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IMPROVEMENT OF SAIL STORAGE STRUCTURE AND DEPLOYMENT MECHANISM FOR NEXT SPIN-TYPE SOLAR POWER SAIL-CRAFT

Abstract

After the solar power sail demonstrator IKAROS successfully deployed its 14 meters wide spinning sail membrane in 2010, 40 meters wide solar power sail-craft for Jupitar Trojan has been developed based on IKAROS at JAXA. In this paper, the result and outcome of the solar sail deployment experiment of IKAROS are first summarized and recent improvements and tests of the structures and mechanisms for the next large solar power sail are explained.

IKAROS is a unique spinning solar sail spacecraft and the deployment method consists of two stages. Several unexpected phenomena were observed such as asymmetric shape after the first stage deployment and non-synchronous behavior during the second stage deployment. In consideration of the phenomena and the increase of the sail size, the structure and mechanisms and the sail storage method have been improved for the next solar power sail. Sail storage spool is enlarged and pin release mechanisms are introduced to fix the center of four trapezoidal petals to prevent the rolled-up sail from dropping out from the spool during launch. The release of the pins is the trigger of the second stage deployment. In IKAROS, the guide bars of the deployment mechanism have three functions: (1) the sail restraint during the launch, (2) the quasi-static sail deployment in the first stage and (3) the trigger of the second stage deployment. In the next solar power sail-craft, the guide bars are detached from the stowed sail and have only one function of (2).

Recently, in order to examine the effectiveness of the improvements, sail roll-up test, first stage deployment test and the second stage deployment trigger test were conducted on the ground using a prototype model of deployment mechanism and a trial model of 40 meters wide trapezoidal membrane with dummy solar cells. It was confirmed that the large membrane was successfully rolled-up by applying the repeatable storage method and that the membrane was almost smoothly reeled out using the deployment mechanism

and tension loading apparatus. It was also confirmed that the trigger pin released by NEA could be separated from the multiple folded membrane.