Title of Paper  
Missions of Small Satellite with Deployable Membrane using Spiral Folding Lines

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Abstract

In microgravity conditions, the structures where the components with low stiffness are installed could maintain its initial shape. By deploying the membrane in space, it is possible to arrange the structural elements in wide area. In this wide area, we can expect the structure of solar panel and sail, antenna, drag shoot for deorbit and so on. Attention has been focused on the availability of satellites in low orbit due to its missions related with the distance to earth. We have developed 1U size small satellite WASEDA-SAT shown in figure 1, by reducing the development costs using consumer products, to grasp the behavior of the film surface in low orbit. In this paper, we report all of the functions and the verification results of the satellite on ground and on orbit if the launch is finished and the operation is stared normally. Assuming the disturbance in low orbit and considering the increase of stiffness from planner membrane, the governing equations of spiral folding lines are newly formulated considering its thickness and applied to fold the curved surface into cylindrical shape. In flight model, the surface is implemented as a parabolic surface with the focal length as 80cm. A polyimide film coated one side with silver is used shown in Figure 2. The paint on the other side is also used for measuring the film surface shape by capturing images projected from the satellite. On the other hand, this membrane equips some functions. The focal length is the same as extension distance to obtain improvement of antenna gain of the satellite. In an anechoic chamber, gain improvement was not confirmed by the problems of shape accuracy after deployment. On the silver coated surface, thin-film solar cells are pasted to show the advantages of the proposed governing equation that has an ability to consider thickness effect of membrane and pasted parts. In addition, the satellite has the LCD panel on one side of body to confirm the effect of radiant heat controlled by its operation, which has been confirmed on the ground. Through 1U size satellite, membrane dependent missions are discussed and we showed detail design of satellite including the result obtained on ground.
Figure 1  Structure of WASEDA-SAT3

Figure 2  Membrane (R350) of Flight Model and folding lines and demonstration by paper

References


