Infrared Thermography Applications at “Kunststoff-Zentrum in Leipzig (KuZ)“

The infrared thermography is an adequate instrument for non-contact temperature measurements. In this way, absolute temperatures, temperature distributions and relative temperature changes can be measured and tracked within dynamic conditions. The capabilities of infrared thermography systems are multifaceted. As a result, applications in all kind of industries exist.

The most popular examples are:

- *Evaluation of thermal insulation of buildings*
- *Determination of the performance of photovoltaic modules*
- *Monitoring with infrared for easy fire detection*
- *Inspection of spot welded joints for car body construction*
- *Safety and object monitoring*
- *Diagnosis of disease pattern in medicine*
- *Quality management of electric/electronic components*

Kunststoff-Zentrum in Leipzig gGmbH

www.kuz-leipzig.de/

Text:
M. Eng. Markus Tröbs
Dr. Thomas Wagner

InfraTec solution:
VarioCAM® series

Due to relative good emission ratios of many plastics, infrared thermography is suitable for the extended characterisation of plastic processing technology and its optimisation. This application report exemplifies infrared thermography applications for plastic processing and inspection technologies at the KuZ.

Cooling performance of a moulded part during the injection-moulding process

The characteristics of an injection-moulded part are determined by the used plastic, geometry, and processing conditions. The cooling behaviour of the part inside the mould plays a major role. When the cooling effect happens too fast, for example, internal tensions can be frozen inside the moulded part. On the basis of attempts to get into the low-stressed condition, the moulded part could be seriously damaged during later applications. Furthermore, the cooling behaviour determines the crystalline structure of a partial crystalline thermoplastic material. Due to a rapid cooling, the crystallization is restrained and therefore the crystallization is at its lowest level. On the other hand, if there is a slow cooling effect, a higher level of crystallization develops, which can have a positive impact on the mechanical properties. In this way the cooling process influences the morphology development of a plastic moulded part. In addition, the cooling down process also influences the shrinkage behaviour. Local temperature differences in a mould cavity cause differ-ent local shrinkage behaviour. This can lead to a deformation of moulded parts. In general, the cooling process plays a big role in the development of moulded part properties.

Nr.	Mould temperature [°C]	Total Cooling Time [s]
1.	60	20
	60	30
2.	60	25
	80	25
	100	25

Tab. 1 Temperature control parameter

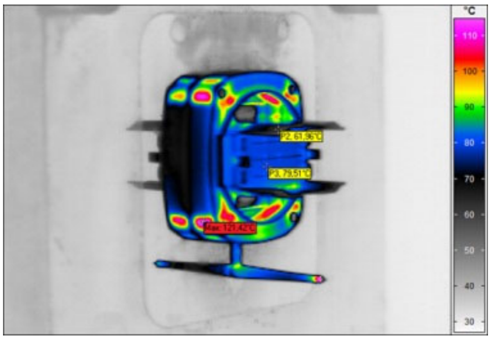

Fig 1 Thermogram of the moulded part at 60 °C mould temperature and 20 s totals cooling time

With the help of infrared thermography, the cooling process of an injection moulded part with different mould temperatures and total cooling times was analysed at the KuZ (see table 1). The used material was PC/ABS. For IR recordings the thermographic system of the VarioCAM®-series of the company InfraTec was used.

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Figure 1 shows the thermogram of the moulded part with open mould after the total cooling time has elapsed. It makes it possible to see quite large local temperature differences due to differences in wall thickness.

Figures 2 and 3 show temperature time sequences of three defined measuring points after opening the mould with a total cooling time of 20 s and 30 s, respectively. The duration of the recorded sequence is 120 s with a frame rate of 2 Hz.

