

## Production processes for high-performance applications

# Thermoset injection and transfer molding

Thermosetting (crosslinking) polymers have several advantages compared to thermoplastics in terms of their chemical and temperature resistance. They are an attractive, high-performance material for demanding application conditions. For example, die-cast aluminum can be partially replaced by thermoset compounds based on phenolic and epoxy resins, leading to a reduction in both weight and costs.

### Materials

Fraunhofer ICT focuses on the processing of granular thermoset molding compounds (see figure 1). Depending on the field of application, the molding compounds contain a filler and fiber fraction of 40 to 80 wt.-%. Predominantly inorganic fillers (milled glass, mineral fillers) and glass fibers are used for structural applications. By combining thermally conductive fillers with low-viscosity resins, attractive applications in the electromobility sector are possible, for example the gentle overmolding of sensitive electronic components.

### Process and equipment at Fraunhofer ICT

The entire process chain from the raw materials to the final parts is available at Fraunhofer ICT. Laboratory-scale and pilot-scale extruders with adjustable process layouts can be used to tailor the material to the specific application and to meet challenging process requirements. For the processing of fiber granular thermoset compounds, injection molding machines of different sizes are available at Fraunhofer ICT (e.g. Krauss-Maffei 550/2000 GX shown in figure 2). In addition to the injection molding machines, transfer molding equipment for large injection volumes of up to 1200 cm<sup>3</sup> is also available.

### Advantages and applications

Thermoset molding compounds are highly adaptive performance materials for specialized applications. They have excellent thermomechanical properties ( $T_g \approx 250$  °C with post-curing process) and chemical resistance against automotive fluids such as water-glycol cooling water and oils. Tailoring the material to the application is possible due to high fiber and filler contents of up to 80 wt.-%. With low mold filling pressure of  $p \approx 10$  bar, sensitive parts such as electronic components can be overmolded. Injection molding (see figure 3) and transfer molding process are well-established, highly productive manufacturing processes.



1 Phenolic resin granules.



2 Fully automated injection molding machine to process granular thermoset molding compounds.

## Research topics at Fraunhofer ICT

With our extensive design experience, we develop ground-breaking new applications together with our partners:

- CAD and CAE-supported design, simulation and product validation
- Process simulation in collaboration with Karlsruhe Institute of Technology (KIT)

Using our state-of-the-art processing equipment for thermoset injection molding and transfer molding, we conduct research on the following topics:

- Injection molding process development for increasing the fiber length in reinforced thermoset molding compounds to improve the mechanical properties of thermoset parts.
- Compounding of tailored material formulations for specific applications.
- Development of new applications in the electromobility sector, such as increasing the degree of function integration of electric traction motors (see figure 4).
- The sustainability of thermoset materials is increased by material recycling (e.g. regrinding) and process efficiency improvements (e.g. active cavity balancing for multi-cavity injection molding).

## Machinery – Compounding and material development

- Laboratory-scale and pilot-scale extruders with adjustable process setup
- Flexible dosing for granules, powders, fibers and liquids
- Analytical techniques for flow-hardening characterization (orifice flow test, differential scanning calorimetry, rheology)

## Equipment – Injection molding

### KraussMaffei 550/2000 GX

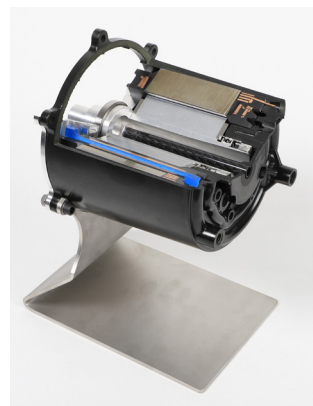
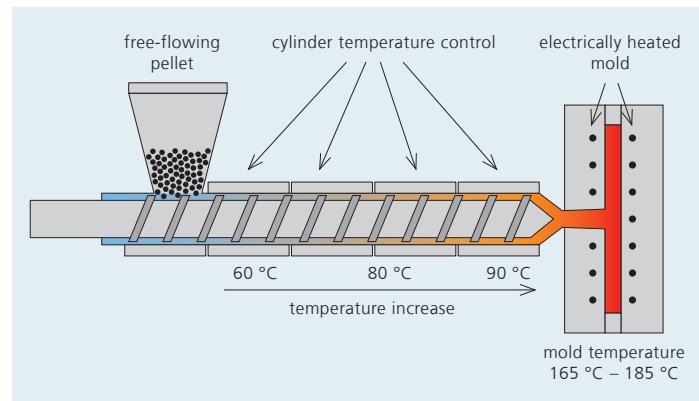
- screw diameter 60 mm
- max. dosage volume 792 cm<sup>3</sup>
- max. injection pressure 2430 bar
- max. injection volume flow rate 848 cm<sup>3</sup>/s
- clamping force 5500 kN
- comprehensive functions for injection-compression molding

### Arburg 320 C 600-250

- screw diameter 30 mm
- max. dosage volume 106 cm<sup>3</sup>
- max. injection pressure 2470 bar
- clamping force 600 kN

## Equipment – Transfer molding

- injection volume 1200 cm<sup>3</sup>
- clamping unit opening distance 1600 mm
- clamping force 1000 kN



3 (above) Plasticizing unit for granular thermosetting molding compounds.

4 (left) High-performance electric motor for traction applications (Fraunhofer ICT).

## Contact

Robert Maertens | Polymer Engineering  
Phone +49 721 4640-304  
robert.maertens@ict.fraunhofer.de

Fraunhofer Institute for Chemical Technology ICT  
Joseph-von-Fraunhofer-Strasse 7  
76327 Pfinztal (Germany)