Durability Test of Spacecraft Materials in LaSEINE

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Space systems such as a satellite, interplanetary probe or a space station, must endure the extremely harsh environment made of space plasma, hyper-velocity particles, radiation, ultraviolet ray, atomic oxygen, vacuum, thermal cycles and so on. Even if a components breaks down, it is usually impossible to repair. Therefore, we are often required to test spacecraft thoroughly.

In December 2004, Kyushu Institute of Technology established LaSEINE (Laboratory of Spacecraft Environment Interaction Engineering). At the center, we carry out research and development of space environment technology that is necessary to achieve the next-generation large-scale space utilization such as high-speed broadband communication, high-precision positioning, remote sensing, material creation, sight-seeing, exploration, energy generation. LaSEINE focuses on the following five main research area at present.

A) Charging and arcing experiment
B) Development of numerical analysis software on the charging phenomena (MUSCAT, Multi-Utility Spacecraft Charging Analysis Tool)
C) Hypervelocity impact experiment
D) Degradation experiment of spacecraft materials
E) Basic study on the surface charging, arcing, hypervelocity impact and explosion, and research and development of elemental technique on the mitigation of them

In the presentation, we introduce the investigation on degradation experiment of spacecraft materials in section D.

It has not been made clear how the electrical properties of space-use materials varies with increasing the duration of exposure in space environments, and not enough researches have been done on the degradation mechanisms. Polymeric materials, e.g. polyimide, fluorocarbon polymer, etc., widely used as thermal control materials covering the outer surface of the spacecrafts are especially degraded by the interaction with plasma, atomic oxygen, ultraviolet ray, charged particle radiation, etc., in space environment, resulting in the undesirable variations of electrical, mechanical, and thermo-optical properties on the materials. In particular, the spacecraft charging analysis software MUSCAT, which is being developed by LaSEINE, requires the database of electrical properties on pristine and degraded spacecraft-surface materials to analyze the charging of spacecrafts. Therefore, our research center, LaSEINE, is doing research on the durability of the materials in space environments. We introduce some investigation currently performed in LaSEINE.