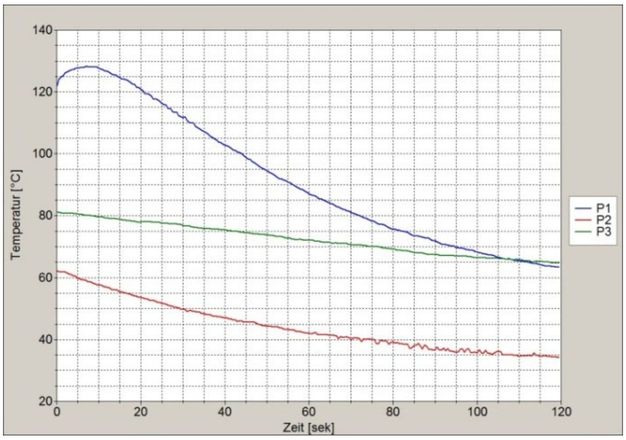

Fig. 2 Temperature-time sequence of the moulded part at 60 °C mould temperature und 20 s total cooling time

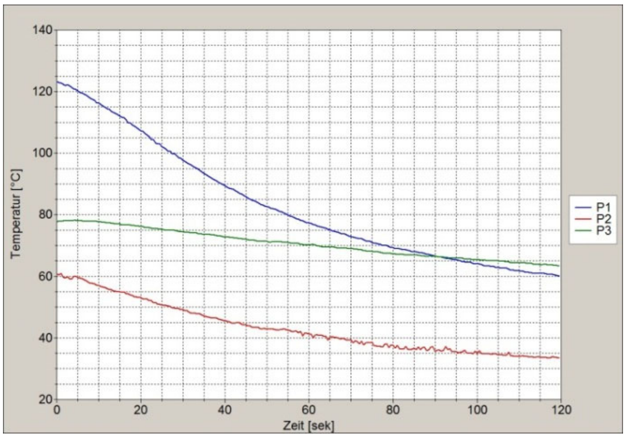

Fig. 3 Temperature-time sequence of the moulded part at 60 °C mould temperature und 30 s total cooling time

It shows that after a 20 s total cooling time the temperature-P1 increases for about 10 s and the temperature time sequence passes a maximum. This effect is the result of the thermal transfer from the warmer inner “soul” into the external layer which raises the temperature of the external layer. Afterwards, a typical cooling process results as seen in P2 and P3. With a total cooling time of 30 s, there is no rise in temperature anymore in the thick-walled area (P1) after the opening of the mould. In the additional 10 s cooling time, the heat from the warmer inner soul was fairly discharged over the mould surface.

Figures 4, 5 and 6 show the recorded thermal images of the moulded part for different adjusted mould temperatures. These examples show the potential of infrared thermography for optimised demoulding and cooling of the injection moulding process. From these so called “hot spots”, temperature differences and curves can be visualised. This is useful for defining and justifying mould temperatures and demoulding times. In addition, through infrared thermography measurements, an optimising of mould design and mould cooling is also possible.

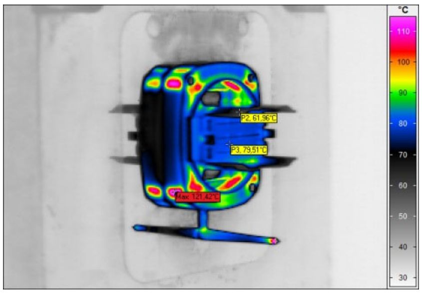

Fig. 4 Temperature-time sequence of the moulded part at 60 °C mould temperature and 25 s total cooling time

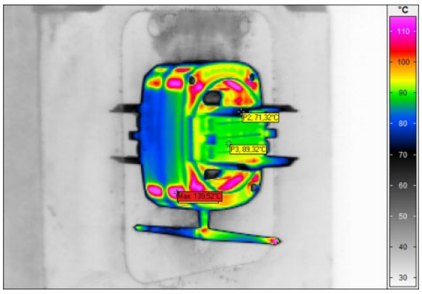

Fig. 5 Thermogram of the moulded part at 80 °C mould temperature and 25 s totals cooling time

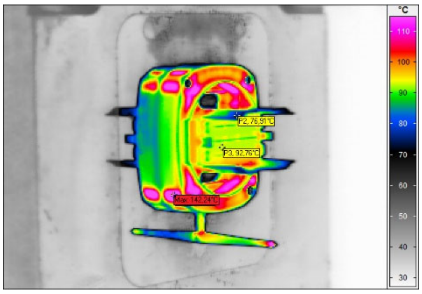

Fig. 6 Thermogram of the moulded part at 100 °C mould temperature und 25 s total cooling time

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Burning behaviour of PA66 during UL94-testing

Important for flame-proofed equipment of plastics is to archive, with the help of suitable filter materials and additives, that the developing melt does not drip off on fire during the firing procedure. In a current research project at the KuZ[1], the burning behaviour of PA66-mixes during the burning process is recorded with infrared thermography.

