The Parts Forecast for Tomorrow

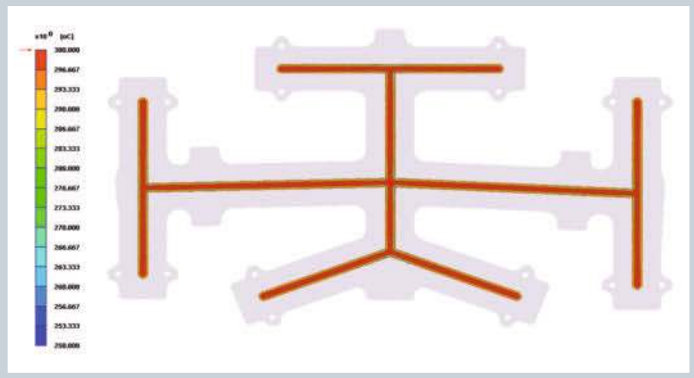

Fig. 1. Visualization of melt temperature in the hot runner (figures: SimpaTec)

Injection Molding Simulation. The quality of the forecasts made by simulation molds is improving all the time, with more and more specialist techniques entering the virtual world. Nearly every new release promises to deliver possibilities and features that will make life easier for designers and model makers – Release 11 of Moldex3D is no different in this regard.

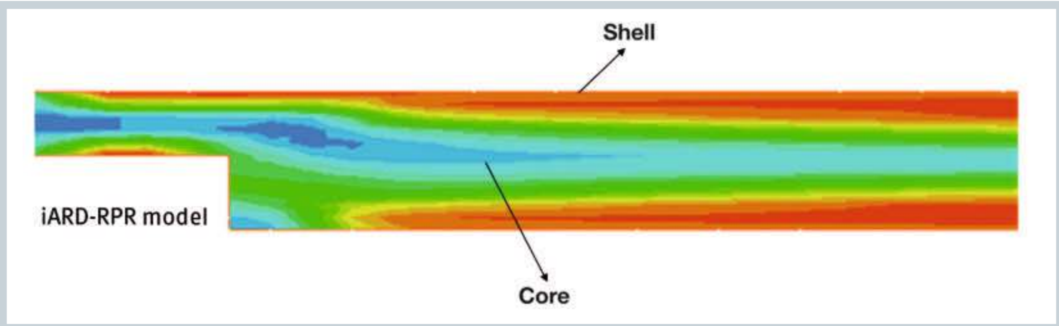

Fig. 2. Visualization of fiber orientation with the newly integrated iARD-RPR model. The colors indicate regions of extensive (red) and weak (blue) orientation respectively

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The new hot runner module in Release R11 from Moldex3D makes it possible to visualize all parts and types of hot runner systems, including complex geometries, clearly and in detail and to adapt them to production requirements. By providing information concerning the temperature distribution in the hot runner system **(Fig. 1)**, controlling the melt temperature via the heating elements, pressure drop calculations, and shear heating of the melt in the hot runner, it guides the user to make the interventions needed for operating a cost-efficient and economical hot runner system.

The Moldex3D Fiber module, which has been radically overhauled, accurately simulates 3-D fiber orientation and predicts the degree of anisotropy of fiber-reinforced injection molded plastic parts. The software developers have achieved this by integrating an iARD-RPR model **(Fig. 2)**. They have also provided support for the closure approximations IBOF (invariant-based optimal fitting) and ORE (orthotropic closure approximation model). For highly filled polymers, R11 features the micromechanical model developed by Mori Tanaka. Predictions for both chopped and continuous strand glass fibers have been improved. Fiber orientation is factored into the warpage analysis in order that anisotropic effects of the reinforced material may be simulated.

Microcellular Foaming of Plastics

A joint development agreement between Taiwan-based CoreTech Systems, which is the originator of the Moldex3D simulation software, and Trexel, Inc., the world's leading developer and marketer of the patented MuCell process, has led to the launch of a powerful module called Moldex3D MuCell for simulating microcellular foam injection molding. This process is ideal for producing complex parts that place high demands on dimensional stability. It entails adding supercritical fluids to the polymer melt, and then injecting the mixture into the cavity. The resulting pressure release causes bubbles to form in the polymer as it cools. Part weight can therefore be lowered, while load-bearing capacity and performance are enhanced **(Fig. 3)**. Other benefits to users are lower injection pressures and processing temperatures, shorter cycle →

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More on the topic

SimpaTec will be providing detailed information on all the new features and enhancements of Moldex3D R11 at **wfb** – the Trade Fair for Moldmaking and Tooling, booth no. C05, 13–14 June in Augsburg, Germany. See also **www.simpatec.com** times, and lower energy and material consumption.

