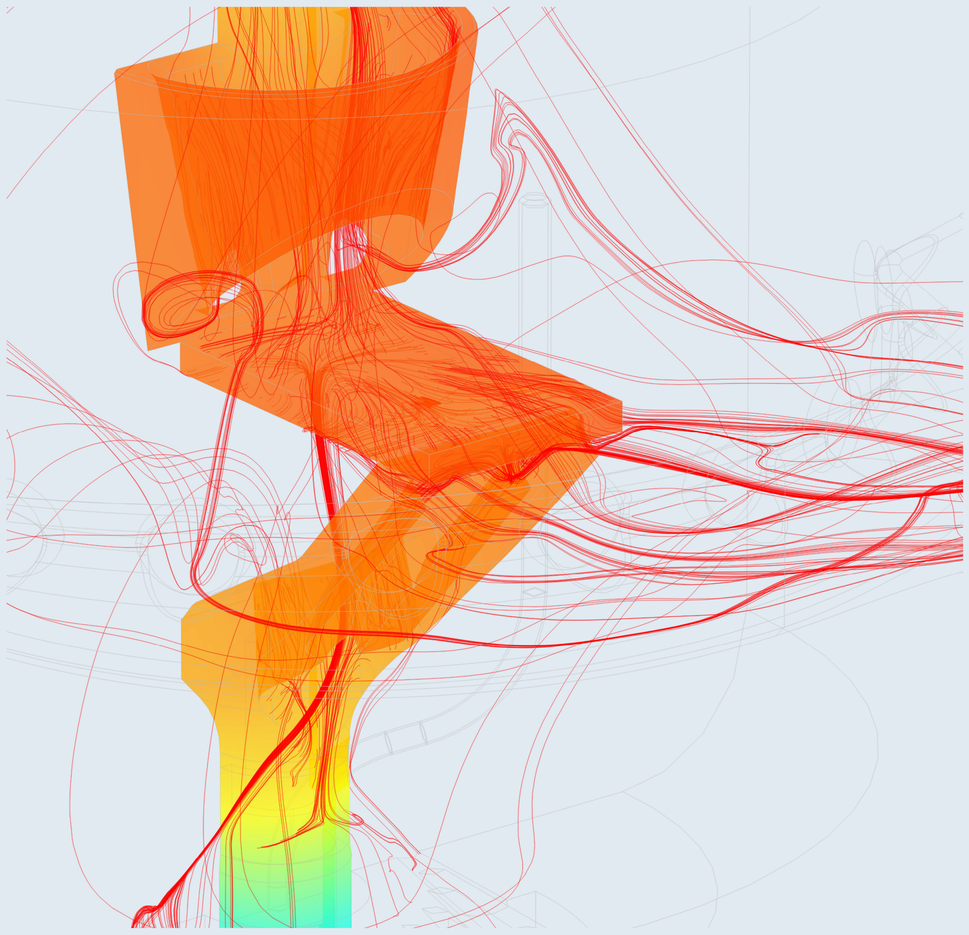

Simulation Driven Design of DMA Measuring Systems

Designing a modular measuring system means understanding the whole testing environment.

Simulation guides the design to consistent results under high variability of specimen and test conditions.

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Introduction and Goals

The Anton Paar Modular Compact Rheometer Multidrive series allows DMA measurements over a broad range of temperatures, from -160°C to +350°C thanks to the CTD600 convective temperature chamber.

The CTD600 has been designed to achieve the lowest gradients in the chamber, the same approach was needed to design a family of measuring systems for three point bending testing of specimens respectively 40, 20 and 10 mm long.

The simulation driven design process aimed to a complete understanding of the measuring scenarios, allowing a faster setup of validation, verification and design iteration.

The simulation twin makes further customized solutions easier to predict and design.

