

MATERIALS AND STRUCTURES SYMPOSIUM (C2)

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

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ULTRALIGHT DEPLOYABLE BOOMS FOR SOLAR SAILS AND OTHER LARGE GOSSAMER
STRUCTURES IN SPACE

Abstract

Future solar sail spacecraft which do not need any rocket motors and propellants are a promising option for long-term exploration missions in the solar system. However, they will require ultralight reflective foils and deployable booms which will allow for the unfolding of huge sails. The achievement of an acceptable ratio of reflective sail area and structural mass, which results in a still small, but significant acceleration under the photon pressure of sunlight, is extremely challenging. The same challenging deployment technique is required for the unfolding of large reflector membranes or antennas (gossamer structures). The key elements are the booms which must be stowable in a very small envelope before they reach their destination in space.

Ultralight carbonfiber booms which were developed by DLR for these purposes have been successfully tested under zero-g-conditions during a parabolic flight campaign in February 2009. It could be convincingly demonstrated that the unfolding process is both controllable and reproducible. The booms consisted of two co-bonded omega-shaped half shells with 0.1 mm wall thickness each and had a weight of only 62 grams per meter. Two different deployment technologies were tested, one based upon an inflatable 12m thick polymer hose inside the boom, the other one using an electromechanical uncoiling device at the tip of each boom. In the latter case, the uncoiling devices will radially fly away from the spacecraft, such that they become “expendable deployment mechanisms” and their mass does not count any more for the spacecraft mass that needs to be accelerated or actively controlled.

In summary, the DLR zero-g test campaign related to the ultralight carbonfiber booms has promoted their design maturity significantly, so that their potential use for solar sails or other large gossamer structures in space is now assuming a definite form.