/nominal resistance.
Globar DTEF: Type + outer dia. hot zone/outer dia. cold ends/ hot zone length/overall length/nominal resistance

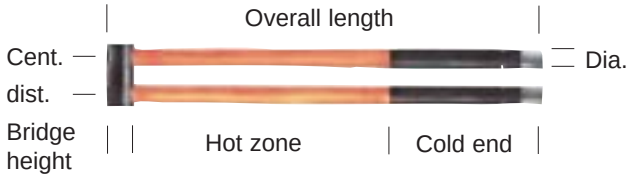
U and W type elements

Hot Rod type U

Type + (outer) dia./hot zone length/cold end length/centre distance/nominal resistance.
Example: Type U 19/305/255/38/1.1

Silit ED-U

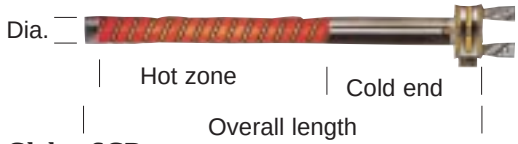
Type/(outer) dia./hot zone length/(bridge height + cold end length)/centre distance/nominal resistance.



Single ended spiral elements

Crusilite DS

Outer dia./hot zone length/overall length + DS/ nominal resistance. Example: Crusilite 35/450/800 DS/4.1



Globar SGR

Type/ Outer dia./hot zone length/overall length/ nominal resistance. Example: SGR 25/305/710/6.96

Systems and Services

Our broad range of resistance materials, finished elements, radiant tubes, construction material and other components cover almost any application up to 2000° C. You can get all your requirements from one supplier, as well as qualified technical advice.
We can also supply complete heating systems e.g. radiant tubes with integrated heating elements or inner tubes for gas heating, Fibrothal and Superthal heating units, Porqupine air heaters, Fibrothal complete systems for renovation of furnaces etc.
A complete system saves time and resources.

We can assist you

- in choosing suitable element material, element type, support systems and insulation
- with the design and calculation of the elements and heating system
- by supplying complete heating elements or heating systems ready for installation
- with the upgrading of old furnaces or the conversion of gas/oil heated furnaces to electricity

Kanthal® Super, Superthal
Complete element assemblies and heating units for max element temp 1900°C, 3450°F.

Wire and Strip
Kanthal and Nikrothal® highest qualitymaterial for max element temp 1485°C, 2590°F.

Metallic Elements
Ready-made metallic elements manufactured by Kanthal workshops.

Tubothal®
Long-life elements for all types of raiant tubes, ideally Kanthal APM, up to 1300°C, 2370°F, furnace temperature.

Extrudes Tubes
Kanthal extruded radiant tubes for gas or electriceally heated furnaces.

Heating elements
Elements and systems for diffution furnaces in the semiconductor industry.

Fibrothal®
A complete modular building system for heating and insulation.

Silicon Carbide
Hot Rod, Crusilite, Globar and mulitleg silicon carbide heating elements for furnace temp between 700 and 1650°C, 1290 and 3000°F.

KANTHAL

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