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# SIGNIFICANCE OF 3U CUBESAT ORIGAMISAT-1 FOR SPACE DEMONSTRATION OF MULTIFUNCTIONAL DEPLOYABLE MEMBRANE

**Abstract**

This paper shares the lessons learned through the development and operation of 3U CubeSat OrigamiSat-1, which has been launched by JAXA Epsilon Rocket in January 2019. "Multi-functional" membrane deployable space structures have been studied in the past to realize ultra-lightweight solar power generation arrays or phased array antennas. However, deployment of such innovative structures has been rarely demonstrated in space yet. To this end, for OrigamiSat-1, the authors successfully developed a 1m-by-1m square deployable membranes, on which thin-film devices are attached throughout its surface.

The deployable membrane structure on OrigamiSat-1 has the following key aspects: (i) Accommodation of non-negligible thickness of the thin-film devices attached on the deployable structure by using "woven textile"; and (ii) Combination of carbon-fiber composite tubular booms and conventional metal convex tapes to realize self-deployment of the textile membrane. In addition, OrigamiSat-1 has a stereo vision system to measure the three-dimensional shape of the entire delayed membrane on orbit. The measurement system includes a 1-m extensible selfie stick, which is another deployable structure in the 3U CubeSat. To establish such new structural architectures, the design of OrigamiSat-1 experienced several iterations. The functions of deployable structure prototypes and a flight model have been verified through deployment tests in suspended conditions, and in a vacuum chamber. In addition, new analytical models have been developed based on elemental stowage and deployment tests.

As for the bus system, OrigamiSat-1 combines standard CubeSat components, which are available commercially, and a newly developed circuit board to mainly handle power inhibits. The power inhibit system is required to satisfy the interface controls with Epsilon Rocket. The system includes three mechanical switches attached at the end of satellite rails to detect the release, as well as SSR (Solid State Relay) and MOSFET to completely separate the battery and the other satellite system until the release.

As a result, the present authors have developed not only an innovative deployable membrane architecture; but also the on-orbit structure measurement system as well as the 3U CubeSat bus platform, which will enable successive space demonstrations of various kinds of deployable structures in near future. This paper describes the flight example of such authors' design to facilitate space technology demonstrations using CubeSats.