

0 1000 2000 3000

1700°C

# Ceramic foam debinding and sintering in one process

The Fraunhofer Institute for Ceramic Technologies and Systems (IKTS) in Dresden, Germany, carries out research into advanced ceramics, ranging from preliminary research through to a wide range of sophisticated applications. IKTS are involved in the development of industrial powder processing technologies and the manufacture of prototype structural ceramics, functional ceramics and cermet (ceramic-metal hybrids).

IKTS research has resulted in the development of an **innovative and complex ceramic foam material** which can be used in many industry sectors. Foamed ceramics are of particular interest for filtration and energy management applications, and also form the basis for ceramic carriers in the catalyst industry. They are ideally suited for the filtration of dust and liquefied material. Foamed ceramics provide the perfect combination of mechanical strength and low mass and are being utilized in metal matrix composites.

For their latest project, IKTS required a **custom designed, silicon carbide heated furnace with a working temperature of 1400°C and 35 l chamber capacity** for the debinding and sintering of ceramic foams. The custom design is based on a standard **CARBOLITE RHF furnace**, the range of which includes 4 chamber capacities: 3, 8, 15 and 35 liters and three maximum temperatures: 1400, 1500 and 1600°C. The production of foamed ceramics by combustion of polyurethane and organic binders produces gases, such as toxic cyanide, isocyanate or nitrogen dioxide, meaning it is necessary to subject the gas to a catalytic treatment to burn them off as fully as possible. The solution was to install an **after-burner comprising a modified tube furnace from CARBOLITE's G-range**, which is fitted with an inconel steel tube. This in turn is filled with a ceramic honeycomb with the catalyst on the surface. This makes it possible for toxic gases containing up to 150 g of polyurethane to be completely burned off. A fan with a capacity of 150 l/min to 250 l/min pulls the atmosphere through the tube furnace in which the catalyst is located, and the cleaned gases then enter the exhaust system at the Fraunhofer Institute.

*Custom designed solution based on an RHF chamber furnace and a G-range tube furnace*



The furnace system was developed as a **fully automated solution for the two-stage process of debinding and sintering**. For the debinding cycle, the furnace is slowly heated from room temperature to 600°C. During this time, the emitted gas is exhausted from the chamber and passes over the catalyst. However, it is vital to protect the catalyst whose temperature must not rise above 700°C.

To protect the catalyst during the subsequent sintering at 1290°C, the exhaust fan is switched off at a furnace temperature of 600°C. This ensures the catalyst is always kept at its ideal temperature, is not overheated and cannot be damaged by hot gases which pass over it. The furnace chamber temperature is monitored by a thermocouple; over-temperature protection with a separate circuit prevents the furnace from over-heating. In addition, a complex flip-flop control system ensures protection of the tube furnace heating elements. Even with the increasing temperature of the exhaust gases, the correct temperature of the catalyst is always maintained and the heating elements are not over-loaded.

## G-range tube furnaces

The G-range of tube furnaces offers a flexible solution for **heating samples of different sizes**, with a maximum heated length of 1200 mm. These furnaces do not have an integral work tube, but the use of tube adapters allows the same furnace to **accept a variety of tube diameters** up to 170 mm. The quick and easy exchange of tubes also permits using **different tube materials** and helps to prevent cross-contamination of samples. Whilst the after-burner offered for IKTS is based on a single zone vertical tube furnace, the **G-range is also available as a 3-zone version which provides an extended uniform zone**. The heated length is divided into three zones each with its own controller – the two end zone controllers track the centre zone temperature and compensate for the heat loss from the tube ends. Thanks to a range of tube end seals and insulation plugs the G-range can be modified for use with inert atmosphere and/or vacuum to  $10^{-6}$  mbar.



*The G-range tube furnaces are available in horizontal and vertical configuration*

## FEATURES

### Debinding and sintering furnace

- ◉ Very good temperature uniformity during sintering
- ◉ Adjustable suction volume with automatic cut-off for sintering process
- ◉ 'Flip-flop' protection for tube furnace elements
- ◉ Specific catalyst for burning PU
- ◉ Long-life catalyst
- ◉ Separate temperature control for chamber and catalyst

## FEATURES

### Tube and chamber furnaces

- ◉ Maximum chamber and tube furnace temperatures of 1100 – 1800°C
- ◉ Range of chamber sizes available
- ◉ Range of tube diameters and heated lengths available
- ◉ Element protection in chamber furnaces available