

# Additive Manufacturing of Ceramics – a New Technology on its Way to Series Production

The production of ceramic components at Bosch/DE has a tradition of more than 100 years. Back in 1939 Bosch had already filed the 1<sup>st</sup> patent application for injection moulding of Technical Ceramics. Since then, various manufacturing processes complying with the standards of the automotive industry have been brought to perfection at several Bosch plants. 3D-printing is one of the latest technology approaches.

One aim was to continuously adapt and refine the latest technologies such as 3D-printing. In this way, for several years now, Bosch has been active in the additive manufacturing of ceramic components using state-of-the-art technology, benefitting from its long years of experience in processing high-quality ceramics.

## “We are CERIX!”

CERIX is a Robert Bosch start-up that was founded in 2016. Expert knowledge and competence in ceramics manufacturing from within the company is pooled, providing components not only for internal Bosch business divisions, but also for external customers.

Based on the increasingly challenging technical specifications of various products used in fields such as medicine, chemical engineering, industrial equipment, sensor technology and the consumer sector, there is a significant potential to enhance considerably the performance of such products using technical ceramics. CERIX is able to offer solutions for technical challenges where traditional materials have long ago reached their limits.

## “We accompany our customers”

Customers are supported with extensive engineering expertise when defining a component design that is compatible with

### Keywords

*additive manufacturing of ceramics, 3D-printing, series production*



Fig. 1  
Twisted internal channels in a nozzle

ceramics production. The long years of experience in CIM technology create an optimal synergy with Additive Manufacturing (AM), as CERIX is able to produce highly complex components with consistent technical features, cost-efficiently as well as in small and large quantities.

Due to the fast growing demand in the field, the 3D-printing capacity is continuously enlarged.

The benefits of additive manufacturing are clear: zero tooling costs, as well as the possibility to implement design modifications at any time. That means for the customers

an unprecedented flexibility and new potentials in product design.

In close cooperation with the additive manufacturing OEMs, the further development of production techniques is propelled. Customers additionally benefit from the existing quality standards of the Bosch Group in use in various divisions.

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**From idea to the final additive product**

In general, the process starts with the CAD model. In close cooperation with the customer, the company develops a geometry of the component to satisfy all requirements. Now, new geometries such as internal channels or undercut that have not been accessible until now, using conventional manufacturing techniques, can be realised. The model can subsequently be printed via stereolithography.

The printing process is followed by a procedure to remove excessive material and to prepare the component for the subsequent process steps. Different strategies and techniques are applied depending on the material and the component geometry. Afterwards, the components undergo the same thermal process as CIM components. Once they are sintered, the components have all of the required features to meet the customer's needs.

In most cases, post-processing is not necessary as the process itself is already

very precise. However, some applications have especially narrow tolerances, which is where the company's competence in hard machining of ceramic components comes into effect. In this way, CERIX is able to offer its customer everything from a single source.

**Series production by means of AM**

The Bosch quality standard is the highest priority for CERIX. Therefore, the same standard as with each other manufacturing process is followed. Concretely, this means a continuous process capability study of all process steps from the CAD model to the sintered component. Each individual process to eliminate potential sources for error is analysed. Traceability is another major feature of the quality standard. The close collaboration with the plant manufacturers is beneficial for both parties to actively develop the 3D-printing technology together, from the prototype to series production by AM. The development of this production method has progressed enough that series



Fig. 2 Functional integration using the example of a self-aligning bearing

production using AM has become cost-efficient, and the first orders are already in production.

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