Fatigue analysis of additively manufactured titanium components

A PhD Project by

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Introduction

Titanium is a material which is not easily manufactured with conventional manufacturing methods. The raw material is expensive and machining is time and tool consuming. In addition, up to 95% of the raw material end as non-recyclable waste until a component is fully drilled [1].
Additive manufacturing of titanium has been developed to be an economical and ecological alternative to actual manufacturing methods. Up to zero waste is created, as material is applied only where it is needed. Apart from this huge benefit, new freedoms in shape design are possible, using inner lattice structures, cavities, and undercuts.
In the future, additive manufacturing will become an increasingly important alternative to conventional manufacturing processes and is already evolving from rapid prototyping to mass production technology.
This PhD aims to contribute to the field of the fatigue analysis of additively manufactured titanium components.

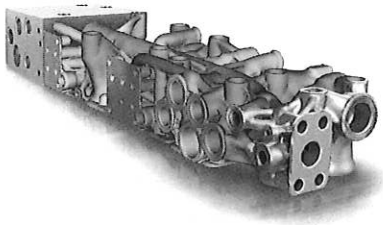

Fig. 1: Shape optimized and additively manufacturable hydraulic valve

References

[1] B. Denkena, M.-A. Dittrich, and S. Jacob. "Energy Efficiency in Machining of Aircraft Components". In: *Procedia CIRP* 48 (2016), pp. 479–482. ISSN: 22128271. DOI: 10.1016/j.procir.2016.03.155.

Objectives

The major parts of this project are:

- Research on the state of the art of the fatigue of additively manufactured titanium components
- Fatigue experiments with additively manufactured titanium specimens
  - Design and production of specimens
  - Conduction of experiments
  - Fatigue analysis of results
- Theoretical adaption and numerical application of the notch strain fatigue approach
- Comparison of theoretical and experimental results
- Software development

Methods

The tests will be carried out on a test bench for fatigue tests. They shall reveal the actual fatigue life of the specimens and the results will be compared to the calculation results. The outcome of the comparison will be analysed to verify the chosen approach.

Fig. 2: Test bench at Kiel UAS

Project Information

The PhD is part of the German research project "FATiG - Formoptimierte Additive Fertigung von Titanbauteilen unter Betrachtung des Gesamtlebensdauer" (Shape optimized additive manufacturing of titanium components with respect to life cycle fatigue). The research project takes part as a cooperation of the Kiel University of Applied Sciences, Scuddy GmbH and Element22 GmbH and is financed by the federal state of Schleswig-Holstein.