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ADDITIVE DESIGN OF HEAT SWITCH TECHNOLOGY: LESSONS LEARNED

Abstract

Additive manufacturing of metals, as a growing market, has a lot to offer in terms of design-manufacturing capabilities and sustainability. One of the game-changing applications is thermal hardware. The paper is to provide an overview of "lessons learned" (both success & failure) on capabilities of additive design applied to two parts of the novel heat switch technology.

The Baseplate part represents half of paraffin pressure-container to withstand an internal pressure of up to 16 MPa, while the deformations reach less than 0.02 mm. Structural reinforcement encourages couple of design solutions, such as topology, parametric or multi-material optimization to reach the best mass-to-stiffness ratio and to demonstrate the capabilities of conventional SW tools. The key challenge was to eliminate internal support structures within a bioinspired design for successful manufacturing.

The second part, Flexible structure, represents the path of heat transfer. The component has a two-position on/off mode allowing a vertical movement. A flexible single-structure proved to be not feasible using current materials as topology-optimized solutions did not meet the flexibility of 6.6 % and stress-concentration requirements. Therefore, a two-part mechanism design based on stems and branches in a "tree shape" was selected. The key manufacturing challenge was to ensure that all 190 surfaces are in contact at the same time for efficient heat transfer.

Additive production of both technology demonstrators was performed on a SLM 280HL machine with AlSi10Mg powder material. Elements of concurrent design and manufacturing engineering were implemented to save time over the development cycle. At the conclusion, the knowledge gaps as software challenges with additive constraints, multi-material or multi-disciplinary optimization are discussed. The presented outputs represent a successful demonstration of the capabilities, maturity and applicability of additive design & manufacturing. However, there are several future steps on the way to full qualification. It is estimated that the readiness of both additive parts was increased from TRL 2 to 3-4 within the project, under the supervision of ESA.