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LATEST IMPROVEMENTS IN ADDITIVELY MANUFACTURED AEROSPIKE ROCKET ENGINE

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1. ABSTRACT

This research addresses the exploration of additive manufacturing for an aerospike breadboard engine, utilizing laser powder bed fusion (PBF-LB/M) with INCONEL®718 powder. The process was assessed through material characterization and non-destructive testing such as computed tomography. Geometric features were also studied to determine overhang and accuracy, shaping the design of the aerospike breadboard engine. The study also discusses general results on surface roughness reduction and shape accuracy, which was found to cause notable reductions in propellant mass flow rates in prior tests in 2019.

2. INTRODUCTION

The advent of micro launchers has created a viable alternative to traditional carrier rockets. Capable of carrying payloads up to 500 kg into a low earth orbit, they strive to play a significant role in the booming small satellite market. Researchers from the Fraunhofer Institute for Material and Beam Technology IWS and the Institute of Aerospace Engineering at TUD Dresden University of Technology have collaboratively developed an additively manufactured rocket engine with an aerospike nozzle, to support its research and diverse future implementation. The metal breadboards, created using Laser Powder Bed Fusion (PBF-LB/M), is designed to significantly improve the efficiency of these systems.

This efficiency in design translates into either less fuel required or an increase in the payload that can be transported. However, the complexity and demanding manufacturing process of aerospikes, particularly the creation of intricate internal cooling channels, have long hindered their practical application. Since 2016, the Institute of Aerospace Engineering (ILR) at TUD Dresden University of Technology and the Fraunhofer IWS have been working closely to overcome these challenges. In 2019, the joint project successfully designed, manufactured, and tested a 500 N aerospike engine, uncovering issues with the cooling system and fuel injection [1]. Since 2020, the project has been supported by the European Space Agency (ESA) and the "AeroSPIke Rocket Engine Realisation" (ASPIRER) project continues to refine the design and performance, pushing the boundaries of propulsion technology [2].

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3. RESULTS

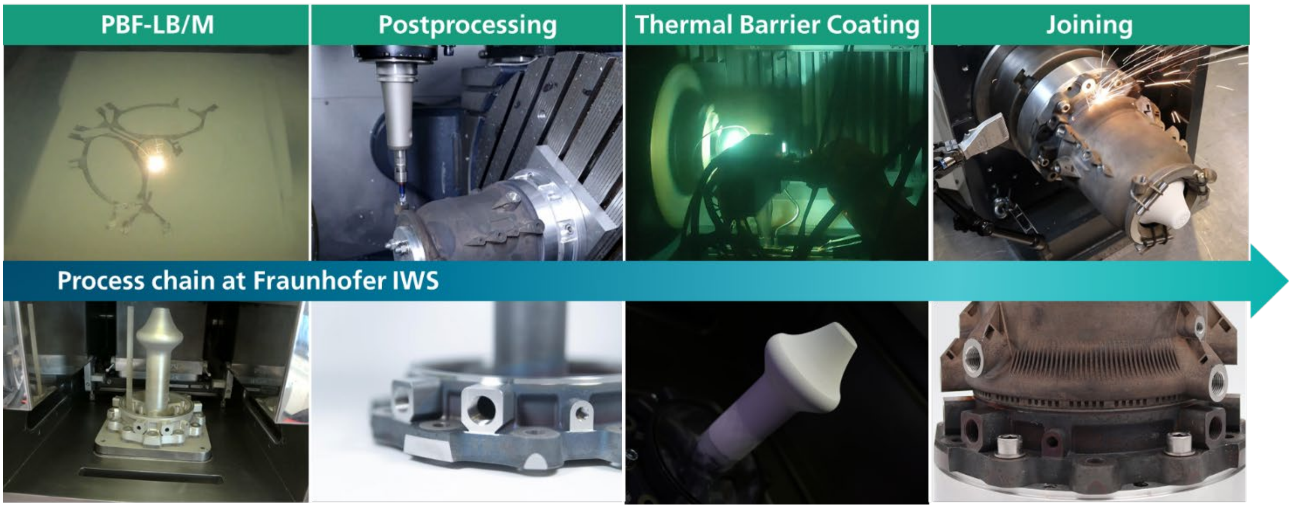

Fig. 1 Manufacturing route of the latest 6 kN aerospike breadboard engine (ASPIRER) at Fraunhofer IWS

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REFERENCES

[1] Buchholz, M., Gloder, A., Gruber, S., Marquardt, A., Meier, L. ,Müller, M., Propst, M., Riede, M., Selbmann, A., Sieder-Katzmann, J., Tajmar, M., Bach, C.: Developing a roadmap for the postprocessing of additively manufactured aerospike engines. In: 71th International Astronautical Congress (IAC) (2020)

[2] Selbmann A., Gruber S., Propst M., Dorau T., Drexler R., Toma L., Müller M., Stepien L., Lopez E., Bach C., Brückner F., Leyens C.: Process qualification, additive manufacturing, and postprocessing of a hydrogen peroxide/kerosene 6 kN aerospike breadboard engine. In: J. Laser Appl. 1 February 2024; 36 (1): 012027. https://doi.org/10.2351/7.0001121