Chair of Metal Forming and Casting
TUM School of Engineering and Design
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MMIC
Multi-Material Injector Casting

Final Report

Motivation

Conventional sequential process chains in gravity, sand and permanent mold casting do not offer the possibility to adjust local part properties during the casting process. The desire for tailored properties, i.e. the right material at the right place in the part, has so far been met primarily in semi-finished product manufacturing. In order to utilize the far-reaching advantages of tailored properties in gravity casting processes, the innovative Injector Casting process is used. This solves both existing problems, such as oxide skin in the casting, and at the same time offers the necessary further development potential for reproducible production of multi-material castings with local material properties out of two melts.

Approach

The aim of the research project is the reproducible production of a part with tailored properties in a multi-material injector casting process. (MMIC). Therefore, a testbench was designed and built at the utg. The interaction of the two melts allows free adjustability of the shape of the boundary layer between the materials. An example would be a combination of wear resistance in the working area and mechanical strength in the area of the connection points.

Especially the mixing of the melts due to density differences and turbulence is a challenge and required explicit modeling. For this purpose, extensive simulations were carried out in order to be able to estimate all relevant cause-effect chains. To validate the simulation results, a test rig for water model experiments was set up. These results were incorporated into the design of both the casting process and the control system.

Results and Outlook

Multi-material specimens were manufactured, and mechanical tensile tests were conducted for those specimens. Flow simulations using FLOW3D-WELD demonstrated the influence of density differences on mixing during the casting process.

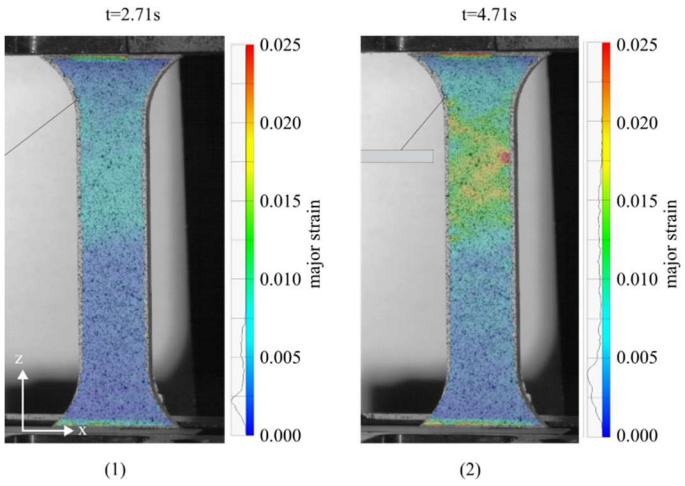

Figure 1 Tensile testing with DIC of multi-material specimens.

Publications

- 10.1088/1757-899x/1335/1/012026
- 10.1007/s40962-025-01809-y
- 10.1007/s40962-024-01289-6

Project run time

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Partnerships

University of Applied Science Augsburg

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