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MATERIAL EXPOSURE EXPERIMENT AT SUPER LOW ORBIT ONBOARD TSUBAME

Abstract

Atomic oxygen (AO), a dominant neutral gas at low Earth orbit (LEO), is an important factor affecting material degradation. Especially, the AO density at an altitude lower than 300 km (called "super low orbit") is estimated to far exceed that at the International Space Station (ISS) orbit, and severe degradation of the material is concerned. In several studies, understanding of the reactions between AO and materials has been performed using the facility of the ISS. However, at a super low orbit, there are few evaluation examples of material degradation, and material degradation phenomena are not well understood.

Therefore, we conducted Material Degradation Monitor (MDM) mission using Super Low Altitude Test Satellite (called "TSUBAME"). MDM is a material exposure experiment to obtain the degradation data of thirteen kinds of materials which are expected to be used for future super low orbit satellites. The material samples were exposed in a super low orbit and observed with a CCD camera more than once a week. This paper shows the analysis results of this mission. The AO fluence to material samples was calculated by a neutral atmospheric model NRLMSISE-00 (MSIS) and the satellite attitude data. As a result, the AO fluence to material samples during the flight period was estimated $1 \times 10^{22} atoms/cm^2$. Moreover, with respect to the images acquired by this mission, the pixel value changes of each sample were analyzed. As a result, it was confirmed that the surface of AO protective coating (SQ coating) coated polyimide film was changed. The entire surface of this film began to change at the AO fluence of more than $1 \times 10^{21} atoms/cm^2$. Moreover, regarding silvered FEP films, the intensity and area of transmitted light increased with increasing AO fluence. This change was presumed to be based on the reaction between silvered layer and AO which reached the back surface.

Moreover, we performed the AO simulation test by using a ground irradiation facility to clarify the reaction mechanisms related to phenomena obtained by this mission. After the AO simulation test, optical observation using the engineering model of the CCD camera installed on the MDM mission was performed. In this paper, by comparing the results of the ground test with that of the MDM experiment, we also discuss the specificity of the material degradation phenomena in a super low orbit.