INSTITUTE OF
POLYMER TECHNOLOGY
Prof. Dr.-Ing. Dietmar Drummer

FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
FACULTY OF ENGINEERING

Media-Tight Hybrid Systems

In Assembly Injection Molding

Barcode zu Ansprech-partner und Infomaterialien

Motivation

The increasing level of automation in many industry branches leads to new areas of application for electronic assemblies. However, the new field of application also lead to new load situations due to various environmental influences, which must be considered in the design and construction of such assemblies in order to ensure adequate protection against different media.

Metallic bushings such as those found in connectors play a central role in this context. The focus thereby lies mainly on the fabrication of a media-tight hybrid assembly in a process suitable for mass production. Assembly injection molding is particularly suitable due to its high automation capability and suitability for large-scale production. In addition, it offers the advantage of short process times and the saving of large-volume potting pans, which significantly restrict the design freedom in classic potting of assemblies and connectors.

For series production, however, there are still a number of challenges to be solved in order to achieve a permanently media-tight composite. Typically produced specimen at the Institute of Polymer Technology (LKT) are shown in Fig. 1 in various configurations.

Fig. 1: Modular specimen for leckage testing at LKT

Challenges

The big challenge in this context is the realization of a high media-tightness in combination with a high composite quality, since the adhesion of metals and polymers is strongly limited. A critical point is to secure both properties at the same time, since a high adhesion does not necessarily lead to a high tightness therefore new solution approaches have to be developed.

For the development and validation of new solution strategies, an understanding of the complete process chain, shown in Fig. 2, is necessary. The fabrication process can essentially be divided into four phases: production of the insert, pre-treatment of the insert, overmolding in assembly injection molding and actual component testing at the end of the respective process. Only a deeper understanding of all phases can be helpful to determine influencing variables that can be used as adjusting screws for the production of new, more durable components.

This is the reason why for the LKT to cover the entire process chain: generating a better understanding. The research focus lies on new insert treatment processes for the creation of assemblies with increased tightness by injection molding. In addition to this, continuous efforts are being made to improve the measurement setup and the detection of leakage paths in order to gain a deeper understanding of the causes of leakage.

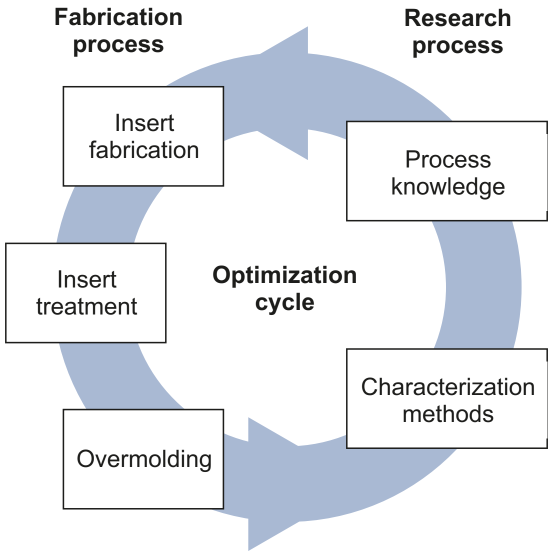

Fig. 2: Schematic diagram of fabrication and research process

Origins of leakage

The causes of leakage can essentially be divided into two different clases: the formation of cracks and the formation of gaps, as shown in Fig. 3. Both phenomena can be attributed to unfavorable shrinkage behavior. As a result of strong shrinkage of the overmolded component onto the insert, high local streses occur in the area of the insert edges, leading to crack formation. In contrast, a shrinkage of the overmolding away from the insert can lead to the formation of gaps, which can also lead to high leakages.

Insert Treatment

One of the main research areas at the LKT is the development of new surface pre-treatment methods to increase media-tightness. A labyrinth sealing effect is used as the active principle, which is implemented by targeted microstructuring of the surface. To this end, various solution concepts were investigated on the basis of plastic-metal hybrids. On the one hand, macroscopic and microscopic structures were applied by means of embossing, through which a significant increase in tightness can be achieved. In addition, a new method was developed in which structuring is carried out by electrochemical etching Fig. 4.

The working mechanism of this new process is based on the generation of undercuts on a microscale basis, which leads both to an increase in the bond quality and to a significantly increased tightness due to a labyrinth sealing effect. In addition, the simultaneous rounding of the insert edges (Fig. 4) also reduces the risk of cracking due to stress peaks. This enables the production of media-tight polymer-metal hybrid components.