However, the process is not without its risks: the introduction of the supercritical fluid into the melt affects flow behavior, material morphology and product surface quality. Steve Braig, President of Trexel, firmly believes that a reliable simulation tool offers the designer enormous assistance for the MuCell process in terms of mold productivity and efficiency.

Moldex3D MuCell uses fundamental computational models of the physics of bubble formation and bubble growth to visualize this complex technology realistically in three-dimensions. The module yields information on such parameters as bubble size and bubble number distributions, and predicts the filling pattern, weld line and weight reduction. Users thus have a realistic MuCell simulation tool which models the complex requirements and characteristics of the process for the various polymers, fillers and process parameters and renders them amenable to simulation.

Using DOE to Combat "Trial and Error"

The new Moldex3D DOE (design of experiments) module has been developed to enable optimum process parameters to be established rapidly and systematically – by means of DOE and without recourse to complex "trial and error" tests – from existing simulation results. Manual data input by the user is kept to a minimum. The module then performs independent, parallel iterations on the results using the Taguchi method. When finished, the program spits out statements about quality and response factors, and suggests an optimized process structure.

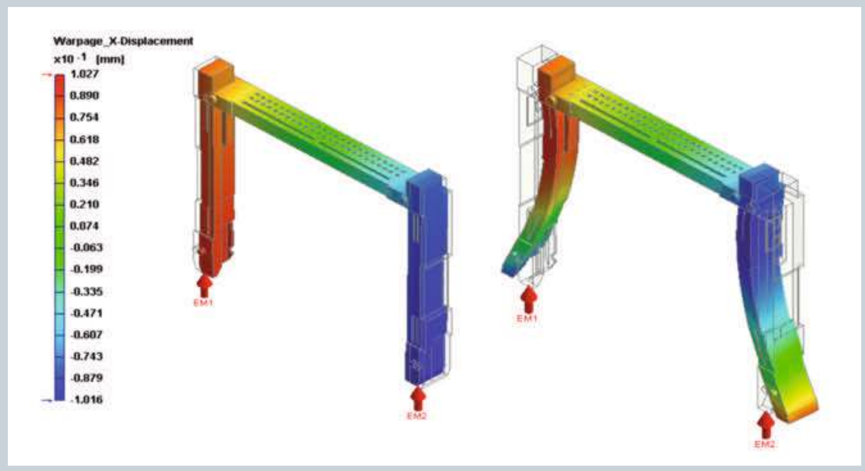

Fig. 3. Comparison of the dimensional stability of a MuCell component (left) and a conventional injection-molded part reveals the benefit of the foam structure (shown in ten-fold magnification)

For example, an injection molded part **(Fig. 4)** was found to undergo volumetric shrinkage of not more than 3.31 %. In an attempt to reduce this, the mutual influence of several process parameters on each other was calculated, namely: filling time (3.0 to 3.2 s), melt temperature (230 to 245 °C), holding pressure time (5.0 to 5.5 s) and maximum pressure in the holding pressure phase (70 to 80 %) were iterated in the specified range. Subsequent application of the DOE-optimized molding parameters reduced the level of volumetric shrinkage to a maximum value of 1.48 %.

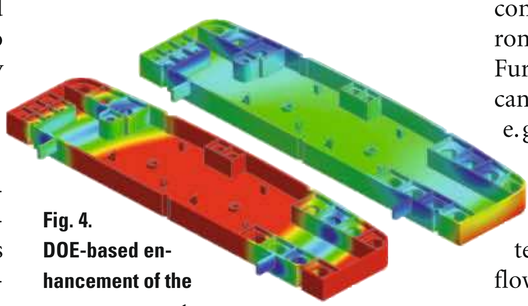

Fig. 4. DOE-based enhancement of the process parameters enables the volumetric shrinkage to be minimized (left: before the analysis; right: afterwards)

Simulating the Sandwich Process

Co-injection molding produces a plastic part comprised of a skin surrounding a core component. It can therefore be used to make products that have a high-quality skin, even if the core consists of low quality or recycled materials. A pleasant bonus of using recycled materials is the contribution which they make to environmental protection, and cost savings. Furthermore, the skin and core materials can be selected to meet the specification, e. g. damping and impact resistance.

