




M M C

Information

**Metal Matrix  
Composite**



## Material for high performance

The range of applications requiring lighter components is constantly growing. Lightweight design relying predominantly on aluminum but also on magnesium and titanium alloys, has become a standard feature in automotive engineering fields. Until now, weight reduction has reached its limits wherever components were required to withstand high mechanical, thermal or tribological loads .

The solution is to selectively reinforce lightweight components, at the point of maximum stress. Such composites made from metal and ceramics, referred to as Metal Matrix Composites (MMC), comprise a metal substrate (matrix) reinforced with hard ceramic particles. The outcome is a product that exhibits the benefits of both materials, low weight of metal on the one hand with the high performance of ceramics on the other.

Recent innovations have permitted a significant reduction in the production and machining costs associated with MMCs. As a global leader of technical ceramics, CeramTec has developed a process that allows lightweight MMC components to be efficiently and economically produced to the highest quality standards.

CeramTec's high-porosity ceramic preforms are infiltrated by the molten metal during casting of the MMC product. This provides a continuous transition between metal and ceramics reinforced areas. Our preform technology is opening a variety of new applications.



*Porous ceramic preform*

With CeramTec's leading expertise in the manufacture of ceramic cutting tools and hard machining know-how, a perfect finish to any MMC surface is possible.





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## Preform technology

CeramTec's MMC preforms are tailored to our customers needs and can be used with standard aluminum alloys. CeramTec offers a ceramic content between 35 and 70%, with grain and pore sizes being equally adjustable. For high performance products an additional hardening additive can be used to further improve the properties. Varied and complex geometries are possible with this production process.

### Customer example

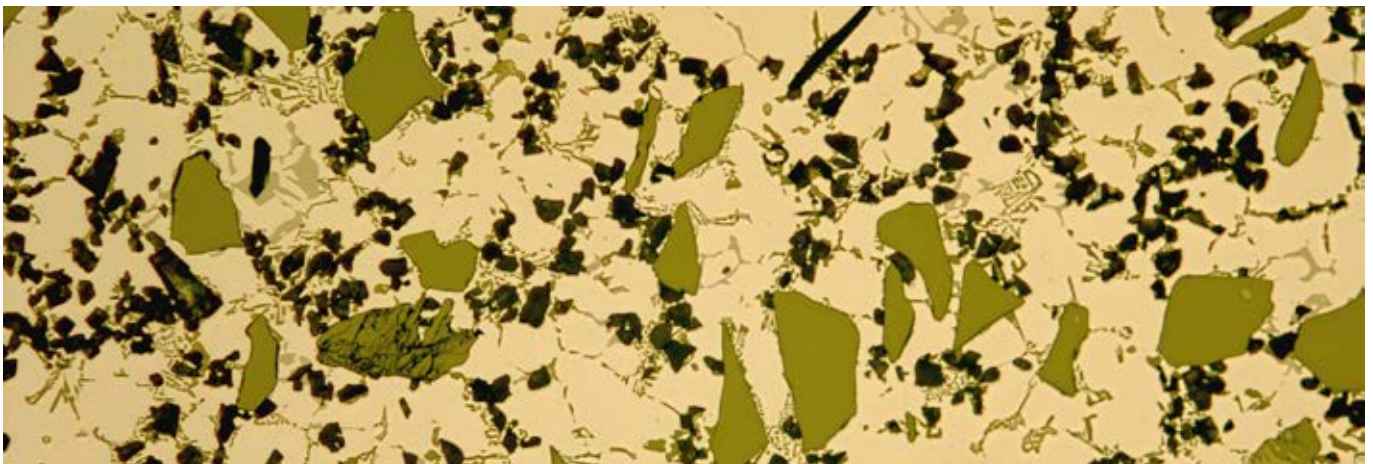
One of our customers asked us whether it is possible to increase the tribological and mechanical performance for a sliding surface. In comparison to a standard metal alloy, it was easy to adapt the MMC for the specified requirement.

Our solution was a preform that consisted of aluminum oxide and silicon particles. The aluminum oxide particles increased the mechanical properties of stiffness and strength. For a better sliding performance, silicon particles were used. The microstructure below shows the tailored material.

Our preform concept, in combination with our tooling know-how, offered an improvement in performance as well as lower total cost of ownership.

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## A Preform is a near end shape, porous, ceramic foam



Our preform portfolio shows a wide range of standard materials made from oxide and non oxide ceramics.

