SPACE POWER SYMPOSIUM (C3)
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DEVELOPMENT OF SUPER-LIGHTWEIGHT LARGE SCALE POWER GENERATION SYSTEM FOR SOLAR POWER SAIL

Abstract

The solar power sail for planetary exploration requires a super lightweight and large scale power generation system. This system requires the specific power more than 2 kW/kg. This lightweight power generation system will utilize a thin film solar array on polyimide films. The thin film solar cells on polyimide film have asymmetric and multi-layer structure. Because each layer of the thin film solar array has different CTE (coefficient of thermal expansion), it will bend with changes in temperature in the space environment. It is needed to suppress curvature of the thin film solar array system to be loaded onto the spacecraft. To suppress curvature, we are developing a shape control procedure by a surface coating method. Thin layer of metal oxide is formed by RF magnetron sputtering. We have used zinc oxide and cerium oxide as metal oxides layer. These have been used as a material for a surface coating, such as to prevent degradation by ultraviolet ray. In this paper, we describe the experimental results of the mechanical and optical evaluation tests. By the experiments, we measured Young's modulus and linear expansion coefficient of the metal oxide layers, and evaluated inner stress which is generated by sputtering. Also, we derived the model formula of the multi-layer structure for a shape prediction. The inner stress is a sum of two stress. One is generated when each layer was formed. It is called the true stress. The second stress is caused by the difference in CTE. It is called the thermal stress. Analysis results of the modelling for the shape of the thin film solar array were in excellent agreement with the experimental results.