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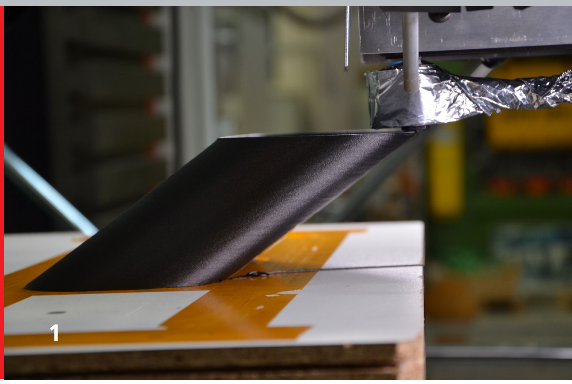

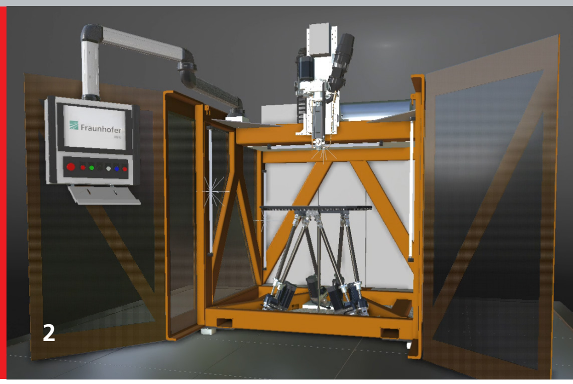

1 *High-speed production of a large-volume component*

2 *Extrusion-based plastification system for processing plastic standard granules in combination with a hexapod parallel kinematics*

ULTRA-FAST 3D PRINTING USING STANDARD GRANULES

3D printing opens up completely new approaches for products and manufacturing. However, many 3D printing processes are expensive and too slow for industrial use, where it is essential to produce a great number of pieces in a short period of time. For this purpose, Fraunhofer IWU developed SEAM, a system and process that is eight times faster compared to conventional 3D printing methods.

The SEAM system

SEAM stands for Screw Extrusion Additive Manufacturing. The SEAM system consists of an extrusion-based plastification unit for processing plastic granules, which was combined with a hexapod. The hexapod, i.e. a 6-axis parallel kinematics that can be swiveled, is equipped with a metal construction platform. The hexapod motion system is characterized by high dynamics and low moved masses, which is associated with high accuracy regarding positioning and path. These properties imply that this system is ideal for motion control of the extruder.

Process principle

The plastic granules are fed into the extruder via a modified extruder screw. Then they are plasticized with achievable process speeds of up to one meter per second. Subsequently, the arising plastic melt is deposited layer by layer onto the construction platform. The parallel kinematics enables tilting of the construction platform along the x-, y- and z-axis, and specifically moves it beneath the nozzle of the plastification unit so that the component shape is generated, which has been programmed before. Due to the continuous deposition process it is possible to manufacture large-volume reliable components.

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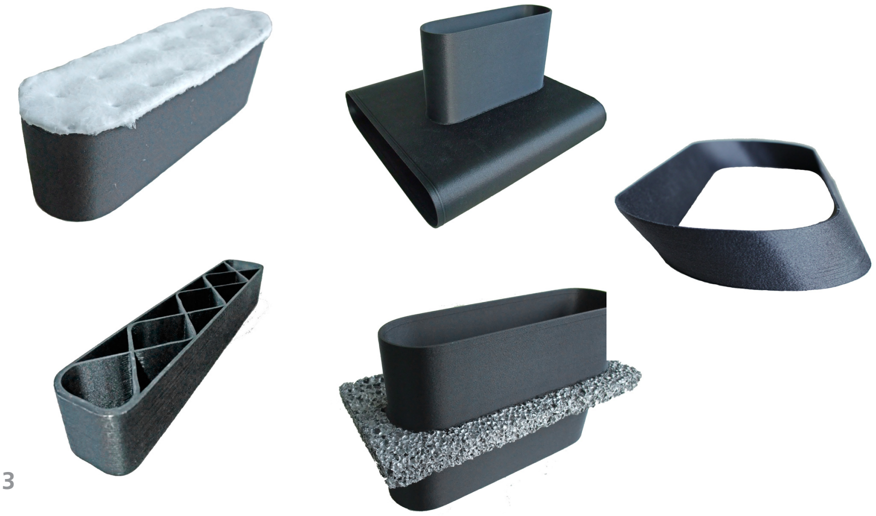

Controlling of the extrusion performance depending on the path speed is required in order to ensure controlled printing of curves and corners, and to allow for jumps in position without material deposition. Due to the highly inert plastification behavior of extruders it is not reasonable to change the volume via the extruder speed. For this purpose an upstream unit was developed, which allows material deposition between 0 and 100 percent depending on the speed.

Processable materials

The SEAM method can process free-flowing, cost-efficient standard plastic granules. This permits saving material cost by up to 200 times compared to conventional fused layer modeling (FLM) processes that use expensive filament. Various plastics have already been tested – ranging from thermoplastic elastomers, to polypropylene and polyamide-6 with a 40-percent content of carbon fibers (PA 6 CF). These are industrially relevant materials characterized by high stiffness and strength or a high elasticity, they cannot be processed by conventional 3D printers.

Process advantages

A major advantage of the SEAM process lies in its processing speed. Up to ten kilograms of plastics per hour are extruded through the one millimeter sized tempered nozzle of the plastification unit. In comparison, conventional FLM, a method for depositing melt strands, requires 20 hours for printing one kilogram of plastics.

Moreover, SEAM makes it possible to manufacture reliable complex geometries without using any support systems. Various wall thicknesses can also be generated within one printed path. While components conventionally manufactured by plastics injection molding exhibit rather thin walls due to the process and design, the SEAM process can realize strand widths between 1.2 and 3.1 mm for PA 6 CF by using a nozzle of one millimeter in size, depending on table speed and extrusion performance.

Summary

The SEAM process significantly extends the possibilities for efficiently manufacturing plastic components in a 3D printing process. The overall component cost can be considerably reduced due to the low material cost and the short production times. Moreover, this method can be used to process materials that could previously not by processed by 3D printing. The surface qualities achieved with this process are the same as those obtained by the standard FLM process.

3 *Demonstration components manufactured by the SEAM process*