

# Previously Unheard-of Technology with Even More Potential

## *Inductive Mold Heat-Balancing: From Full Mold Surface Replication to Material Savings*

Inductive mold heat-balancing in injection molding machinery is an “all-around talent”. It can be used to remove typical visual defects, create attractive designs in a cost-effective one-shot process, or save material and cycle time. KraussMaffei and Roctool are cooperating to advance this technology around the globe.



Exciting surface effects can be created with the inductive mold heat-balancing (right) offering new design options in comparison to conventional processes (left)

(© KraussMaffei)

Those who want to remain competitive in the market as a plastics processor will undoubtedly be confronted with a wide range of technical and economic challenges. First of all, immaculate parts must be produced, and here, the development of joint lines or the warpage of geometries can quickly cause rejects. Thin-wall articles may not be completely filled, or a pattern inserted into the mold may be hardly visible on the plastic part itself. Add to this the costs. Engineering plastics, particularly temperature-resistant plastics, are expensive, and the reductions in wall thickness impose many limits from a process technology standpoint. And in some applications, even comparatively simple designs force one to use cost-intensive finishing processes.

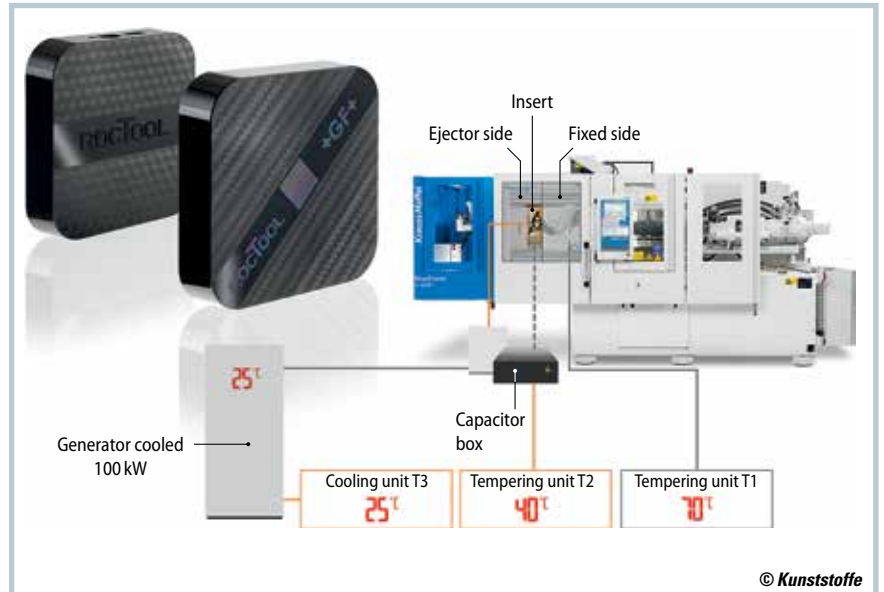
A possible solution approach for all of these challenges offers the inductive mold heat-balancing, i.e. targeted, cyclical heating of precisely defined areas of the injection mold. With

this variant of dynamic mold heating, you can eliminate your manufacturing problems, utilize your savings potential and create attractive surface effects. On the market today, many different variants of dynamic mold heat-balancing are available, some with ceramic inserts, water/water or water/steam systems, or others even featuring laser-based technologies. In terms of heating dynamics and maximum achievable temperature, however, all fall short of the “HD Plastics” (High Definition Plastics) inductive technology patented by Roctool.

The possibilities for use are so diverse that the French mold specialist Roctool and the engineering company KraussMaffei, Munich, Germany, have sealed a collaboration (Global Collaboration Agreement) to tap into new markets all around the world. The two partners have already worked together in the past. The HD plastics technology and the injection molding machines »



**Fig. 1.** Interior car part with unique laser texturing (© Roctool)



**Fig. 2.** The user can conveniently control different temperature zones with the complete system from KraussMaffei (source: KraussMaffei)

## Advantages of the Technology

With the possibilities that inductive mold heat-balancing brings, there are almost no bounds to the imagination, and the era of this process is just beginning. Even today, it offers a simple and efficient solution for many issues in everyday manufacturing. It improves image precision and, as such, enables the attractive decoration of articles through the cost-effective one-shot process. Component defects, such as joint lines and insufficient filling, can be eliminated, and foamed parts can thus achieve a high-gloss surface. Due to the partially increased flow capacity, walls can be designed to be thinner, and recycled plastics are now also an attractive option for visible parts. The partnership between KraussMaffei and Roctool enables newcomers to get on board with this technology comfortably – and with the security of a global service network.

