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THERMAL ANALYSIS OF HYBRID SYSTEM COMBINED WITH THIN FILM AND BULK STRUCTURE FOR SOLAR POWER SATELLITE

Abstract

We are studying and developing a hybrid system combined with thin film and bulk structure to realize a huge space system of a solar power satellite (SPS). We carried out thermal analysis and the thermal testing using thermal models of this hybrid system.

The SPS generates electricity using a large-scale solar array and transmits energy by microwaves to the ground without an effect of the weather or day and night. Therefore, the SPS is expected to promote the large-scale introduction of solar power.

One of the problems to realize SPS is the transportation of materials into the orbit. A tethered SPS which is considered in Japan is composed of the power generation and transmission panels with module structure. Also, the tethered SPS consists of a large-scale panel of several km square size with several cm in thickness. Deployable panels of the tethered SPS will be transported over 1000 times by launch rockets and be constructed in the orbit. Thus, we are considering using thin film structure to reduce the frequency of transportation. The thin film part is a deployable structure using frame mechanism. However, in the case of thin film, the heat path is small, and it has a low natural frequency. Therefore, RF circuits and power control and distribution circuits need to be installed in the thickness parts (bulk structure). For these reasons, we're studying and developing the deployable hybrid system combined with thin film and bulk structure.

In the case of the hybrid structure for the SPS, thermal deformation is required to be considered. Since the power transmission side of the SPS in the orbit always faces the earth, irradiation conditions of the power generation and transmission panel by the sunlight are cyclically changed. Therefore, a cyclic thermal deformation will occur in the SPS. In the tethered SPS, a deformation of the transmission antenna by thermal stress in the power generation and transmission panel leads to a deterioration of wireless power transmission efficiency. Also, from the viewpoint of thermal design, it's necessary to consider the heat generated from the electrical and electronic circuits installed on the hybrid structure.

In this paper, we'll describe the results of thermal analysis and experiments using the thermal models about the hybrid system for the SPS.