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DISCHARGE PHENOMENA OF HIGH-POWER RADIATION ANTENNAS

Abstract

We are developing a high-power radiation antenna for a solar power satellite (SPS) and a synthetic aperture radar (SAR) satellite. Discharge phenomena is one of significant problems of such high-power antennas. We carried out evaluation experiments of discharge phenomena and performed evaluation by simulations.

High power microwave radiation antenna that can radiate several hundred W/m^2 is required for wireless power transmission by microwaves from space to the ground or for the earth observation from space. Because, microwaves are not affected by the atmosphere and have a very few attenuation. The discharge phenomena may be caused by using high-power microwave in the space environment. If the discharge occurs in the high-power radiation antennas, high-power microwave components may be damaged. Therefore, it is necessary to clarify the discharge phenomena in the space environment to avoid obstacles to the satellite. But there are some uncertainties about the mechanism of them.

We are trying to solve them through experiments and simulations. Then, experiments were performed using the prototype antenna for X band. In the experiments, we used the traveling wave tube amplifier in order to input high power microwaves to the antenna. Waveforms and power of input and reflected microwaves were observed with power meters, detection diodes and digital oscilloscope. Optical cameras were used in order to captures images of discharge phenomena which occurred in the antenna. We observed that discharge phenomena occurred inside the prototype antenna less than 1 kW input power. Discharge phenomena were observed at specific powers and frequencies on the antenna. In the simulations, we analyzed electromagnetic field and discharge threshold. In those results, we found the four important things. First, electromagnetic field intensities of antenna have frequency dependence. Second, adhesive sheet which used to adhere parallel plates and the other parts was produced the highest electric field in the antenna. Third, the threshold levels of multipactor discharges that can occur in an RF environment were more than two orders of magnitude higher than the experimental values. Forth, when the degree of vacuum in the antenna degraded, corona discharge occurs under 1 kW input power.

In this paper, we will describe the results of the discharge experiments using the prototype antenna and evaluation method of the discharge analysis by simulation.