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Author: Mr. Fahd Moumni
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology, Japan, moumni.fahd655@mail.kyutech.jp

Mr. Alexandre PAUL-SIMON
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology, France, simon.alexandre-paul490@mail.kyutech.jp
Mr. Takahiro IMAI
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology, Japan, p111003t@mail.kyutech.jp
Mr. Kazuya MIHARA
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology, Japan, mihara.kazuya514@mail.kyutech.jp
Mr. Paul MICHEL
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology Japan, France, paulmichel211@gmail.com
Mr. Minoru Iwata
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology, Japan, iwata@ele.kyutech.ac.jp

# GROUND TEST ANALYSIS OF POLYMERS DEGRADATION CAUSED BY CHARGED PARTICLES IN GEOSTATIONARY ORBITS

**Abstract**

Polymers are of utmost importance in spacecrafts thermal insulation. Their good thermo-optical properties are effective against infrared radiations, the primary heat transfer source in space. However, their degradation in the space environment, identified by the phenomenon of darkening, induces a strong need to test them before application. The optical degradation results mainly from the charged particles, such as protons and high energy electrons, present in the geostationary orbit. Compared to on-orbit testing, ground testing presents advantages such as, the choice of samples and materials, and faster tests execution. Yet, it requires specific machines in different facilities. Consequently, logistics become an issue for these experiments. Particle irradiations have already been conducted on polymers to understand how to ameliorate their radiation resistance but distinction between particles for GEO conditions is uncommon. This research aims to simplify and improve the ground testing methodology by comparing proton and electron irradiations of thermal insulation polymers (ex. Kapton) for spacecraft applications. The comparison helps to identify which charged particle degradation effect dominates in the geostationary orbit and, to reduce the testing procedure, maintenance and cost. Practical experiments are started after Monte-Carlo simulations of the particles distribution within a sample. The uniform comparison of a large range of energies, between protons peaked profiles and electrons', solicits the creation of a theoretical "Spread-Out Bragg Peak" using the Monte-Carlo Matrix Computation Method. This methodology is typical for proton therapeutic radiation consideration. The new "Vacuum Transport Vessel" (VTV) developed in the Kyushu Institute of Technology is used to prevent the "recovery" of degraded samples at air exposure. The VTV keeps samples in an adequate vacuum of 10-3 Pa during 5 days, between

facilities. Before and after irradiation, polymers' transmittance is measured under vacuum with a UV-Visible Spectrometer. Chemical species are identified, in air, with an FTIR spectroscope. Kapton samples of 28m thickness, underwent electron irradiations of 0.11 MeV and 50A (2 MGy dose). Proton irradiations were conducted with an energy of 0.5 MeV (2 MGy), then 2 MeV (10 MGy). Preliminary results show a decrease of transmittance of around 3