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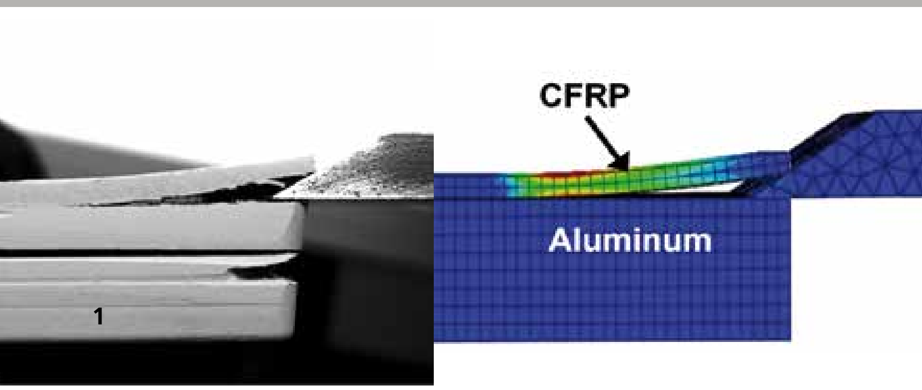
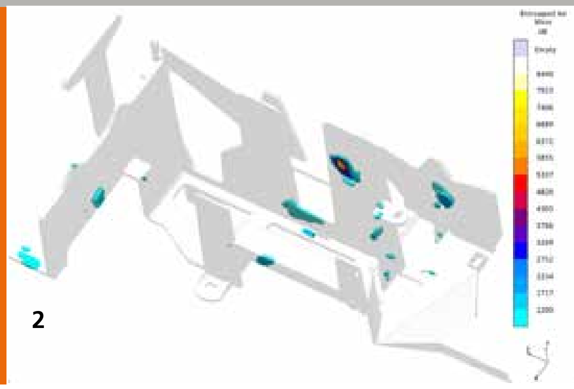




1 *Interface modelling of a hybrid composite system.*

2 *Casting simulation: Prognosis of the enclosed air amount as an error indicator during high-pressure casting.*

NUMERICAL SIMULATION – ILLUSTRATION OF COMPLEX SYSTEMS AND PROCESSES

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM
– Shaping and Functional Materials –
Wiener Strasse 12
28359 Bremen | Germany

Institute Director
Prof. Dr.-Ing. habil. Matthias Busse

Contact

Casting Technology and Lightweight Construction

Alireza Ebrahimi, M. Sc.
Phone +49 421 2246-7152
casting@ifam.fraunhofer.de

Dr.-Ing. Dirk Lehmhus
Phone +49 421 2246-7215
casting@ifam.fraunhofer.de

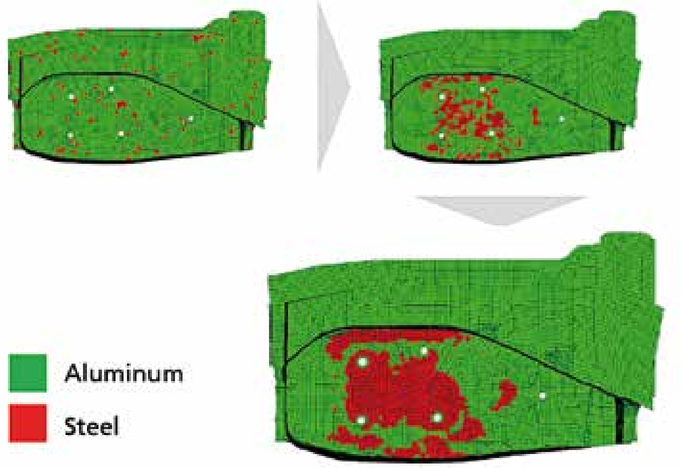
www.ifam.fraunhofer.de

Innovative approaches in casting technology such as compound casting or the manufacture of hybrid structures and materials in one casting process increases the functionality, efficiency, and lightweight construction quality of new products. Right from the start, these potentials require a joint consideration of the aspects of the materials, processes, and properties.

