MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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MULTIDISCIPLINARY DESIGN OPTIMIZATION OF A SATELLITE STRUCTURE BY ADDITIVE MANUFACTURING

Abstract

Fraunhofer EMI currently designs, builds and tests a Mid-wavelength infrared (MWIR) payload for a 12U nanosatellite. The mission is called ERNST (Experimental Spacecraft based on Nanosatellite Technology) and its main goal is to evaluate the utility of a nanosatellite mission for scientific and military purposes. The satellite bus is based on CubeSat components where possible and its main payload is an advanced MWIR camera.

As spacecraft weight remains to be a main mission driver for space missions Fraunhofer EMI decided to apply Topology Optimization algorithms in the construction of secondary Satellite Structures in order to achieve significant weight savings. After screening the satellite for reasonable components to undergo a topology optimization, we decided to focus on two different subsystems. Namely, the radiator and the optical bank which is the major structural member mounting all optical devices: camera including active cooling system, lenses and filters.

Main design drivers for the Topology Optimization are considered to be vibration loads during the launch period as well as thermal loads emerging from the temperature conditions in space. The structures will be designed by combining both vibrational and thermal loads into a Multidisciplinary Design Optimization model. To have preferably low design limitations in the numerical optimization process, where material is only placed at necessary areas, Additive Manufacturing (AM) can offer a solution. The significant advantage using AM exists in the design freedom with almost no design restriction compared to conventional manufacturing methods. Selective Laser Melting as one of many AM-Methods will be used to manufacture the optimized structure based on an aluminum alloy (AlSi10Mg).

As the validation process in the field of space engineering remains to be a significant part of the development process, the presented work also correlates the simulated results concerning the vibration response with experiments carried out with a shaker. More precisely the calculated Eigen-frequencies, the sinus response and random-response will be evaluated using simulated and experimentally determined data.