Characterization and Comparison of mechanical Properties of SLM Materials with regard to Process Cycle Time Improvement

Since a high productivity is a crucial criterion for the use of a specific manufacturing process, it is the aim of this project to find optimal exposure parameters of the SLM process with regard to required cycle time and component quality.

The sensitivity analysis as a first major issue within this project aims at shedding light regarding the influence of exposure parameters on the mechanical properties of SLM manufactured stainless steel 316L. As an example, Figure 2 shows monotonic stress-strain curves for 316L processed on a SLM 250HL respectively SLM 280HL. It can be seen, that both processes result in fundamentally different behaviour under monotonic loadings.

Figure 2: Monotonic stress-strain curves for the SLM processed 316L
By analysing the microstructure, the differences in strength and ductility can be explained according to the Hall-Petch relationship.

![Image](image1.png)  
![Image](image2.png)

**Figure 3:** EBSD maps for 316L obtained through a 400 W Laser (SLM 250HL, left) and a 1000 Watt Laser SLM 280HL (right)

It can be seen, that the evolution of the local microstructure is strongly depending on the exposure parameters. While the conventional 400 W laser results in a weakly textured fine grain structure, the 1000 W laser causes significantly larger grains strongly elongated in build direction. In order to obtain a deeper understanding regarding these effects of exposure parameters, design of experiments (DoE) was used to allow for a systematic approach concerning this multi-parameter problem. The optimizations were carried out towards a high density and hardness.

Further work packages focus on a comparison between a SLM 250HL and a SLM 280HL with respect to build-up rate and the resulting component quality. Therefore, a reference build-job was defined in order to measure the process-cycle time of both SLM systems. Recent investigations have shown the possibility to increase the build-up rate about 77% by use of the SLM 280HL compared to the conventional SLM system. Finally, all project results regarding an optimal balance between build-up rate and component quality will be transferred to a real component in order to demonstrate the performance of the SLM process.

This research project is being processed by the two departments “Automotive Lightweight Construction” and “Institute of Applied Mechanics.”