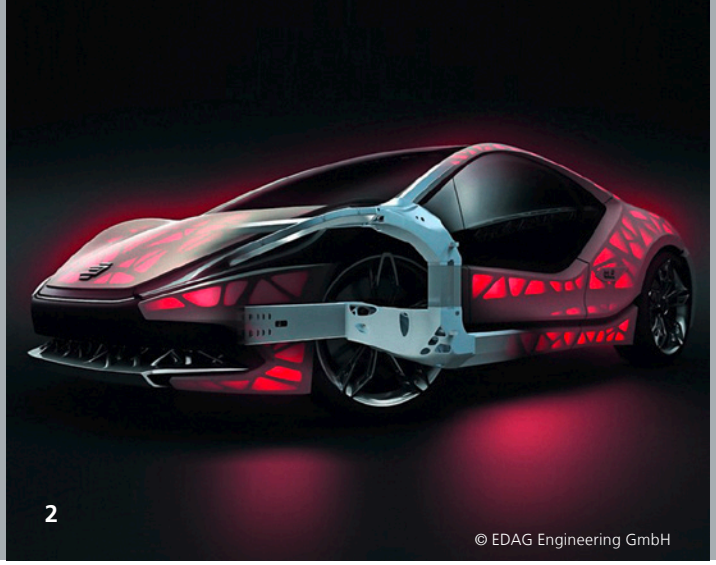

MODELING AND SIMULATING ADDITIVE MANUFACTURING BY SELECTIVE LASER FUSION

Additive manufacturing processes have become an integral part of the production of small-batch size, high-stress components such as blades or fuel nozzles for gas turbines. Besides aerospace, automotive manufacturing is predestined for the use of additive manufacturing methods because of the large variety of products. In the BMBF-sponsored project "CustoMat3D", we develop simulation methods in this area in cooperation with our partners.

1 *In selective laser melting, the portion of the powder layer belonging to the component is melted first and then the contour is traced for a better surface quality.*

2 *The car bodies of tomorrow are not only lighter, but above all highly flexible in design. The EDAG Light Cocoon concept car demonstrates the new possibilities of structural optimization opened up by additive manufacturing methods.*

New options and degree of freedom in design

The basic principle of additive manufacturing is the layer-by-layer manufacturing process, which eliminates many design limitations due to traditional production methods, like pre-determined tool paths or draft angles. This allows to make full use of the potential of end-use specific lightweight construction as structural components need no longer be of a generic design covering all possible load cases.

Today's aluminum alloys are generally not customized for a specific application and do not fully exploit cost and weight reduction potentials. Simulations reveal the interplay of material properties, design, and manufacturing processes. However, the optimal simulation approach is still the subject of ongoing research.

Custom aluminum materials for the automotive industry

Partners in the CustoMat3D project are: Daimler, Concept Laser, MAGMA, Fraunhofer IAPT, ECKA Granules, FKM Laser Sintering, Institute of Materials Science (IWT), and Altair Engineering. The project is funded within the BMBF project and research scheme "ProMat_3D". The project´s aim is to use simulation-aided development and qualification to create custom-made aluminum alloy materials for use in laser additive manufacturing for the automobile industry.

In cooperation with MAGMA, we are developing new approaches to simulate the extremely fast phase transitions and solidification process as well as the resulting material structures. To predict deformation, we take into account all relevant length and time scales. Specifically, we include:

- The details of the powder and melt pool in the vicinity of the laser.
- The effects of the punctiform influx of heat due to the laser on the residual stress and temperature distribution throughout the component.