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PASSIVE THERMAL CONTROL BY INTEGRATION OF PHASE CHANGE MATERIAL INTO ADDITIVELY MANUFACTURED STRUCTURES

Abstract

Optical Instruments require an extremely stable thermal surrounding to prevent loss of data quality by misalignments of the instrument components resulting from material deformation due to temperature fluctuations (e.g. from solar intrusion). Phase Change Material (PCM) can be applied as a thermal damper to achieve a more uniform temperature distribution. The challenge of this method is, among others, the integration of PCM into affected areas. If correctly designed, incoming heat is latently absorbed during phase change of the PCM, i.e. the temperature of a structure remains almost constant. In a cold phase, the heat during phase change is released again latently until the PCM returns to its original state of aggregation. Thus, the structure is thermally stabilized. At FH Aachen – University of Applied Sciences research is conducted to apply PCM directly into the structures of affected components (baffles, optical benches, electronic boxes, etc.). Through the application of Additive Manufacturing, the necessary voids are directly printed into these structures and filled later with PCM. Additive Manufacturing enables complex structures that would not have been possible with conservative manufacturing methods. A corresponding Breadboard was developed and manufactured by Selective Laser Melting (SLM). The current state of research includes the handling and analysis of the Breadboard, tests and a correlation of the thermal model. The results have shown analytically and practically that it is possible to use PCM as an integral part of the structure as a thermal damper. The results serve as a basis for the further development of the technology, which should maximize performance and enable the integration of PCM into much more complex structures.