Aim

The rising requirements placed on the quality of moulded parts, with a simultaneous increase in the complexity of the moulded part and the process, are making it necessary to optimise, further refine and also develop new control and process monitoring strategies. It is clear that further development will only be possible if new information can be obtained on the course of the process. Ultrasonic measurement technology serves as a basis for the development of approaches to the assessment of internal properties in medicine, in particular, as well as in materials testing. Since none of the methods currently established in injection moulding permits statements to be made on internal properties, the aim is to integrate ultrasonic measurement technology so that the database can be extended.

Method

There are two essential aspects when it comes to the use of ultrasound for process analysis in injection moulding. These are, firstly, linking the propagation speed of sonic waves to the mechanical properties of the transport medium and, secondly, the phenomenon of sonic reflection on boundary surfaces. The use of ultrasonic sensors in the injection mould provides an acoustic fingerprint of the course of the process, since the solidification of the part is coupled to a clear change in the viscoelastic properties and hence also in the acoustic properties of the part. Given that ultrasonic measurement technology has so far been used on a commercial basis primarily for (quasi-)static processes, it is a matter of developing a measurement system that is suitably aligned to the highly dynamic injection moulding process. The interpretation of the ultrasound signals recorded during the injection moulding process is based inter alia on additional process parameters, such as the cavity pressure and surface temperature, etc.

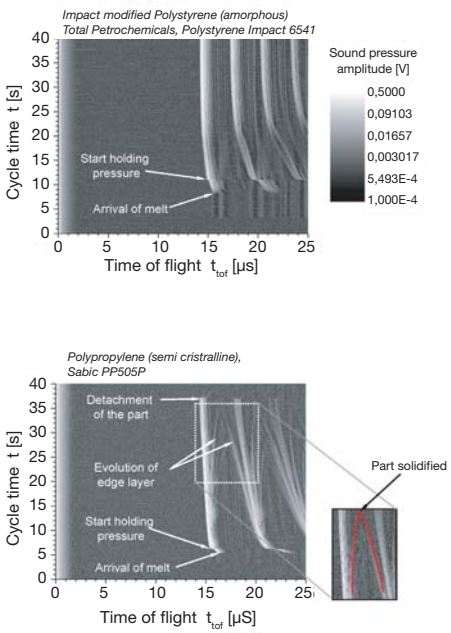
Results / Solution

The modular measurement system that has been developed permits statements to be made on the phases in the moulded part formation process and offers a number of different modules for the automatic assessment of the process sequence. The ultrasonic signal provides information on the arrival of the melt front, the detachment of the moulded part, the temperature equalisation process in the moulded part and the formation of the surface layer during the solidification of semi-crystalline thermoplastics. Variations that occur during the running process, such as changes in the pressure or temperature level, can similarly be detected.

Prospects

Alongside the results of experimental investigations conducted to date, an observation of the physical fundaments shows the considerable potential offered by ultrasonic measurement technology when it comes to solving questions of relevance to injection moulding. The results set out here are only a small sample of the full range of conceivable applications. Future research will be aimed at highlighting additional uses for ultrasonic measuring technology.

Acoustic fingerprint of the course of the injection moulding process (change in position of the ultrasonic echo over the cycle time)



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