- [www.roctool.com](http://www.roctool.com)
- [www.kraussmaffei.com](http://www.kraussmaffei.com)

## The Authors

**Dipl.-Ing. (FH) Jochen Mitzler** is Head of Strategic Product Management for KraussMaffei Technologies GmbH, Munich, Germany; [Jochen.Mitzler@kraussmaffei.com](mailto:Jochen.Mitzler@kraussmaffei.com)

**Mathieu Boulanger** is Chief Executive Officer for Roctool S. A., Le Bourget du Lac, France; [Matt.Boulanger@roctool.com](mailto:Matt.Boulanger@roctool.com)

## Service

### Digital Version

- A PDF file of the article can be found at [www.kunststoffe-international.com/4262814](http://www.kunststoffe-international.com/4262814)

### German Version

- Read the German version of the article in our magazine *Kunststoffe* or at [www.kunststoffe.de](http://www.kunststoffe.de)

from KraussMaffei are therefore already well adjusted to each other. These diverse possibilities for use include surfaces of new components and new component and device classes from various industries, such as the automotive (**Fig. 1**), electronics, entertainment and sports/leisure industries. Examples of typical finished products include housing panels for coffee machines, automotive interiors, computer laptops, wearables or gaming accessories.

## Copper Wires Run through Drill Channels

In the case of inductive mold heat-balancing, close-to-contour cooling and drill channels are introduced just below the molded part surface. Engineered induction copper wires run through these drill channels, which is connected with a generator by means of a capacitor box. Similar to the induction oven, as soon as current flows, an electromagnetic alternating field is generated within the channels, which induces eddy currents. The tool steel converts the energy of this magnetic field into heat, heating rapidly the mold surface by conduction. In this manner, temperature increases of up to 25°K per second and maximum temperatures of 400 °C are possible, while the additional energy costs in comparison with other methods remain low. Inductive heat-balancing can be used in one or both mold-halves and different temperatures can be generated on either side.

With the support of KraussMaffei and Roctool, the user can enter into the use of new technologies easily and obtain completely equipped production cells. Next to the injection molding machine and automation, this also encompasses the generator for the operation of the inductive heat-balancing and a package for the provision of engineering services for the parts design and mold design (**Fig. 2**). This lets you use the technology for the three main areas of application: The elimination of typical injection defects, conserving material and optimizing cycle time, and reaching new surface designs.

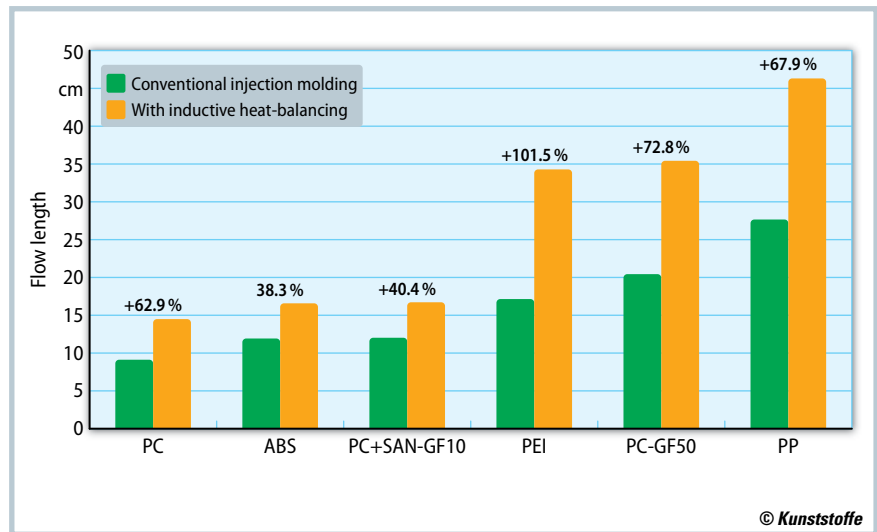
### Say Goodbye to Joint Lines and Fault Patterns

In a conventionally operated mold, joint lines form when the plastic that touches the steel contour cools faster than the inner "core" – at the point where cooling melt flow fronts meet one another. They are clearly visible, as they show a divergence in color or a different degree of gloss on the finished product. In addition, the component can be so weakened at this spot that it breaks later in use. If the mold temperature is increased here in some places – and the cooling of the material is reversed before the flow fronts meet one another – the surface and function remain pristine.