The Casting Technology and Lightweight Construction department offers its customers a wide-ranging support in the component and process simulation and optimization. The variety of available and partially in-house developed tools covers product and process development and supports the analysis of novel materials and structures. Used early on in the product development process, reliable simulations decrease the high costs of experimental investigations. The field of simulation considers this by reaching beyond pure component simulations to link process parameters with component properties, leading to the holistic evaluation of the product. Our competencies include casting simulation, load-suitable design of multi-material structures, deriving the influence of defects on component behavior, and recently also stochastic approaches. Of great importance for compound cast and hybrid components is the analysis of internal stress and interface properties. All approaches are increasingly being integrated into Industry 4.0 concepts.

Component design and computation

The department uses current software for FEM simulation and the optimization of components (Abaqus). Specifically for multi-material and hybrid structures, there are additional tools that enable the optimal distribution of materials in such structures. Multiphase topology optimization (MTPO) achieves a rigidity-optimized configuration through a repeated exchange of material elements and iterative FEM calculations.



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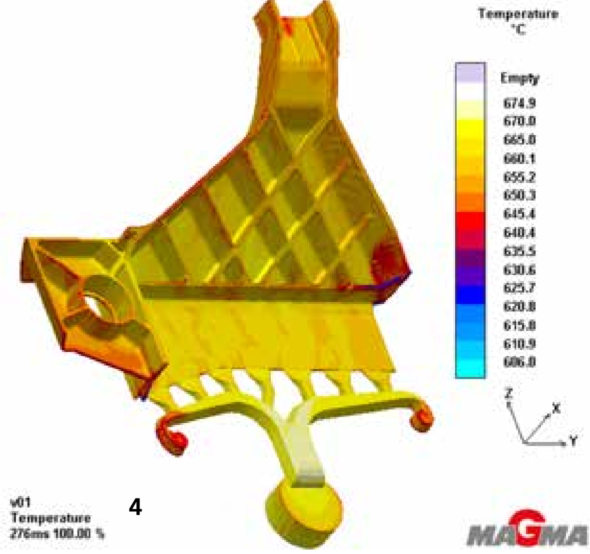

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Process simulation

The simulation of form filling and solidifying is indispensable in the design of casting tools and castings. The department uses commercial software packages to evaluate and optimize tools and processes (e.g., MAGMA, ProCast). Possible casting defects can thus be detected early on and can be influenced through shape and positioning. The resulting data are used in the assessment of the component behavior through FEM analysis. Thus, the department is developing stochastic approaches to describe the effects of defects and link these to the casting simulation.

Thermophysical data on casting and shaping materials can be derived experimentally or through thermodynamic modeling (e.g., ThermoCalc, JMatPro).

Material development and characterization

Composite materials and hybrid material systems pose new questions in material characterization and simulation. Thus, knowledge of the interface properties is essential for an understanding of the material behavior in material composites. At the macroscopic level, the department uses adapted testing processes with accompanying simulations to parametrize interface models for selected material combinations. At the microscopic level, the modelling of innovative materials (e.g., syntactical foams) is done via representative volume elements (RVE).

Industry 4.0: The digital twin

The connection of process features and component properties does not end with the component and process design. Industry 4.0 approaches are shifting the focus from the series to the individual component: Captured manufacturing parameters flow into a process-accompanying, component-specific simulation – a digital twin – which allows a more precise evaluation of the individual product. This allows, among other things, the targeted adjustment of downstream steps in the manufacturing chain, such as warping analysis and compensation.

CAD construction

Simulation and computation approaches require a digital imagery of the component geometry. Therefore, we also support our customers in the CAD construction (e.g., CATIA, Autodesk Inventor, Creo). A 3D-measurement system (GOM ATOS II) enables also the reconstruction of component geometries in the sense of a reverse engineering approach.

3 *Optimized distribution of the materials in multi-material components and structures via multiphase topology optimization (MPTO); comparison of multiple iterative steps.*

4 *Casting simulation: Temperature distribution in the casting after filling.*