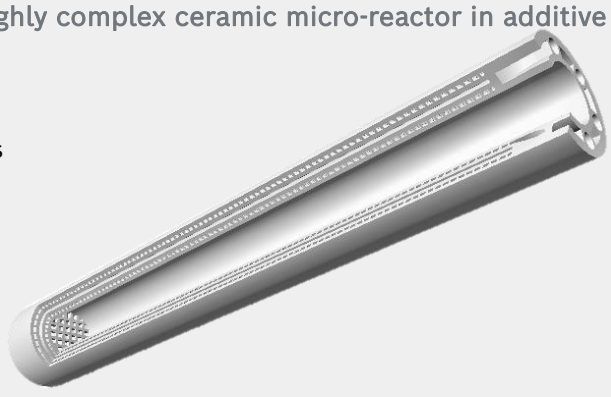
Fact Sheet
Advanced Ceramics

January 2022

Technology revolution on a small scale: Bosch develops highly complex ceramic micro-reactor in additive manufacturing with KIT and BASF

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



(Fig. 1: Microreactor BASF/ KIT with internal channels/ cross section)

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

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

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

Technical ceramics defy specific environmental conditions

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

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 regarding to the outer cooling jacket. In this area of the design, a temperature drop of several 100 K per millimetre occurs during operation.

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

Moreover, due to the low electrical conductivity and the translucency of the ceramics, the interior of the reactor is accessible for various measurement and control techniques, which in principle cannot 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

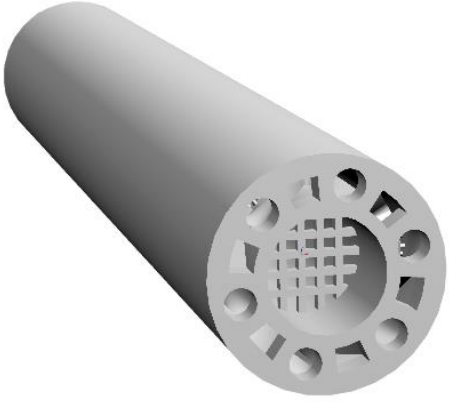
Additive manufacturing enables the production of complex and at the same time precise components

Because of the additional degrees of freedom in the production process of additive manufacturing, costs are fundamentally higher than with 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 effort, however.

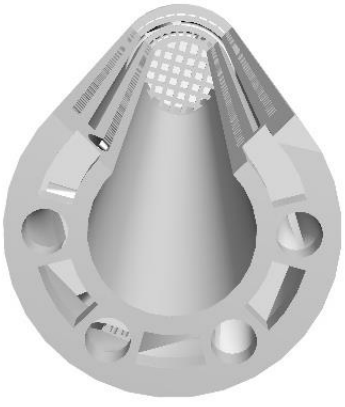
It is only 3D printing that makes it possible to redesign components, as structures that are specially adapted to the process or the necessary function can be realized with greater flexibility - true to the principle of process-specific apparatus engineering. For the KIT and BASF microreactor, this means in concrete terms that the temperatures and material flows in the reactor can be controlled particularly precisely with this setup, which opens up new possibilities for optimizing reactions.

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

Micro-reactor:



(Fig. 2: Micro-reactor: whole component)



(Fig. 3: Micro-reactor: cross-section)

Company profile

Bosch Advanced Ceramics
Robert-Bosch-Straße 1
87509 Immenstadt

Bosch is world-renowned for its quality and precision in advanced ceramics for the automotive sector. Bosch Advanced Ceramics now enables the use of advanced ceramics in new markets and offers functional ceramics for various industries like consumer goods, industrial, electronical and healthcare. 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. In this context, Bosch Advanced Ceramics sets new standards with innovative manufacturing 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