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Abstract

Accelerating the measurement of dynamic material properties of AM tensile specimens

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Computed Tomography (CT) is widely used as a reference non-destructive testing method to analyze the inner structure of safety-critical parts especially in heavily regulated industries such as medical. In particular, additively manufactured (AM) components often with their bionic design will lead to very complex-structured parts, which can be light weight and robust at the same time.

Metallic AM components produced in a powder bed fusion process are used for example as implants and could even be tailored to the individual needs of each patient. However, such a unique and complex design has the disadvantage that mechanical properties and changes in internal structures are not easily predictable.

By using micro computed tomography (µCT) scans, even these complex components can be examined directly with high resolution, which can help in understanding a variety of properties of the 3D printed part.

The dynamic material properties are particularly important in the development of medical implants. Typically, fatigue characteristics have to be established through extensive and time-consuming cyclic testing. In this study, we investigate the possibilities of shortening the duration of this classical approach by performing intermediate µCT scans during the test cycle. This allows for detecting and analyzing emerging cracks before the defined failure of the specimen occurs.

We integrated a tensile test stage into a µCT system to investigate 3D printed Ti6Al4V tensile specimens with and without load. We further evaluated different approaches to implement 4D CT algorithms in order to analyze displacement fields and deformation of microstructure between intermediate µCT scans during the cycle test. Using these 4D CT algorithms will furthermore open up the possibilities of visualizing dynamic processes, where specimens undergo changes during the duration of the CT scan.

In this study, we first present results of the intermediate scanned tensile specimens and show the current state of our developed 4D CT to visualize static and dynamic changes in the specimens.

AUTHOR'S STATEMENT

Conflict of interest: All authors are employees of VisiConsult X-ray Systems & Solutions GmbH, Stockelsdorf, Germany. Animal models: n. a. Informed consent has been obtained from all individuals included in this study. Ethical approval: n. a.

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