【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering)

Title of Project : On-orbit Observation of Charging and Arcing Phenomena by a Nano-Satellite for Realization of High Voltage Space System

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Research Area : Space Engineering
Keyword : Space Environment, Spacecraft Charging, Small Satellite

【Purpose and Background of the Research】

To realize a large space platform of 1-MW class, power generation at a high voltage, at least 300V, is necessary. Arcing occurs, however, on solar array surface due to charging via plasma when the voltage exceeds 200V in LEO. The arcing threatens reliability of large/medium satellites. In satellite development, we carry out ground tests to investigate whether arcs occur and their effects. The biggest problem is that nobody measured the arc current waveform nor saw the arcs. To carry out "physically correct testing", we need to measure the current and identify the location of arcs in orbit.
The purpose of this research is to observe various phenomena related to spacecraft charging and arcing and demonstrate the mitigation technology via a nano-satellite, HORYU-IV. We launch the satellite to an orbit crossing the aurora zone. We will carry out the following experiments,

(1) Measure the arc current on solar array, identify its location from the arc image and investigate IV performance degradation due to arcs.
(2) Demonstrate solar array design that does not arc during 300V power generation.

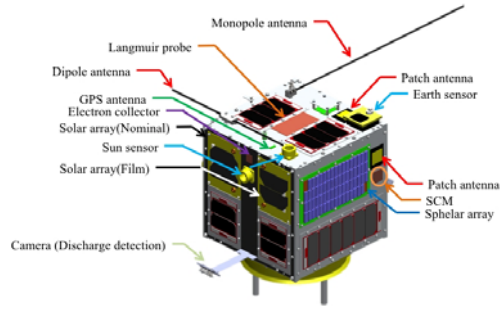

Figure 1 HORYU-IV

(3) Demonstration of spacecraft charging mitigation by ELectron-emitting Film (ELF).

【Research Methods】

In 2012, we succeeded in photovoltaic power generation at 350V in orbit for the first time in the world onboard a nanosatellite HORYU-II. We will further the achievement in this research.
HORYU-IV is based on HORYU-II. The satellite is made of COTS-based components available on the market or developed already for HORYU-II. We will develop the mission payload, a high-speed oscilloscope, and integrate it to the camera and data acquisition board. We will carry out all the tests except radiation at our university. We plan to develop the satellite in 2.5 years. We will launch the satellite either via H2A or a foreign launcher. The satellite operation is at least one year.

【Expected Research Achievements and Scientific Significance】

We will reflect the findings to revision of ISO-11221, "Space systems – Space Solar panels - spacecraft charging induced electrostatic discharge test methods" and contribute the reliability improvement of large satellites. The demonstration of arc-free solar array design contributes to realize a 1MW-class large space platform and a 100kW-class electric propulsion system. The demonstration of ELF will contribute to the reliability improvement of Earth remote sensing satellites and Geostationary satellites by providing revolutionary charging mitigation methods.

【Publications Relevant to the Project】

・Cho, M., Masui, H., Iwai, S., Yoke, T., Toyoda, K., "Three Hundred Fifty Volt Photovoltaic Power Generation in Low Earth Orbit", J. Spacecraft and Rocket, doi: 10.2514/1.A32559, 2013.
・Hosoda, S., Cho,M., et al., "Development of 400V Solar Array Technology for Low Earth Orbit Plasma Environment", IEEE Trans. Plasma Sci. Vol.34, pp. 1986-1996, 2006

【Term of Project】 FY2013-2017

【Budget Allocation】 157,700 Thousand Yen

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