Mechanics and rheology determine the minimum wall thickness of an article. For optimal material consumption, the product should be as thin-walled as possible. However, often the filling of the cavity is not entirely successful, because the plastic cools and solidifies beforehand. For example, this can be the case in corner areas and display border areas. Through inductive heat-balancing, and depending on the polymer used,

the flow capacity improves up to 100%, and the filling is absolute (Fig. 3).

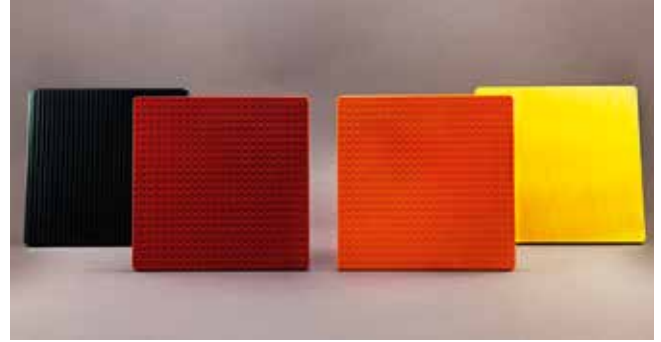
Here, the door is opened to component optimization. If walls or ribs can be designed to be thinner, this not only reduces the risk of sink spots (the material remains hot in the mold and »



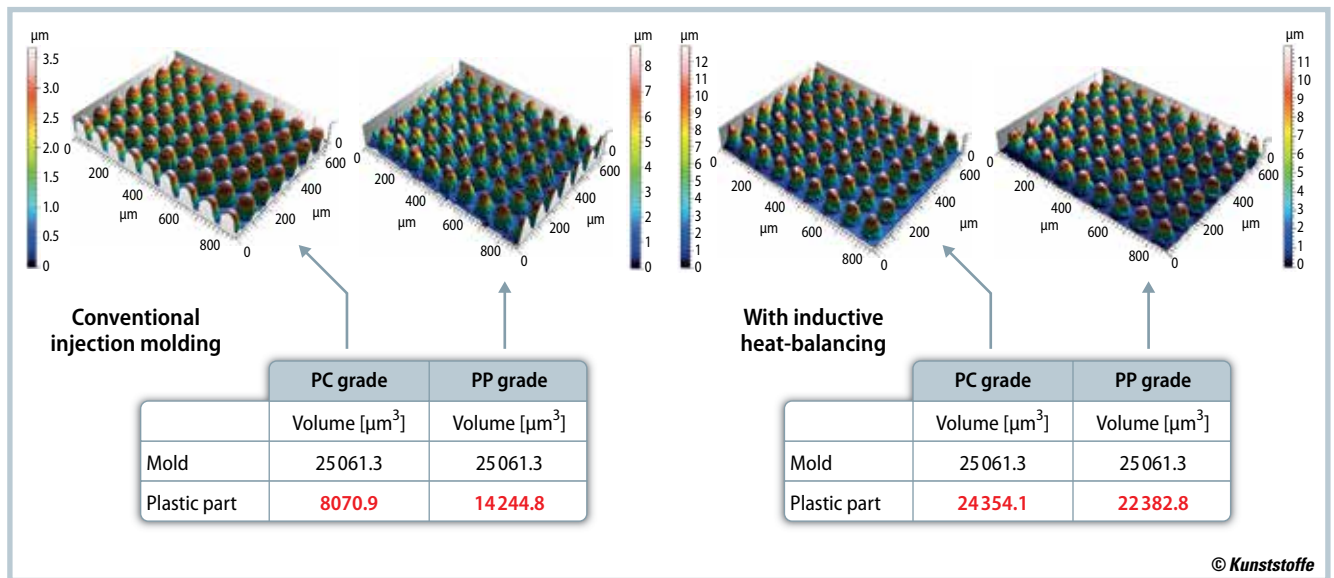
**Fig. 3.** The dynamic mold heat-balancing (here for 1.5 mm wall thickness and 1000 bar injection pressure) improves the flow properties of up to 100% depending on the material (source: Roctool)



