Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, 2023, Vol. 5, No 1, Suppl. 1, Article ID 834, 1 Page

Abstract

Adapted scanning strategies for more accurate implants manufactured by LPBF

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Laser Powder Bed Fusion (LPBF) is an additive manufacturing technology that provides a great degree of freedom regarding the geometry of metallic 3D-printed objects. To end up with a satisfying result one needs to master all influencing factors that have an impact on the manufactured part. Here, we want to emphasize the necessity of choosing the right scanning and slicing strategies to improve the dimensional precision of LPBF processed parts.

A complex open-pored cellular structure was investigated. Areas with specific topographic features, as e.g. bridges, bulk or open-pored cellular features were automatically identified within the CAD model and assigned with adapted scanning strategies and laser parameters respectively using special slicing functions. This new manufacturing approach resulted in higher dimensional accuracy as well as higher quality of the components. The dimensional deviation from the CAD model was only up to 3% for the here presented adapted route but up to 20% for the manufacturing using the conventional way. Additionally, LPBF fabricated implants with cellular structures offer the potential to support osseointegration without external coatings. In an application-oriented scenario the production time would be reduced by 6 weeks and the production costs by 33% compared to the conventional CNC-production route with additional coating step.

In a second example we show the potential of manufacturing uniform, filigree and superelastic structures made of NiTi on conventional LPBF machines with strut diameters of around 200 µm. These filigree parts show the achievement of optimizing the digital workflow of adaptive scanning strategies [1], which realize a higher freedom of geometry when producing lattice structures and a more precise replication of the digital model. By means of the selected laser parameters and scan strategy, the quality of the structure as well as the phase transformation temperatures and therefore the transformation stress levels are adjusted. As a result of the chosen unit cell designs and the superelasticity of NiTi, we show a metallic structure, which exhibits a leap in stiffness under compression and a deformability of 30 % without failure.

AUTHOR'S STATEMENT

Conflicts of interest: C. Ortmann and M. Liebelt are employees of Mathys Orthopaedie GmbH, 07646 Moersdorf, Germany.
Research funding: The project “MediSlice” was financially supported by AGENT-3D/BMBF.

REFERENCES

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DOI: 10.18416/AMMM.2023.2309834