HARTING's task

HARTING has recognised the problem that there is a hard cut between prototyping using additive manufacturing technologies and series injection moulding. There is no smooth transition between these technologies. If this transition from the prototypes to the product, from additive manufacturing to injection moulding, were to be broken up, new possibilities in product development could arise.

This is where the idea of additively manufactured injection moulding tools emerged, which could close this gap.

Solution

As part of the cooperation between ALTANA and HARTING at the material level that has existed since 2022, HARTING brought this problem up for discussion. Various solutions were discussed together. Due to its wide range of materials and many years of experience in the field of additive manufacturing, ALTANA proposed a possible solution based on the material base developed for audiology and silicone casting, on the basis of which a similar approach for injection moulding was discussed.

This led to a joint project to evaluate, validate and develop a material suitable for injection moulding. The aim was to additively manufacture injection moulds that not only meet the high demands of the materials used by HARTING, but also allow a high degree of geometric freedom for the components produced by injection moulding.

In joint test series at HARTING, the feasibility of using technical and filled plastics was demonstrated in a very short time. A significant advantage of the material is its 'water solubility', which enables a high degree of geometric freedom due to the elimination of slides and thus the realisation of complex geometries and undercuts.

Various material iterations, mould designs and process parameters were tested as part of different test series in order to ensure optimum interaction between the processability of the material in the 3D printing process, to withstand the tough requirements of the injection moulding process and to optimise the 'water solubility'.

HARTING recognised the high potential of the material and the application after the first tests. The high flexibility due to the processability of the material on various 3D printing systems, as well as the realisation of complex geometries in the shortest possible time, which are tired in prototypes in technical thermoplastics.

Material - 3D printing:

Within the project, the focus was placed on the processability in the additive manufacturing process, as well as on the resistance in the injection moulding process. In both cases, the material must fulfil the highest requirements.

It was important to HARTING and ALTANA that the material could be processed on a variety of systems in order to avoid having to limit themselves from the outset and to simplify adaptation

to existing systems. Thanks to ALTANA's many years of experience, this requirement could be successfully implemented and tested on a wide range of additive manufacturing systems.

When producing the mould using additive manufacturing, the material must be able to reproduce the smallest geometries and finest details, while at the same time we have high volume and wall thickness fluctuations due to the geometry of the component to be sampled, the mould geometries and the wall thicknesses required to withstand the conditions prevailing in injection moulding.

The 'washability' of the material has just as great an influence as the post-curing of the mould. Here, material, design and process optimisations were jointly developed to improve the geometric accuracy of the mould.

Material in injection moulding:

Through various series of tests, HARTING was able to provide ALTANA with constant feedback that could flow directly into material development. This enabled ALTANA to produce a wide variety of material iterations in the shortest possible time, which HARTING was able to incorporate directly into the next series of tests. Thanks to this continuous loop of feedback and material adaptations, material development could be accelerated considerably in close co-operation.

Various injection moulding parameters and geometries were tested and evaluated to validate the materials. It quickly became clear how material and mould design influence each other. This made the close coordination between material, 3D printing parameters and mould design all the more important.

HARTING only used engineering plastics for sampling the injection moulding geometries, which are also used in series production.

What became apparent during the trials was the advantage of 'one-shot' moulds over other approaches, such as highly filled ceramic resins and the injection moulds created from them.

Not only is there significantly less reworking, or if the mould design and pressure parameters are correct, this can be completely eliminated, but the cycle time is also significantly shorter. The 'one-shot' mould also has a clear advantage over additively manufactured ceramic moulds in terms of the complexity of the components to be sampled or reproducible features, as there is no wear or chipping.

Reworking / dissolving:

The final process step is to dissolve the mould in order to expose the finished injection moulded part. Various aspects have to be taken into account as early as the mould design stage.

As the volume and the surface exposed to the dissolving medium influence the 'dissolving time', these aspects should, if possible, already be taken into account in the mould design.

Outlook:

The common goal is to further optimise the material and the processes and to better understand and eliminate the current limitations.

Through a better understanding of the behaviour of the moulding material in the injection moulding process and in the subsequent dissolution process, the material can be further

optimised and thus specially adapted to the specific requirements arising from the plastics used in the injection moulding process and the dissolution media used.

Summary:

HARTING has established that there is a clear gap between prototyping using additive manufacturing and series injection moulding. There is no smooth transition between these technologies.

In collaboration with ALTANA, the idea of using additively manufactured injection moulding tools was developed to close this gap. ALTANA contributed its experience and material diversity to develop a suitable material for this application.

A joint evaluation and development project was launched. The aim was to additively manufacture injection moulds that could withstand the high requirements and enable complex geometries.

Initial test series at HARTING quickly demonstrated the feasibility. One advantage of the material is its ‘water solubility’, which enables complex geometries. Various material iterations and process parameters were tested in order to optimise the processability in 3D printing and the requirements in injection moulding.

HARTING recognised the high potential of the material and the application, in particular the flexibility and the ability to quickly realise complex geometries.