Development and investigation of a multi-material FDM printing process for the manufacture of integrated seals

The additive manufacturing process using FDM printing systems enables the production of complex component geometries, as well as the combination of different materials within a single component. Multimaterial printing allows the specific properties of different materials to be utilised in a targeted manner to produce functional components with locally adapted properties. In particular, the combination of dimensionally stable thermoplastics such as PLA or PETG with flexible TPU opens up a wide range of potential applications, for example for fasteners, damping elements and integrated seals.

Processing different materials places specific demands on the printing process and the bonding between them. In addition to material-specific properties and thermal behaviour, the adhesion between the materials is of particular importance. An inadequate bond can lead to delamination at the interface, thereby compromising the mechanical stability and functionality of the component.

Within the scope of this thesis, different joining strategies for multi-material FDM prints are to be investigated and evaluated in terms of their mechanical properties. To this end, PLA or PETG will be combined with TPU. By varying suitable process parameters and specifically designing the geometric interlocking and transition zones, specimens will be produced to systematically investigate their influence on the material bond. A further focus is on the integration of functional sealing areas. To this end, different Shore hardnesses of the TPU will be compared in terms of their suitability as sealing materials. In addition to the mechanical strength of the material bond, the sealing performance under defined test conditions will be evaluated in particular.

Within the scope of this student project, the fundamentals of multi-material FDM printing, as well as the relevant material properties and process parameters, are to be investigated first. Building on this, suitable specimen geometries and printing parameters will be defined. The fabricated specimens will then be tested using tensile tests to determine the strength of the material joints and to evaluate the influence of the selected materials and process parameters. In addition, suitable test methods are to be developed to systematically investigate the sealing performance of the various types of TPU.

The findings obtained are to be applied to the design implementation of an existing electrochemical cell. In this process, the selected materials are to be combined within a single printing operation and the necessary sealing areas integrated directly into the component. The developed design is then to be examined with regard to the mechanical bonding of the materials and their sealing performance, in order to lay the foundations for the reliable manufacture of functionally integrated components with additively manufactured seals.

Prerequisites:

- An interest in materials science and additive manufacturing
- (Basic) knowledge in the field of CAD and FDM printing systems

Type of position:

- **Practical study placement (15 ECTS) at the WWHK**
- **Practical placement and Bachelor's thesis (30 ECTS) at the WWHK**
- **Research and development module (10 or 20 ECTS) at the WWHK**

Duration and academic extent depend on the programme regulations and the nature of the student's work

Start date: immediately

Contact: Edgar Hoffmann, Aline Wagner