Fact sheet
Advanced Ceramics

January 2022

TECHNOLOGY REVOLUTION ON A SMALL SCALE: BOSCH DEVELOPS CHALLENGING CERAMIC MICRO-REACTOR IN ADDITIVE MANUFACTURING WITH KIT AND BASF

- Bosch Advanced Ceramics produces sophisticated ceramic microreactor for high-temperature applications using the 3D printing process.
- The reactor was developed in a joint project with BASF and KIT.
- 3D-printed technical ceramics withstand high demands of chemical reactions.

Immenstadt – Together with the Karlsruhe Institute of Technology (KIT) and the chemical company BASF, Bosch Advanced Ceramics has developed a complex micro-reactor made of technical ceramics for high-temperature reactions and produced it using additive manufacturing. Microreactors, which are often used, to research the fundamentals of chemical-technical processes, have to withstand the harshest conditions.

Only by combining the additive manufacturing method (3D printing) and the special material properties of the technical ceramics could the demanding technical requirements of the customer BASF ultimately be mapped. The use of additive manufacturing enables the design and construction of very small flow channels (0.5 mm channel width) for the chemical reactions inside the reactor.

(FIGURE 1: MICROREACTOR BASF/ KIT WITH INTERNAL CHANNELS/ CROSS SECTION)

Dimensions	
Component heigth	107 mm
Component diameter	16 mm
Channel width	0,5 mm
Bar dimensions	0,3 mm

TECHNICAL CERAMICS DEALS WITH SPECIFIC REACTION CONDITIONS

Due to its unique properties, such as strength, temperature-, abrasion- and corrosion-resistance, BASF and KIT chose aluminum oxide as material.

This material is ideally suited to meet all the requirements placed on the component. The heat resistance and high strength of the material allow it to work safely under extreme process conditions. The thermal conductivity of 37 W/mK allows good temperature control, and the material's low thermal expansion of 7 x 10-6 K-1 helps to ensure that only minor distortions occur in the apparatus, even with large temperature differences. In actual reactor design, this is particularly important with regard to the outer cooling jacket. In this area of the design, a temperature drop of several 100 K per millimeter occurs during operation.

Depending on the reactant inside the reactor, the corrosion resistance of the reactor is advantageous. A long service life can be achieved through the use of ceramics. This is also an important economic aspect.

Moreover, the low electrical conductivity and translucency of the ceramics make the interior of the reactor accessible to various measurement and control techniques that cannot generally be used with reactors made of metal.

Advantages of ceramic 3D printing:

- **Heat and corrosion resistance**
- **Low thermal expansion**
- **Electrical insulation capability**
- **Internal structures not possible with any other process**
- **High dimensional stability**

Fact sheet
Advanced Ceramics

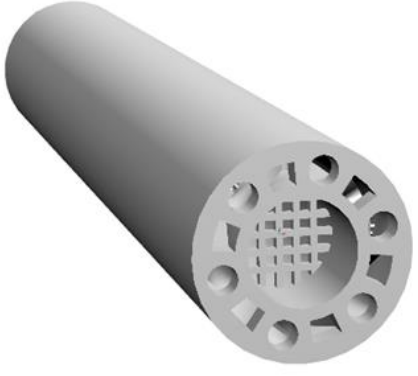
ADDITIVE MANUFACTURING ENABLES THE PRODUCTION OF COMPLEX AND AT THE SAME TIME PRECISE COMPONENTS

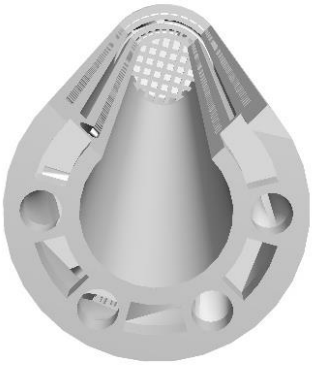
In principle, manufacturing by means of 3D printing involves higher costs than conventional techniques, such as injection molding, turning, milling or similar. Without additive manufacturing, a ceramic reactor with such elaborate internal structures could not be produced at a reasonable cost.

Only 3D printing thus makes it possible to redesign components, since structures specially adapted to the process or to the necessary function can be realized with greater flexibility - true to the principle of process-specific apparatus engineering. For the KIT and BASF microreactor, this means in specific terms that the temperatures and material flows in the reactor can be controlled particularly precisely with this structure, thus opening up new possibilities for optimizing reactions.

The competence of Bosch Advanced Ceramics in terms of mastering the manufacturing process and the know-how about necessary design adaptations, which ensure functionality and producibility, essentially contributed to a successful implementation.

MICRO-REACTOR:





(FIGURE 2: MICRO-REACTOR: WHOLE COMPONENT/ FIGURE 3: MICRO-REACTOR: CROSS SECTION)

Company profile

Bosch Advanced Ceramics
Robert-Bosch-Straße 1
87509 Immenstadt

Company profile

Bosch is world-renowned for its quality and precision in advanced ceramics for the automotive sector. Bosch Advanced Ceramics now enables the use of these advanced ceramics in new markets and offers functional ceramics for the food goods, industrial goods, electrical and medical sectors. The combination of innovative production capabilities and Bosch's proprietary materials makes it possible to produce unique and precise ceramic products for a wide variety of markets. The demand for ceramic products is continuously increasing: the requirement is higher complexity combined with precision and economy. At this interface, Bosch Advanced Ceramics sets the new benchmark with innovative production technologies.

grow platform GmbH
Groenerstraße 9
71636 Ludwigsburg
Germany

Bosch Advanced Ceramics
Phone: +49 711 811 - 13891
advanced.ceramics@bosch.com
www.bosch-advanced-ceramics.com