Additive manufactured lightweight structures for civil aircraft components

The Selective Laser Melting (SLM) process provides huge advantages for aircraft components like valve blocks and structural parts. In this project funded by the BMWi – "Federal Ministry for Economic Affairs and Energy", the benefits of substituting conventionally manufactured parts by additively manufactured parts will be examined and quantified. The scopes are, reducing costs, weight and time in comparison to the traditional design and the conventional manufacturing method.

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1. Objectives

The aim is to develop a decision support scheme for future applications during the product engineering process and to elaborate the fundamentals for a Additive Manufacturing material database based on lightweight and composite structures, besides solid material properties. Moreover, investigations working on improving the process through topology optimization, which includes increasing the building speed of the SLM process and to develop fast and stable process routes that can be used for serial production, will be acquired. The intention is to reduce the processing time in every stage of the process chain, particularly in the Additive Manufacturing process.

2. Procedure

The project is divided into two work packages, the first work package works on identifying several promising aircraft components and to adapt a trade-off methodology to rank these parts. According to this tradeoff methodology, a decision scheme for future decisions will be developed with a complete description of process chain mapping possibilities and influencing factors for the process. The second work package works on the development of lightweight structures and composite structures and their mechanical properties for several target functions. Moreover, the mechanical properties of solid material built with various adjusted parameter sets will be determined. The gained knowledge of the previous working steps will be merged in topology-optimized components to demonstrate the possibilities of Additive Manufacturing and the results of the project.

3. Latest results

Since the project started in January 2016, the fundamentals for the different working steps are worked out. First ideas for the material database were discussed and the adaption of the trade-off methodology is ongoing. Furthermore, the initial steps for the determination of mechanical properties of the structures to be examined were done. A first knowledge base of the behavior of lattice, composite and support structures, and the influence of the part position on the building plate has been established.

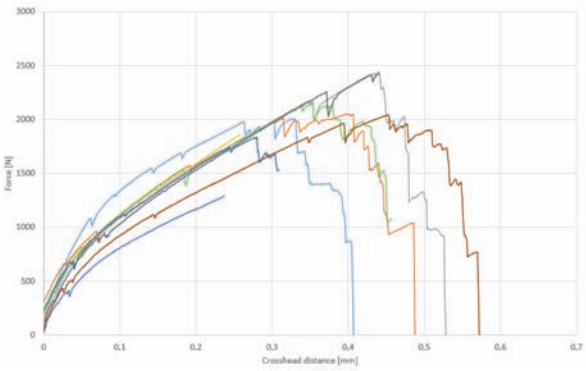

Figure 7: Force-distance diagram of support-structure (block) tensile specimen

In addition to that powder ageing effects in different build jobs with the same powder were analyzed and first investigations on increasing the building speed through parameter optimization has been done.

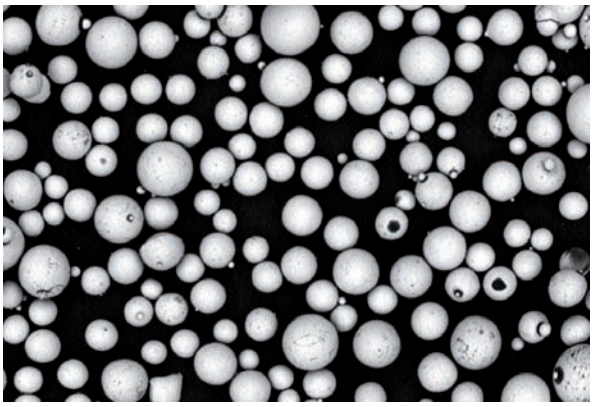

Figure 8: Influence of the number of build jobs on the powder morphology of TiAl6V4 – Morphology after 3 jobs

4. Outlook

The next working steps are further investigations on the topics mentioned above. The whole project is an iterative process and the gained knowledge during the project will be used for first topology optimized parts which will be finished in early 2017. Moreover, additional and extensive investigations on increasing the building speed while at least holding the properties and on combining different materials in composite structures will be examined.

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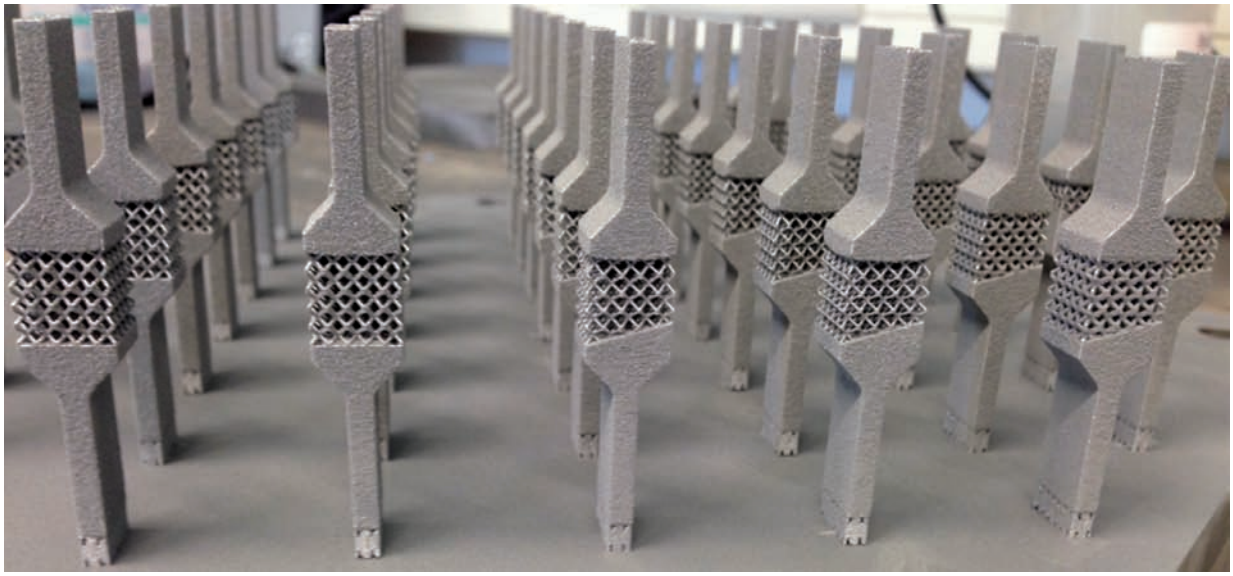

Figure 9: Building plate with different samples for the investigations on standard lightweight structures