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VALIDATION OF VISCOELASTIC MULTI-LAYERED DEPLOYABLE SOLAR PANEL MODULE FOR 6U CUBESAT OF STEP CUBE LAB-II

Abstract

Recently, the space industry is pursuing economical satellite development method according to the New Space paradigm. Accordingly, small satellites are being mass-produced because it can be developed in a short period of time and have relatively low risk of mission failure, and existing missions performed by large satellites are being replaced by multiple small satellite constellations. Therefore, the advancement and diversification of missions of small satellite are required, and application of large solar panel is required to satisfy increased power consumption. In case of CubeSat, which is classified as small satellite, deployable solar panel is mainly applied to increase storage efficiency under limited volume requirements caused by being stowed inside the deployer during launch. However, as size of solar panel has increased, there is limit to ensuring structural safety of solar cells due to excessive dynamic displacement under launch vibration environment. In general, a method of minimizing dynamic deflection of solar panel by increasing stiffness by applying additional stiffeners made of various materials such as aluminum or composite material has been applied. However, this method is difficult to apply to CubeSat which has limited design requirements because it causes increase in volume and weight. In addition, holding and release mechanism (HRM) is applied for deployable solar panel. The HRM using nylon wire could develop low shock and low cost as compared to explosive HRM or shape memory alloy-based HRM applied to a commercial satellite, and this system is relatively simple and thus it is easy to apply for CubeSat. Therefore, a nylon wire cutting method HRM is generally applied for CubeSat, in which fastening force is applied to solar panel using nylon wire and heating resistance to release the restriction when CubeSat is operating. However, as it depends only on the tension of the nylon wire when restraining the solar panel, the fastening force is weak, and there is a disadvantage in that the solar panel is not restrained in-plane direction. This study proposed a highly damped viscoelastic multi-layered stiffener based solar panel module for applying to 6U earth observation CubeSat 'STEP Cube Lab-II'. This solar panel module has high damping characteristic by suppressing the vibrations transmitting through the solar panel by constrained layer damping achieved using printed circuit board (PCB) based multi-layered thin stiffeners with double-sided viscoelastic tapes. Furthermore, holding and release function of the solar panel was achieved by cutting a nylon wire using three spring-loaded pogo-pins based mechanism. This mechanism has great advantages of higher holding capability, ability to constrain along in-plane and out-of-plane directions of solar panel and simplicity in tightening of nylon wire. Through the application of pogo-pins, it can be used as electrical connection, and the electrical system can be simplified. Basic characteristics of this solar panel module were measured through free-vibration tests. Design effectiveness of the solar

panel module was validated through qualification-level launch vibration test and life cycle test.