The innovative surface treatment process offers several benefits compared to the most commonly used application of adhesion promoter systems. Due to its short cycle times, it can be easily integrated into the existing process chain of assembly injection molding. The number of work steps can thus be significantly reduced and transport routes can be saved through direct integration.

These solution approaches are now to be transferred to plastic-plastic composites in further test series, as they are commonly found in electronics and sensor components, in order to be able to produce a high protective effect against environmental influences.

Measurement Setup

In order to test the suitability of new solutions, such as electrochemical treatment, the LKT also focuses on the further development of existing measuring methods. For this purpose, a modified version of the air-under-water test was developed, which is shown in Fig. 6. The standard test method was extended by a graduated test tube, which enables an actual determination of the leakage rate without any falsification by the clamping device. In addition, the water bath was enhanced by an active temperature-control to be able to measure components under varying thermal loads. furthermore, a clamping assembly was designed with which a measurement can be carried out under a static mechanical load.

These supplements help to develop a detailed understanding of leakage causes and thus to be able to specifically develop new solution concepts. For this purpose, further additions to the measuring setup are planned.

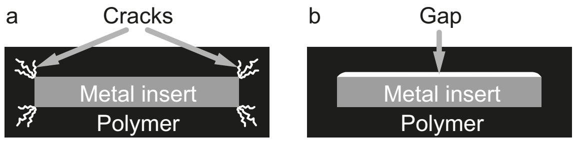

Fig.3: Causes of leakage due to a) Crack formation and b) Gaps

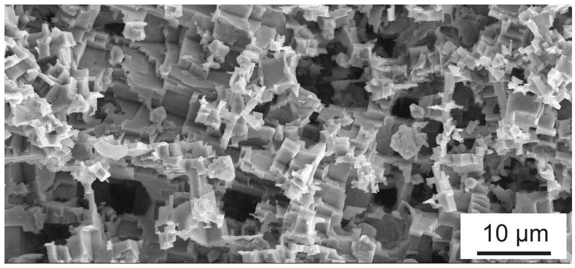

Fig.4: Microstructure on insert surface after electrochemical treatment

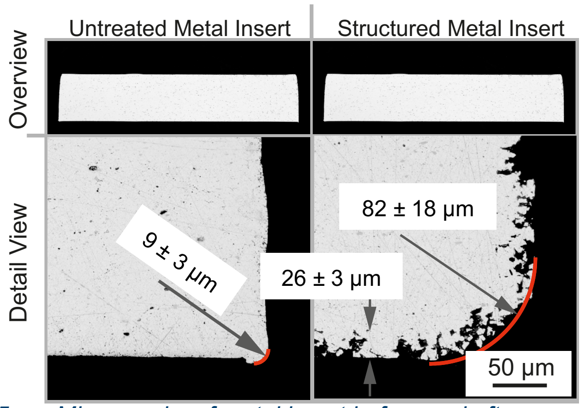

Fig.5: Micrographs of metal insert before and after treatment. Overview shows the cross-section of a punched grid,detailed view shows an enlarged example of a corner area

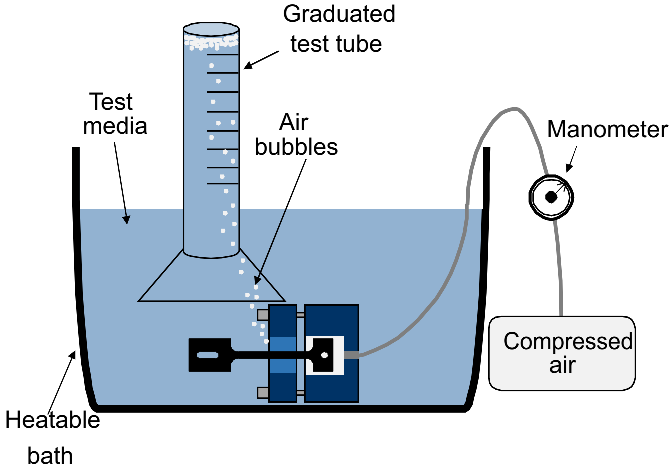

Fig.6: Setup of the air-under-water test

Research Objects and Service for Industry

- Thermoplastic overmoulding of insert parts
- Overmoulding of electronic components
- Development of new surface treatments
- Development of new testing setups
- Testing with differential pressure and air-under-water test

| Institute of Polymer Technology | Am Weichselgarten 9 | 91058 Erlangen-Tennenlohe, Germany
| Phone: +49 9131 85-29700 | Fax: +49 9131 85-29709 | Mail: info@lkt.uni-erlangen.de
| https://www.lkt.tf.fau.eu/