As a decision-making tool, Moldex3D Co-injection **(Fig. 5)** generates results concerning the material interface and distribution in the cavity, flow-front patterns, penetration of the core material, and the skin break-through point. It also yields metrics such as injection pressure and clamping force for aid-

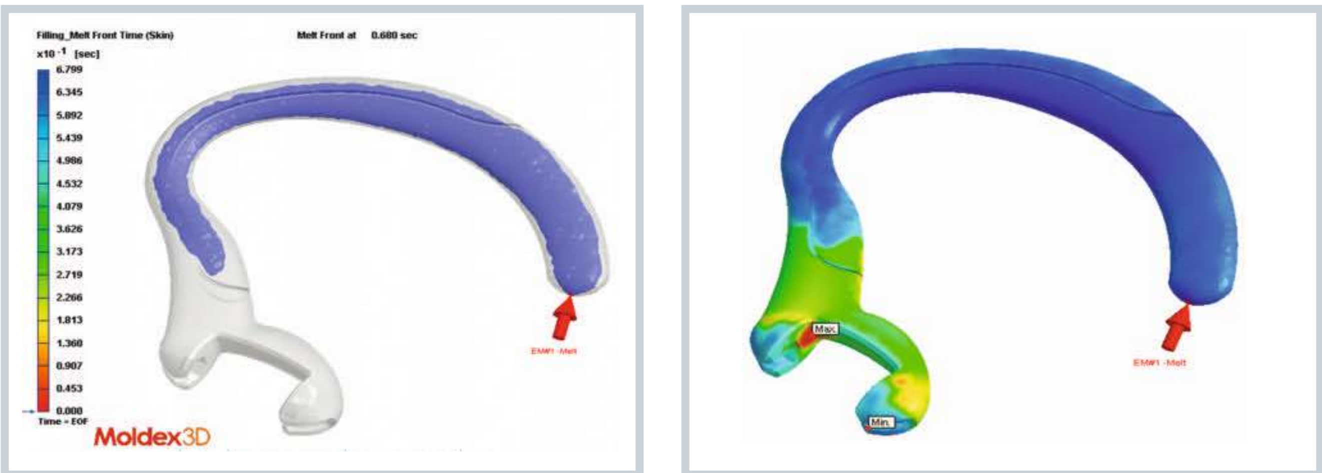

Fig. 5. Co-injection: The flow front of the core component during filling (left) and the distribution of wall thickness (right) for a headset

ing with proper machine selection. It can analyze potentially critical areas of high temperature and stress, and reveal possible deformation arising from the interaction between shell and core. Thus, the designer gains an insight into the complexity of the process and is able to optimize the manufacturing process and reduce development costs.

Fast, Real 3-D Results Support Economics

Moldex3D R11 boasts other enhancements and new features, e.g. a specially developed structural-mechanical tool (which is based on linear-elastic principles and incorporates relevant information such as weld lines and fiber orientation into the simulation); geometry changes without the need for external CAD programs; a new effective mesh generation capability for better-quality simulations; and the use of tracer particles to depict mold filling. It is now possible for the first time simulate the flow behavior of the coolant within the injection molding simulation in true 3-D by means of CFD analysis and to optimize it to requirements. Furthermore, crystallization can now be visualized during filling, and in the holding pressure and cooling phases. R11 also supports a core shift analysis to simulate deflection of part inserts due to imbalances in filling pressure and so helps the injection molding process to be optimized.

Parallel computing capability significantly increases the economics of a process. Moldex3D exploits all the advantages of multi-core or CPU hardware configurations – local, cluster or graphics processing units (GPUs) – to speed up simulation and shorten the time needed to achieve results and solutions aimed at optimizing the manufacturing process. ■

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