IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

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DEVELOPMENT AND DESIGN OF MULTIFUNCTIONAL LIGHTWEIGHT STRUCTURES FOR SATELLITE APPLICATIONS

Abstract

In the project multiSat multifunctional composite structures for satellites are developed. The main objective is the integration of passive and active functions into the spacecraft primary structure. The passive functions are heat transfer, radiation shielding and protection against orbital debris impact, whereas the active functions include vibration suppression and transmission of data and electrical energy. Composite materials and structures usually consist of multiple layers which makes them suitable for functional integration since each layer can be defined and designed to provide one or more specific functions. The concept of a multifunctional structure leads to the reduction of the overall satellite mass and savings of installation space required for subsystems. Furthermore, it also offers high potential for highly integrative and standardized production processes which will result in lower total costs and time for manufacturing, qualification and launch of the satellite.

Sandwich panels and beams made of composite materials are investigated as representative structural parts of a satellite. Based on a conceptual analysis, a design of a multifunctional composite sandwich panel is developed. Various materials and lay-ups are investigated in order to implement the passive functions and enable the integration of tertiary structures for the active functions. The heat transfer within the structure is improved by the use of structural materials with high thermal conductivities and radiation shielding is enhanced by layers with high radiation absorption capability. Metallic lattice structures and high-strength fabrics are integrated into the core of the sandwich in order to effectively break up and slow down impacting debris particles. Vibration suppression is achieved by means of flat piezoelectric transducers bonded to the face sheets and connected to shunt circuits, whereas flat cables and optical fibres are embedded into the composite structure for the transmission of electrical energy and data. For the simulation of the vibration suppression finite element models with integrated piezoelectric transducers are implemented. The efficiency of various vibration control strategies and different shunt electric circuits is compared by means of reduced order modelling. Experimental tests at coupon level are conducted on sandwich panels and beams in order to verify the integration and the performance of the passive and active functions. In this paper the pursued multifunctional structural concepts and the results

of the experiments are presented. The performance, mass and level of integration of these structures is compared to conventional structural designs of satellites with stand-alone subsystems and components.