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Author: Dr. Susanna Laurenzi
Sapienza University of Rome, Italy

Mr. Damiano Rufo
Sapienza - University of Rome, Italy
Dr. Marco Sabatini
Università di Roma "La Sapienza", Italy
Prof. Paolo Gasbarri
Università di Roma "La Sapienza", Italy
Prof. Giovanni B. Palmerini
Universita' di Roma 'La Sapienza', Italy

SYSTEM LEVEL EXPERIMENTAL CHARACTERIZATION OF A DEPLOYABLE BOOM IN CARBON FIBER-REINFORCED PLASTIC

Abstract

Materials adopted in manufacturing of space structure are continuously evolving, always targeting a reduction in mass with the improvement of their performance parameters. At the same time, the structural design approaches need to be modified and to take into account materials' properties in order to better exploit them. Moreover, at the end of the process, verification methods should be also updated to effectively test the characteristics of these advanced structural subsystems. At the present stage, such a wide spectrum of innovation needs a case-by-case detailed analysis, and all experiences are useful to gain more general knowledge. In such a frame, this paper aims to present the work carried on at Sapienza Università di Roma in order to realize and characterize a boom structure made of carbon fiber-reinforced plastic. The boom structure is capable of changing the configuration from a packed arrangement, which is suitable for the launch phase, to a large-scale deployable configuration once in orbit. The appealing properties of such a specific subsystem, designed at Saslab, are depicted and proofed by presenting the findings of extensive studies and analyses. The manufacturing process is also described. Then, the step of the overall subsystem test is considered, first dealing with the deployment and then looking at the structural characteristics of the appendage to define how they will affect the spacecraft bus. To this aim, the extremely rigid boom has been accommodated on the 3 d.o.f. free floating platform at the Guidance and Navigation Lab to investigate its behaviour in the zero gravity condition. Specifically, the attention has been devoted to understand the subsystem properties in transmitting/damping the vibrations. In such a way, it has been possible to gather the data relevant for the design of a performant attitude control system for the platform, capable first to damp the oscillations induced at the sudden deployment of the boom, and then - in steady conditions - to accurately maintain a required pointing during a reorientation manoeuvre even in presence of a significantly long appendage. On the other hand, the same study allows to characterize in terms of vibration environment the tip of the boom as a possible accommodation for instruments. In such a way, the complete design and manufacturing cycle of an advanced structural component can be reported, providing useful insight on the peculiar steps to be followed up to the final test tasks.