MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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VERIFICATION TESTING OF THE GOSSAMER-1 DEPLOYMENT DEMONSTRATOR

Abstract

In recent years the German Aerospace Center (DLR) developed gossamer structure deployment technology, corresponding mission concepts and qualification strategies. The work was carried out in DLR's Gossamer-1 Project. The technology allows the deployment of membrane structures applicable for various space applications. A focus was on solar sailing and flexible photovoltaics as well as drag augmentation. The technology was subjected to various qualification tests. The paper presents the latest results of that test campaign. The performance of the technology with respect to its field of application will be discussed.

A first technology demonstration mission has been studied and a mission statement and mission requirements as well as a suitable operations concept were established. After analyzing these specific requirements a stowing and deployment strategy was chosen. It is based on aluminium coated polyimide thin-film membranes and carbon fiber reinforced plastic shell booms. In the further course of the project the mission design was detailed and the required mechanisms, electronics, and algorithms were engineered. With the Gossamer-1 technology a sail size of approximately 25m is realized. A specific qualification/verification testing strategy for deployable membrane spacecraft structures was established based on a test-as-you-fly approach.

Engineering models were built and the deployment technology was subjected to development and qualification tests. All aspects of the deployment were tested in ambient environment and several components were also subjected to environmental qualification testing. In the further development a fully functional qualification model of the deployment unit was manufactured, including all avionics and two sail segments, partially equipped with thin film photovoltaics. The qualification model was subjected to qualification tests. These tests included vibration, fast decompression, thermal-vacuum and deployment testing.

With the latest qualification tests the deployment technology approaches Technology Reediness Leve (TRL) 5. Using the established test strategy a characterization of the deployment performance with its deployment forces was made. This data can be used for further development and as input for mechanism and structure sizing. In addition the deployment electronics and the implemented logic were tested. The established test strategy and the deployment test rig can easily be adapted for test of deployment technologies in other fields of application and other projects. Examples for this know-how transfer are the ESA drag sail projects Deployable Membrane and Architectural Design and Testing of a De-orbiting Subsystem (ADEO) as well as the tether deployment of the HP3 experiment on the NASA/JPL Mars mission Insight.