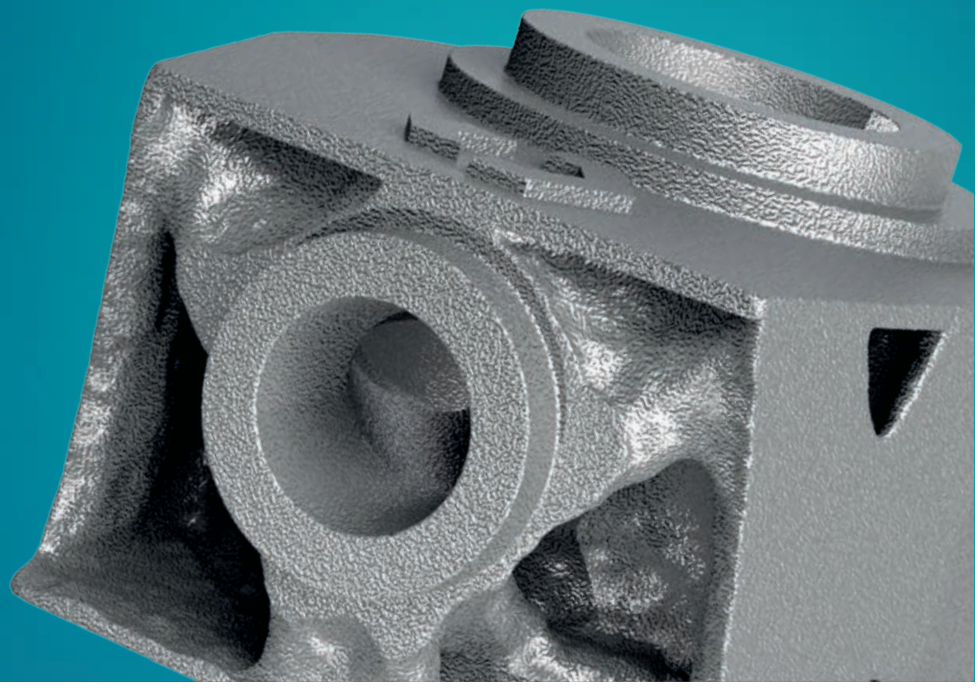
sgl carbon

# The future of design

## Topology optimization for additive manufacturing

### Customer benefits

- Computer-generated organic design with 35 % less material
- Radically new shapes with optimal performance
- Incredibly fast digital process chain from idea to prototype



## Form follows function

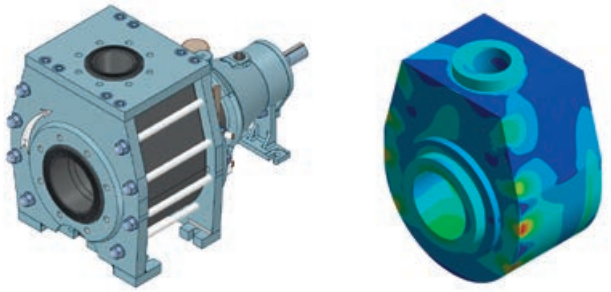
At SGL Carbon, we believe that smart solutions will require radically new designs. Thanks to additive manufacturing and topology optimization techniques, design approaches are set to change. To achieve radical improvements and incredibly fast design cycles from idea to prototype we use entirely new techniques.

With topology optimization, the material layout is determined by a set of applied loads, within a described design space. In contrast to conventional design approaches, a computer algorithm determines the optimal shape based on the set requirements. This technique results in non-intuitive organic forms that would be impossible to come up with otherwise. This technique is the driver for truly innovative designs.

## The case

- A pump insert needed to be redesigned for additive manufacturing with the ceramic carbon composite CARBOPRINT® Si
- The manufacturing constraints for the post-processing, in this case infiltration with liquid silicon were considered in the design process without the need for trial-and-error
- Topology optimization was used to take advantage of the design freedom of additive manufacturing and come up with a completely non-intuitive solution which was suitable for liquid silicon infiltration while also being optimized for weight and materials use

**Conventional design before optimization:** the assembly of the pump housing (left) and the conventionally manufactured solid pump insert (right) with visualization of mechanical stress from a FEM simulation.

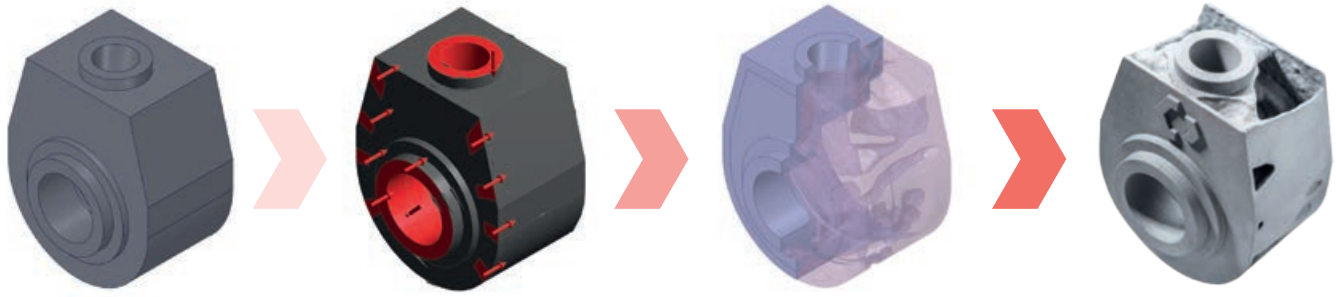


## Our Solution

In the design process, we started by defining the design space, the loads, and the constraints. We also considered the manufacturing constraints of the post-processing steps. Instead of manually designing a solution, we used a topology optimization algorithm to automatically compute an optimal shape based on the specified information and the material properties.

The obtained shape was smoothened and prepared for 3D printing using CARBOPRINT Si material in a binder-jetting process. In the final post-processing step, the 3D printed carbon was infiltrated with liquid silicon to form a ceramic carbon composite material with ideal properties for harsh environments and high temperatures.

## From idea to optimized prototype



**Digital process chain for creating radically new designs in extremely short timeframes. Optimized design of pump insert:** 35 % less material providing the same performance. The optimization results in radically new shapes that can be realized with additive manufacturing.

From left to right
- Initial solid design of the pump insert
- Definition of design space, loads, and constraints
- Optimal design with non-intuitive organic structures found by the optimization algorithm
- **New design printed with CARBOPRINT technology The new design uses 35 % less material providing the same performance.**

Need to improve your design?
Need to speed up your process chain from idea to prototype?
**Get in touch with our experts.**

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