«Continuous product and process innovations is the key to face the future market challenges.»

Prof. Dipl.-Ing. Bruno Bürgisser, professor for Plastics Engineering at the HEIA-FR, member of HES-SO, Director of the iRAP-Institute

The Institute for Applied Plastics Research (iRAP) in Fribourg disposes of the specific know-how and equipment in the field of Ceramic Injection Molding (CIM) to support industrial partners in the development of innovative products and solutions.

Ceramic Injection Molding (CIM) for high-end applications

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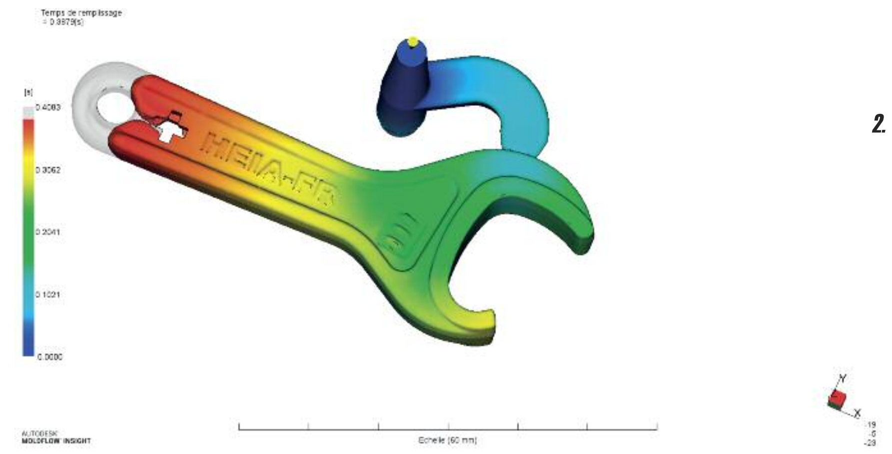

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The Institute for Applied Plastics Research (iRAP) is attached to the School of Engineering at Fribourg (HEIA-FR), member of the University of Applied Sciences and Arts of Western Switzerland (HES-SO). iRAP institute pursues the goal of developing innovative and economical products and processes in collaboration with industrial partners. The institute offers core competencies in the fields of plastic product development, injection molding, micro and nanostructures, compounding and high added value materials such as magnetic or electrically conductive plastic compounds. In addition, the institute disposes of key competencies in the field of Ceramic Injection Molding (CIM).

Ceramic Injection Molding (CIM) is a net-shaping process which enables the large-scale production of complex-shaped components for diverse industrial applications. This technology combines the advantages of the economical plastics injection molding process and the interesting physical properties of ceramics. The injected feedstock is a compound of a polymer matrix and ceramic powders such as alumina (Al_2O_3), zirconia (ZrO_2) or silicon nitride (Si_3N_4). After injection molding, to take of the polymer matrix and densify the part, the product is placed in ovens for the debinding process and sintering. The end product is composed of pure ceramics and therefore offers unique properties in terms of mechanical stiffness and wear resistance. This makes the parts suitable for applications under extreme conditions like high temperatures, corrosive atmospheres, abrasive conditions and high mechanical stresses.

Furthermore, the excellent biocompatibility and the good resistance to sterilization makes ceramic parts interesting for applications in the medical sector.

As explained above, CIM is a complex multi-stage process. For achieving high and stable component quality, all process steps must be fully mastered.

In recent years, iRAP has carried out many projects in the field of Ceramic Injection Molding. These projects focused for example on the production of complex internal geometries that are difficult to demould. Figures 1 and 3 show the development of innovative products by combining CIM and overmolding technology which allows for assembling two different parts. Furthermore, we aimed at exploiting the achievable limits of microstructure replications applying CIM technology, the increase of mechanical properties and density of injected ceramic parts and the impact of the different processing parameters on the part quality and process stability.

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1. Ejection of the demonstrator part showing the feasibility for integrating a logo to a CIM part through overmolding.

2. Numerical simulation of the mold filling during the injection process of a ceramic feedstock.

3. The four basic steps of the CIM process: feedstock preparation, injection molding (green part), debinding (brown part) and sintering (sintered part). In addition, the part integrates a logo by overmolding.

4. Close-up showing the precision for integrating a logo to a CIM part through overmolding.

Today, the machining of an injection mold for industrial ceramic injection molding is very time-consuming and expensive. During a specific industrial project, iRAP has evaluated possible ways to reduce both by rapid tooling. A solution has been developed in which prototypes of injected ceramic parts can be produced within only 2 weeks with a high reduction of tooling costs.

Furthermore, in the context of industrial projects, the iRAP has also built up specific knowledge and expertise in numerical simulation (Figure 2) and has acquired state-of-the-art CIM equipment. The iRAP institute is able to carry out the product or process development and accompany the industrialization of the product on the site of the industrial partner. Finally, iRAP works currently with some industrial partners to develop new high-end applications, such as instruments, tools and implants for the Medical sector.

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