

MATERIALS AND STRUCTURES SYMPOSIUM (C2)

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

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GROUND TESTING OF A 8-METER 4-QUADRANT SCALABLE SOLAR SAIL

Abstract

Solar sails are thin film space structures which span very large areas. Qian Xuesen Laboratory of Space Technology, CAST is designing a 160m solar sail and developing a 8m scalable solar sail. This paper describes the structure static tests of a 8 meters 4-quadrant scalable solar sail, which are conducted for the purpose of validating analytical models that will be required by a flight test program to predict in space performance. Two kinds of sails are tested, one is $12.5\mu\text{m}$ thickness aluminized Kapton and the other is $25\mu\text{m}$ Kapton. The 4-quadrant solar sail is connected from the three corners to the end of the inflation deployed masts. The sail is suspended horizontally, and the tension forces at the corner vary from 10N to 50N. The sail billows due to the gravity in the 1g environment and wrinkled due to the tension force at the corner. A laser scanner is applied to measure the deformation and morphology of the sail and obtain the continuous and smooth surface, where the in-plane and the out-plane surface measurement accuracies are higher than 0.2mm and 1mm separately. Results show that laser scanning is an effective method to measure the large area thin film structures. For the $25\mu\text{m}$ sail, the maximum deflection decreases from 430mm to 120mm with the increasing tension forces from 10N to 50N, and the depth to sail size is about 5.4% to 1.5%. For the $12.5\mu\text{m}$ sail, the maximum deflection decreases from

325mm to 115mm with the increasing tension forces, and the depth to sail size is about 4.1% to 1.4%. The deflection decreases with the increasing tension forces, and tends to be constant when the force is above 40N. The difference between the deflection of the two kinds of sails tend to be close as the tension force is above 30N. Wrinkles appear at the corners of the sail, the direction of which is approximately the same as the tension force direction and the maximum wrinkle is about 50mm wide and 20mm high.