Paper ID: 40843
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student

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advancements in Materials Applications and Rapid Prototyping (9)

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PRELIMINARY DESIGN AND EVALUATION OF RADIOWAVE TRANSMISSIVE MLI FOR SPACECRAFT

Abstract

Multilayer insulation with polyimide foam (PF-MLI) has been studied as a new insulator for next generation spacecraft. PF-MLI has higher insulation performance than that of conventional MLI as we had shown in previous work (Takagi *et al.*, 63rd IAC, 2012). In the case of the mission which needs high insulation performance such as deep space or lunar exploration mission, it is required to cover an antenna by MLI. However, MLI does not transmit radiowave because they are composed of multiple layers of metalized films with low emittance. In this work, we have been studying a radiowave transmissive MLI based on PF-MLI by using a new thermal control material instead of metalized film.

The new thermal control material is called as COSF (Controlled Optical Surface Film). COSF consists of a polyimide film for substrate and dielectric multilayer coating on it. The solar absorptance and infrared emittance can be freely controlled by the interference of its dielectric multilayer, and the COSF has radiowave transmissivity. The COSF is designed by genetic algorithm method. The information of multilayers, such as materials and thickness, is encoded as a gene and evaluated according to an evaluation function.

The solar absorptance of COSF used on the outer surface of PF-MLI is 0.06 and the normal emittance and total hemispherical emittance is 0.76 and 0.70 at 300 K respectively. On the other hand, the normal emittance and total hemispherical emittance of COSF in the middle layer of PF-MLI is 0.14 and 0.17 at 300 K respectively. These thermo-optical properties has been measured by monochrometer, FTIR at room temperatures and calorimetric method in the temperature range of 173-373 K.

The radiowave transmissive MLI called as RT-MLI has been made by combining polyimide foam with COSF and its effective thermal conductivity has been measured by guarded hot plate method in the temperature range of 163-350 K. The density of polyimide foam (BP301, UBE Industries, Japan) is 6-8 kg/m^3. The prototype of RT-MLI is composed of 2 layers of polyimide foam (BF301, $t = 5$ mm) and 1 layer of COSF in the middle of them. As a result, the effective thermal conductivity is reduced by 30 % compared to that of polyimide foam (BF301, $t = 10$ mm) without COSF. This RT-MLI will be used for a lot of mission in near future.