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Overview of Spacecraft Charging Research in Korea

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***Abstract*— Spacecraft charging research is becoming more active in Korea. In charging simulation area, Kyung Hee University and Korea Aerospace Research Institute (KARI) are developing a surface charging simulation code based on the particle-in-cell (PIC) method. The initial version of the code has been used to study basic properties of the plasma-wall interaction and applied to analyze the surface charging of a Korean low-Earth satellite. We are also performing data analysis for the surface and internal charging using spacecraft measurements. An interesting study is the investigation of a very strong internal charging event that was observed by the Van Allen Probes spacecraft in the outer radiation belt. This event is investigated in detail using the internal charging monitor and particle detectors covering large energy ranges onboard the Van Allen Probes spacecraft. Two space missions with space environment detectors are being developed in Korea. One of the missions is a small satellite mission (NEXTSat-1), which will be launched on 2016 into a low-Earth orbit. The other is a geosynchronous satellite mission (GK2), which will be launched on 2018. An interesting issue is that a charging monitor will be launched onboard the geosynchronous satellite with particle detectors covering the energies from 100 keV to a few MeV. This mission will provide in-orbit measurement data to study the effect of space environment on spacecraft charging in the geosynchronous orbit.**

Keywords—spacecraft charging; space missions

Since the launch of the first satellite in Korea on 1992, Korea has conducted many space missions. However, until recently there have not been active researches on spacecraft charging. From 2010 Korea started to develop a surface charging simulation code and analyze satellite data for spacecraft charging. Still spacecraft charging research in Korea is in the beginning phase and only a small number of researchers are working in this field. In this paper we will briefly introduce the research activities on spacecraft charging in Korea.

From 2010 Kyung Hee University and Korea Aerospace Research Institute (KARI) have developed a surface charging simulation code for low altitude satellites. The code is based on the particle-in-cell (PIC) method, and a rectangular grid system is employed. The code includes precipitating electrons in the auroral region, secondary electron emission (SEE), and photo-electron emission (PEE). Monte Carlo method is used to determine the injection of electrons according to the estimated yield. The initial version of the code was completed in 2013 and applied to analyze surface charging of a Korean low altitude satellite. Currently the code is undergoing modification to include geosynchronous satellites.

Data analyses on the effects of space environment on the surface and internal charging are also performed using spacecraft measurement. Using the spacecraft potential and cold plasma measurements from a Korean low altitude satellite STSAT-1 the effects of cold plasma densities and temperatures on the variations of spacecraft potential have been investigated. It was found that temperature difference and potential difference have good linear correlation with each other. An investigation on strong internal charging is also being carried out using the internal charging and high energy particle measurements from Van Allen Probes in the outer radiation belt. The preliminary results of the study will be presented by J. Lee (abstract #212) in the poster session.

Space missions would be the most active area in relation with the spacecraft charging. Currently two space missions with space environment detectors are being developed in Korea. One of the missions is a small satellite mission (NEXTSat-1), which will be launched on 2016 into a low-Earth polar orbit. The scientific mission of NEXTSat-1 is to study space storms in the ionosphere and auroral regions. For this a package of space science instruments, Instruments for the Study of Space Storms (ISSS), was selected as a main scientific payload [1]. ISSS consists of space radiation monitoring instruments and space plasma instruments. The space radiation monitoring instruments consist of medium energy particle detector (MEPD), which measures electrons and protons with energies from tens of keV to ~400 keV, and high energy particle detector (HEPD), which measures electrons with energies from 100 keV to ~1 MeV and protons with energies up to ~10 MeV. The space plasma instruments consist of a Langmuir probe (LP), a retarding potential analyzer (RPA), and an ion drift meter (IDM). The space plasma instruments will measure thermal ionospheric plasmas.

The other mission is a geosynchronous satellite mission (GK2), which will be launched on 2018. A package of space environment monitors will be onboard the satellite as a secondary payload. The package consists of a particle detector (PD), a magnetometer (MG), and an internal charging monitor (CM). PD will measure energetic particles with energies from 100 keV to 2 MeV. CM will be similar with the internal charging monitor of Engineering Radiation Monitor (ERM) onboard Van Allen Probes. Currently design of the instruments is being performed. GK2 will be located at the longitude of ~126 ^{o}E, which is almost the opposite from the GOES satellites.

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Thus, GK2 may provide good complementary data of space environments in the geosynchronous orbit.

In summary, even though only a small number of people are working on the spacecraft charging, lots of efforts are put to understand space environment and its effect on spacecraft charging.

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