**Fig. 4.** Unblemished high-gloss surfaces can be easily produced with the inductive mold tempering process (© Roctool)



**Fig. 5.** The dynamic mold heat-balancing enables a better surface quality with a large color range and no additional painting (© Roctool)



**Fig. 6.** Radical surface quality enhancement with precise mold surface replication. The result is significantly improved properties of the component surfaces, left: 57% max. replication, right: up to 97.2% replication (source: Roctool)

thus packing can be hold) and material accumulation, but potential cost savings may arise. As such, thinner walls means shorter cycle times and less material, as well as lower costs. These material savings can quickly reach considerable proportions, especially in products that are continuously exposed to high temperatures throughout their service life, such as those in engines

or water boilers, where plastics are increasingly being substituted for metal. After all, the price of a kilo of heat-resistant plastics is estimated at around 25 to 20 EUR.

### High Gloss for Glass-Fiber-Reinforced Plastic and Foamed Parts

If any transparent article stress areas or joint lines are present, function is impeded. Display windows will not be able to offer a clear view and in the case of fiber optics, performance capacity is minimized. Requirements are becoming more stringent all the time for the light design of the modern car interior, and as such, the components require absolutely reliable light conduction and light spreading properties. With the use of inductive mold heat-balancing, these products are defect-free and have no stress marks. Even the manufacturing of ultra-thin lenses is possible with it.

Up until now: Fiber-reinforced and foaming plastics did not deliver an attractive surface because, for example, structures or streaks would show from the results of escaping gas (foaming agent at foam injection molding) through the enclosed fibers. At the problematic points, processors can increase the mold temperature by means of induction, which is possible with both

materials mentioned above, as well as with high-gloss surfaces (Figures 4 and 5).

### *Hologram and Soft Touch without Film and Coating*

In design, inductive mold heat-balancing even enables the option to implement appealing effects in the cost-effective one-shot process – completely without downstream finishing steps. Degree of gloss is one example. If different matte and high-gloss surfaces are combined, the effect is often not as brilliant as intended without targeted heat-balancing, because fine structures in the mold are insufficiently reproduced by the cooling plastic.

Under the microscope, this phenomenon is clearly visible and measurable (Fig. 6). Eroded surfaces are classified according to their average roughness  $R_a$ , whereby values between  $R_a\ 0.4\ \mu\text{m}$  and  $R_a\ 18\ \mu\text{m}$  are possible. For an article made from polycarbonate (PC) and made by conventional process control with a mold temperature of  $80\ ^\circ\text{C}$ , the roughness depth in the mold is reduced from  $1.43\ \mu\text{m}$  to  $0.8\ \mu\text{m}$  at the part surface. Consequently, image precision is only 56 %. If the mold temperature is increased to  $160\ ^\circ\text{C}$  with HD Plastics, image precision can improve significantly. The graining depth of the plastic then amounts to  $1.22\ \mu\text{m}$ , which results in image precision of 85 %.

You can even achieve mold structures in nanometer ranges via laser etching. If these are created at variable angles, incoming daylight is reflected in all colors. In this way, astonishing hologram effects can be produced – effects which were previously only possible to create using cost-intensive surface technologies. On the contrary, with the inductive mold heat-balancing – compared to the back-molded film in-mold labeling (IML) – a number of manufacturing steps can be saved, including those involving IML film screen printing, shaping, punch press pressing and positioning in the mold. Holograms can serve, for example, as a proof of authenticity for products where counterfeiting may be an issue, such as in the case of premium quality cosmetics. However, even in cases where manufacturers want to place their logo on a consumer electronics device, here they have a visually and cost-effective alternative to such processes as (secondary) painting, pad printing or hot embossing.

### *Manufacturers Can also Do Everything while Using Recycled Material*

All previously mentioned effects are also possible to achieve with recycled plastic, for example, recycled acrylonitrile butadiene styrene (ABS). Normally, unsightly clouding forms on the component surface, and as such, it is rarely used for visible parts. This phenomenon simply disappears under the inductive heat supply and the material with 100 % recycled content now delivers perfect surface aesthetics equal to those of new raw material – at approximately half the price.

It would be interesting to test to which extent it may consequently be suitable for a subsequent chroming process. As is known, electroplating enhances all types of surface defects, and as a result, recycled ABS had previously not been worth considering. Apart from the cost savings, there are also environmental aspects to consider. With 100 % recycled plastics, inductive mold heat-balancing is a step on the path towards sustainability. ■