Figure 7 shows the thermogram of a UL94-panel of additive PA66 after a heating duration of 10 s. The evaluation of the thermogram was done with two measurement points and one measuring range. It is conspicuous that the maximum temperatures are very local. With an increasing distance to the flame along the panel, the temperature decreases exponentially (as in figure 8).

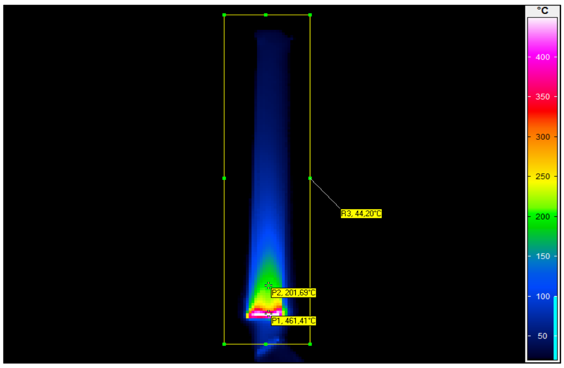

Fig. 7: Thermogram of the burning UL94-test object after 10 s flaming period

In figure 9, the temperature-time sequence of the three measurement points is shown. In the first stage, the temperature increase is due to the first flame treatment. After removing the burner from the sample, the temperature decreases suddenly by approx. 150 K. The second rise in temperature was caused by the second flame treatment. Afterwards, temperature-P1 and R3_MAX (max. temperature of evaluation scale) lead into a plateau. This plateau is penetrated by drastic temperature reductions which are caused by the polymer melt drip off. After the burner is removed again from the sample, the undisturbed cooling down process can be observed. It is expected that there are differentiated assessments from this research about influence of compound structure and other parameters to the process of flame development during melt drops drip offs.

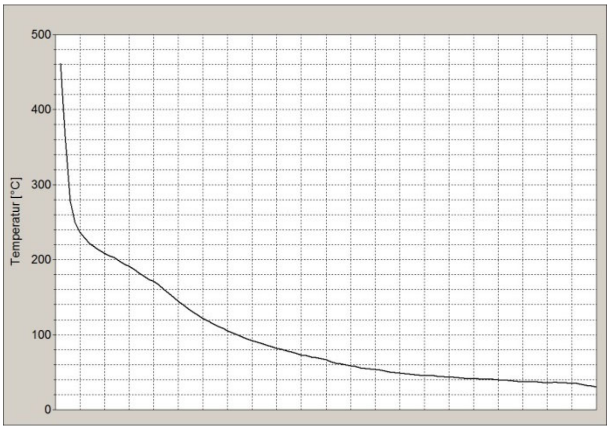

Fig. 8: Temperature-Time sequence of the burning UL94- test object

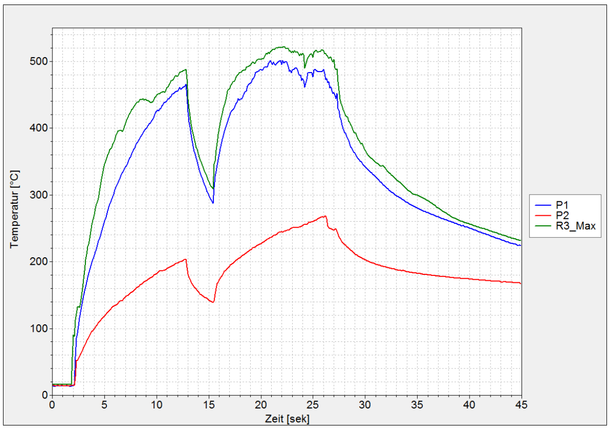

Fig. 8: Temperature in relation to the test object lengths

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[1] Founded by: Bundesministerium für Wirtschaft und Technologie (Reg.-Nr. VF120006)