

66th International Astronautical Congress 2015

MATERIALS AND STRUCTURES SYMPOSIUM (C2)

Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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MECHANICAL CHARACTERIZATION OF DEPLOYABLE THIN SHELL CFRP-BOOMS FOR THE  
CUBESAT “DE-ORBIT SAIL”

**Abstract**

The risk for spacecraft in Low Earth orbit (LEO) to be hit or damaged is increasing due to a growing space debris population. Reduction and limitation of this risk is addressed by de-orbiting end-of-life maneuvers. To realize such a maneuver a drag augmentation device that increases the drag efficient surface of a satellite, acting with the residual atmosphere and accelerating the decay of orbit altitude until re-entry into Earth’s atmosphere, is necessary. Currently such a device is being realized with the CubeSat based drag sail satellite DeOrbit-Sail by DLR, the University of Surrey and other partners. The goal is to demonstrate the in-orbit deployment of a 4 m x 4 m drag sail, suitable for small and medium size satellites, as an end-of-life de-orbiting device. The device has a squared sail design utilizing 4 triangular membrane sail segments that are deployed and spanned out by thin shell CFRP (carbon fiber reinforced plastics) booms. The focus of this paper is on one of the main structures, the deployable thin shell CFRP-booms that are susceptible to buckling. Properties and characteristics of full scale booms regarding structural load capacities in all applicable load directions are being determined in a newly introduced vertical load test stand. Thresholds and robustness for certain load cases like axial compression and lateral bending, and load carrying capabilities after buckling several times, are determined and quantified in practical testing, quantifying boom performance in reality. This is of high importance in order to be able to predict and design a robust drag sail structure, not failing due to overloading in space. Furthermore booms with different CFRP materials, under diverse angles of load attack, are investigated in the tests. Finally in the paper test results are compared with results of according analyses that have been performed, and will be discussed.