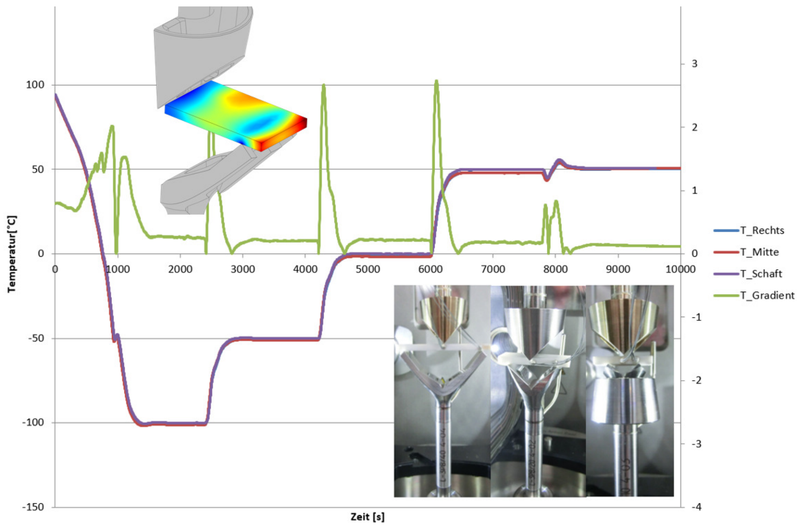

FIGURE 1. Verification of the model via testing of the manufactured prototypes by mean of a temperature sensing specimen

Methodology

The CTD 600 achieves its temperature range with air convection, the way the flow interacts with the specimen and the measuring systems is crucial to the development of hot and cold spots.

A combined heat transfer and turbulent CFD simulation with COMSOL® is set up for the whole testing apparatus and mirror symmetry is used to reduce computation time. The energy balance in the chamber and the flow boundary conditions are given from previous project simulations.

A verification of the prototype is used as validation of the model and allows scaling for the different types to design.

Results

The CFD simulation have shown how the measuring system can be used as an aerodynamic component to avoid acting as a heat shield for the specimen. A fine flow analysis let the designers produce a testing specimen to validate and ease verification for testing engineers.

As shown in the diagram, after a short transient due to different heating mechanisms of the specimen and measuring systems, the absolute temperature gradient in the specimen remains stable over the duration of the tests.

The gradients in the chamber and in the specimen have been tested to comply with international standards and offer reproducibility for all the measuring setups.

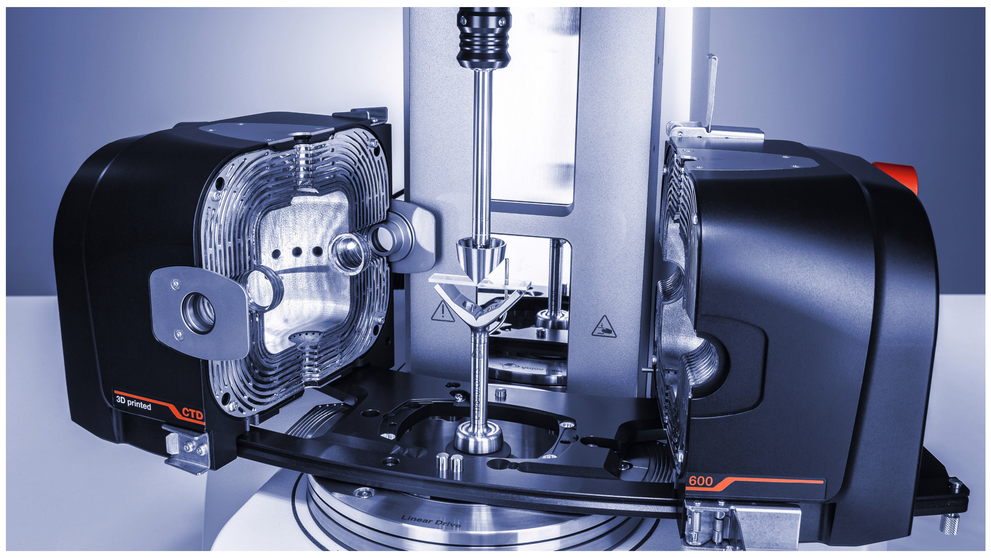

FIGURE 2. The full testing setup with MCR Multidrive, CTD600 and a three point bending measuring system for 40mm specimen

REFERENCES

International Standard, Plastics – Thermomechanical analysis (TMA) – Part 1, ISO 11359-1:1999

Anton Paar

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