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INVESTIGATION OF MATERIAL BEHAVIOR OBSERVED AT VERY LOW EARTH ORBIT ONBOARD TSUBAME

Abstract

Atomic oxygen (AO), a dominant component of residual atmosphere at low Earth orbit (LEO), is an important factor affecting degradation of spacecraft materials. In particular, the AO density at an altitude lower than 300 km, called very low Earth orbit (VLEO), is estimated to be higher than that at altitude of the International Space Station (ISS) such as 400 km. However, because there are few material exposure experiments at VLEO, material degradation phenomena under high AO density environment are not well understood.

Material Degradation Monitor (MDM) experiment onboard Super Low Altitude Test Satellite (called "TSUBAME") was designed to obtain degradation data of thirteen types of materials which are expected to be used for future VLEO satellites. Their optical images were obtained by using a CCD camera and two types of LEDs, frontside and backside LEDs. The frontside LED illuminated the front of the samples, and their visible light reflection characteristics were observed. The backside LED illuminated from behind the samples, and their visible transmission characteristics were observed.

This paper shows analysis results of AO fluence and the optical images, and degradation mechanism of the material samples are discussed based on results of ground-based AO irradiation. The AO fluence was calculated using a neutral atmospheric model NRLMSISE-00 and the satellite attitude data. The total AO fluence was estimated such as 1×10^{22} atoms/cm^2. A polyimide film with AO protective coating (*SQ* coating) and silvered FEP films were found to significantly change during the exposure by analyzing the obtained images.

Ground-based irradiations were conducted with an AO irradiation apparatus to clarify the phenomena obtained in this flight mission. The *SQ* coated polyimide film and the silvered FEP films were irradiated with AO, and their surface morphologies were observed. It was suggested that the *SQ* coated film might have physical defects due to the reaction between AO and the *SQ* layer, and the change of the silvered FEP films observed here was presumed to be based on the oxidation reaction between silver layer and AO which reached the backside of the samples.