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Author: Dr. Masahito Tagawa
Kobe University, Japan

Ms. Yokota Kumiko
Kobe University, Japan

# ROLE OF INERT GAS COLLISION ON A MATERIAL DEGRADATION IN LOW EARTH ORBIT

**Abstract**

It has been well-known that many polymeric materials used at the exterior of spacecraft are affected severe degradation during the flight in low earth orbit (LEO). This phenomenon has been recognized due to hyperthermal atomic oxygen collision which is a major component in the upper thermosphere of the Earth (100-600 km above sea level). The breakage of the material (aluminized polyimide) was reported due to atomic oxygen-induced etching occurred within one year of exposure on the International Space Station. Much effort has been paid for simulating the materials degradation in a ground-based facility. A laser detonation atomic oxygen beam source, which creates atomic oxygen beam with translational energy of 5 eV, has been used for simulating atomic oxygen environment in LEO. However, inconsistent results of erosion on fluorinated polymers have been reported between laboratory and space. This phenomenon has been recognized by the synergistic effect of atomic oxygen and vacuum ultraviolet from oxygen plasma. Recent studies, however, identified the remarkable lack of synergistic effect of atomic oxygen and ultraviolet, and pointed out the effect of high-energy component of atomic oxygen on the accelerated erosion phenomena. The experimental results as well as theoretical calculation predict that the fluorinated polymer could have high-resistance to atomic oxygen collision at 5 eV in LEO environment. Due to explain the erosion phenomena of fluorinated polymer in LEO, influence of heavy molecule collision on material degradation is considered in this study. The experiments were carried out using laser detonation beam source with chemically inactive Ar as source gas. Erosion of fluorinated polymer and polyimide was measured from the frequency shift of the quartz crystal microbalance (QCM). In order to narrowing the energy spread of the atomic oxygen beam pulse, a high-speed mechanical chopper wheel was used in this experiment. It was clearly observed that the polyimide does not show any erosion by Ar beam exposure, in contrast, mass of fluorinated polymer decreased with high-energy collision (¿6eV) of Ar bombardment. The threshold energy of Ar-induced erosion of fluorinated polymer is lower than the collision energy of N2 in LEO, which is the second major composition in the upper atmosphere of the Earth. The possibility of N2-induced erosion is suggested on the fluorinated polymer erosion in LEO.