### **Silicon carbide (SiC) preforms**

For tribological optimization, a SiC preform is a perfect fit. Using a SiC preform gives higher thermal conductivity and enhanced abrasion resistance.

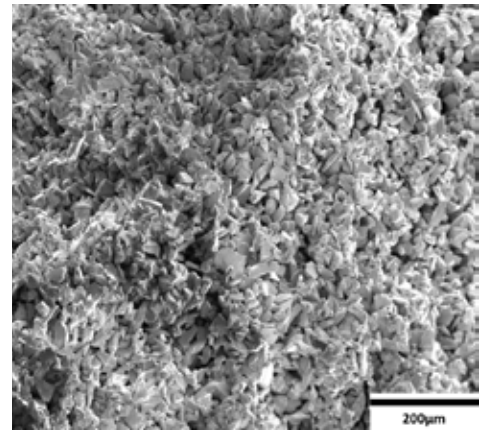
One example of Silicon Carbide MMC components are brake discs. Due to the enhanced abrasion resistance, MMC brake discs produce less brake-dust emissions, have a significant longer lifetime and a reduction in weight about 50% compared to regular grey cast discs.

### **Aluminium oxide (Al<sub>2</sub>O<sub>3</sub>) preforms**

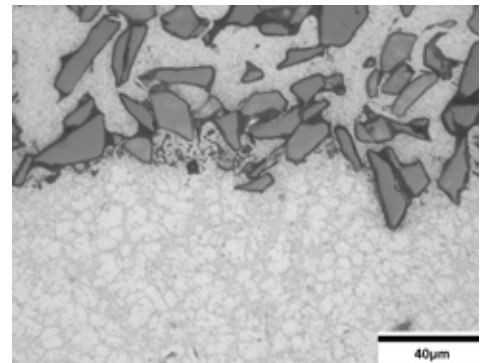
For applications with highly loaded mechanical components, an MMC made from an aluminum oxide preform is an excellent choice. This material shows high bending strength, increased Young's modulus and a good fracture toughness.

An example of MMC aluminium oxide preform application is a bearing bridge within an engine. Local reinforcement of the surrounding light metal area by the MMC gives the possibility of more complex designs and lighter weight due to the 100% increase in Young's modulus and 75% increase in strength.

Since the Thermal Expansion of the MMC and surrounding material are close together, less thermal stresses are introduced compared to a standard grey cast bearing bridge.



*Microstructure of an aluminium oxide MMC-Preform*



*Transition from reinforced area with a black secondary phase (top) and surrounding material (bottom)*

## **Machining**



Increasing the content of ceramic particles within the MMC preform can make more of a challenge for our customers subsequent hard machining processes.

CeramTec's expertise in the hard machining of ceramic materials and manufacturing of ceramic cutting tools ensures we have the knowledge to support our customers through their whole manufacturing process.

CeramTec also develops cutting tools for MMCs and provides opportunities with undefined cutting edges. We offer laser cutting services for high precision requirements and waterjet cutting services for faster material removal rates.



## Key features



„Decades of experience in manufacturing hightech ceramic products lead to this out-performing composite material. The best of two worlds we can offer from now on to our customers.“

*Dipl.-Ing. Jan Heidle  
Product Manager Machinery at CeramTec*

### What is a MMC

Metal-Matrix-Composite – a material composed of various phases, a hardener and a filler. For example, a light metal aluminum and a ceramic component.

### Where are MMCs used?

- Antenna waveguides in Hubble space telescope
- Commercial satellites
- Automotive e.g. cylinder liner and brake discs
- Aerospace e.g. rotor blade sleeve in helicopters

### Why should I use the preform technology?

This technology enables the customer to locally reinforce a product, which reduces tooling cost. High ceramic content up to 70% is possible. Combinations of several reinforcements are possible e.g. ceramic/ceramic or ceramic/hard metal particles.

### How does CeramTec support me as a customer?

CeramTec develops and manufactures tailored preforms to our customer requirements. We cater from a few pieces up to high volumes. Based on our deep material knowledge, we support our customers when it comes to implementation within their casting process.

CeramTec can offer our customers the full range of MMC know-how, both the preform and our tooling solutions.

### How to get in touch with our experts?

Via e-mail: [mmc@ceramtec.de](mailto:mmc@ceramtec.de)



### Typical applications:

- Lightweight construction
- Enhanced mechanical strength
- Increased hardness and wear resistance
- Enhanced tribology
- Increased Young's modulus
- Lower thermal expansion
- Adjustable thermal properties
- Improved fatigue resistance
- Higher oxidation resistance (of hard component)

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