PROCESSING OF ALTERNATIVE FDM MATERIALS 3.0

The qualification of new polymers for the FDM process, using known material data, is not practicable and the qualification of processing are conducted experimentally. During the qualification process of a new material, further material properties must be considered in addition to the general processability in the FDM process. In a previous DMRC project in 2018 it was investigated which alternative high-performance plastics can be processed in general. After the general processability of the materials was examined the achievable weld seam strength was determined. In the subsequent project in 2019 the shrinkage and warpage behavior was studied. In this project, fully developed FDM process parameters are generated, based on the basic parameters defined in the previous projects.

PROJECT OVERVIEW

DURATION

05/2020 – 11/2020

PARTNER

Industrial Consortium of DMRC

FUNDED BY

Industrial Consortium of DMRC

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Project objective

The aim of the board project “Processing of Alternative FDM Materials 3.0” is to set up fully developed FDM process parameters based on the basic process parameter developed in the previous projects. So, the FDM process parameters are to be optimized for a selection of successfully tested materials to get a material specific adaption. The final outcome is the development of a material specific method for determining FDM process parameters in relation to the slicer and the firmware.

Review

In the past project in 2018, different materials were tested with regard to their processability in the FDM process in close consultation with the DMRC industrial partners. Different polyether ether ketone (PEEK) materials and a glass fiber reinforced polypropylene (PP) were processed. In particular, PEEK is used for high temperature applications. The processing is demanding because special equipment is required to process high-temperature materials. The weld seam strength has been considered as a criterion for evaluating the processability. In the following project year 2019 the warpage behavior of different materials was examined. Warpage results due to the shrinkage behavior of a material and is therefore a material specific property. The shrinkage and warpage behavior were investigated, because in the FDM process, the part is produced out of a large number of layers. Strands are deposited, each strand cools down and shrinks separately. The occurring shrinkage leads to residual stresses in the part which can lead to warpage. With a special specimen geometry, the warpage has been detected and quantified.

In the further course of the project the task was to combine the project results from the years 2018 and 2019. The aim was to determine a process window for the used materials, in which the highest possible weld seam strength with at the same time low warpage is achieved. Thus, an optimized nozzle temperature as well as an optimized build chamber temperature could be determined. These processing parameters will be adopted and used in the project “Processing of alternative FDM materials 3.0”.

Project procedure

The aim of the board project “Processing of Alternative FDM Materials 3.0” is to set up fully-developed FDM process parameters. The first step is to select the materials to be used in this project. The material selection will be based on the materials from the previous project in 2019. Then the FDM processing parameters will be optimized. This will start by optimizing the FDM process parameters that are defined in the slicing software. Here, the goal is to prevent typical error patterns such as oozing/stringing (Figure 2) by adapting in the slicer software. Different slicers are examined. Additionally, advanced FDM processing parameters that are usually handled by the machine firmware (e.g. for controlling the material extrusion during strand deposition) should be optimized for the chosen materials. Finally, the mechanical properties will be determined by manufacturing and testing tensile specimens according to DIN EN ISO 527-2 or ASTM D638 in XY- and Z-direction.

Thus, the transition from material specific process parameter optimization to component characterization is made. The material properties can be identified and compared with conventionally available materials. Then a demonstrator part will be manufactured with the developed parameter set. An example is shown in Figure 3. This concludes the process parameter development.

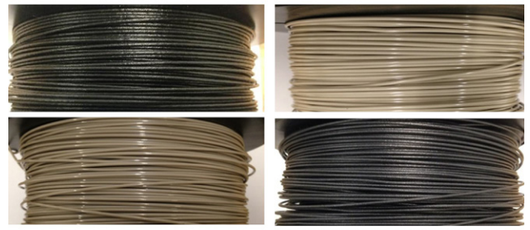

FIGURE 1 Material selection

FIGURE 2 Typical FDM error pattern oozing / stringing

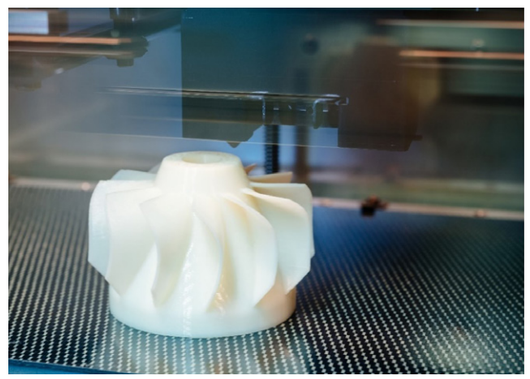

FIGURE 3 Manufacturing of a demonstrator