RESULTS OF ELECTRIC STATIC CHARGE MEASUREMENT ONBOARD ETS-V,ETS-VI,ADEOS

Matsumoto, H.*(Japan); Nishimoto,H.*(Japan); Goka,T*(Japan)

*NASDA,TEL;+81-298-52-2279,F AX;+81-298-52-2299,e-mail;Matsumoto.Haruhisa@nasda.go.jp

ABSTRACT

Electric static charge had been measured by monitors onboard 3 satellites, ETS-V, ETS-VI and ADEOS. ETS-V (Engineering Test Satellite-5) is geostationary satellite which has measured floating voltage and discharge pulse on the surface for 10 years. ETS-VI is geosynchronous transfer orbit satellite which had measured floating voltage on the surface for about 2 years. ADEOS is polar orbit satellite which measured surface floating voltage for 10 months. W e describe charging characteristics of satellite surface material observed by those monitors.

1. INTRODUCTION

Satellite would be operated normally in the environment surrounded by space plasma, high ener gy particles, Solar ultra violet radiation and so on. The plasma consists of electron and positive ion (proton mainly), and the satellite is char ged by these char ged particles. The electrification potential of the satellite in plasma is concerned with the balance of the char ged particles flowing into the surface and the leakage particles. Thus, the surface of satellites would be covered with insulating materials but these materials should be char ged in various potential due to those specification. For example, polymeric film (about 100 m thickness) to control thermal condition cause char ge potential between the surface and the electroconductive body of satellites. Especially, when the satellite of high altitude such as geostationary orbit encountered earth 's shadow or geomagnetic storm, the potential becomes the order of several kV, and if this potential become higher than the dielectric breakdown voltage , the satellite dischar ged.
The discharge which caused by electrification and electrification of satellites cause degradation of surface material and anomaly of payload.

From such consideration we developed potential monitor (POM), and measure the surface chargeing potentials on some typical insulation materials due to charged particles in space environment [Ref.1, Ref.2] by these monitors onboard ETS-V, ETS-VI and ADEOS._Ref.3_

2. OUTLINE OF POM

POM consists of a sample unit, a voltage detector unit , and electrical circuit. A sample unit consists of a board on which max three dielectric samples are able to be mounted. Output voltage from these samples are in proportion to the electrification potentials. A voltage unit contains electrostatic electrodes, high impedance, choppers and drivers, and an electrical circuit consists of two amplifies, phase detector and oscillators. The leakage electric field from an aperture of a sample is modulated by a 1kHz chopper and the electrostatic electrode detects the electric field. The signal is amplified by the amplifiers, and measured the phase difference (0 to 180degree) by the phase detector to obtain the polarity. The leakage current from the inside conducted layer, is exchanged by the current- voltage exchanger, and checked the polarity by the phase comparator, and is output from the logarithmic amplifier.

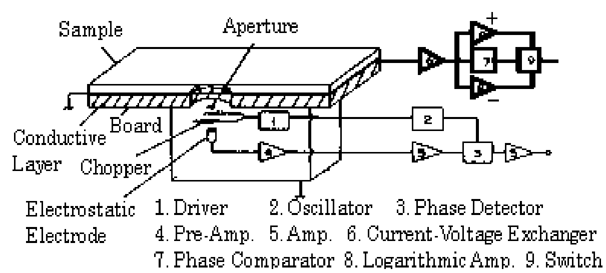


Figure 1 Configuration of POM

There is no leakage current measurement function in the monitor onboard ETS-V. Table 1 shows the list of POM dielectric samples and set-up positions.

Table 1 Location and identification of samples

Satellite	Dielectric Sample	Position(Direction)
ETS-V	Aluminized Kapton Slivered Teflon Optical Solar Reflector	South Mission Panel (+Y)
ETS-VI	Aluminized Kapton Slivered Teflon Optical Solar Reflector	South Mission Panel (+Y)
ADEOS	Optical Solar Reflector	(+X)

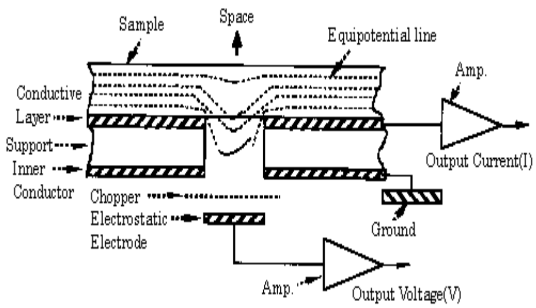


Figure 2 Conception of POM

3 OBSERVATION RESULT

3.1 ETS-V

Figure 3 shows the measured data of char ging characteristics and the flux of high ener gy electron (>2MeV) and proton (6-60MeV) around the solar flare event of October 20, 1989.

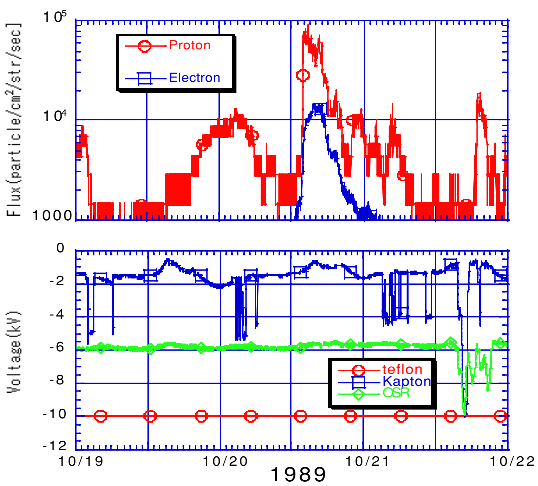


Figure 3 Surface char ging potential and flux of electron and proton around the solar flare event October 20, 1989.

In this period the char ging characteristic of kapton film decreased from 2:00 UT to 7:00UT. It decreased on 21st with OSR by the effect of the solar flare on 20th. Figure 4 shows char ging potential characteristic over the 10 years. In this graph, the POM data at 0:00UT for every day are plotted. The potential decrease between February and September decreases the other period is increased. During the potential decrease, the location of monitor has been shaded, and photoelectric effect decrease.

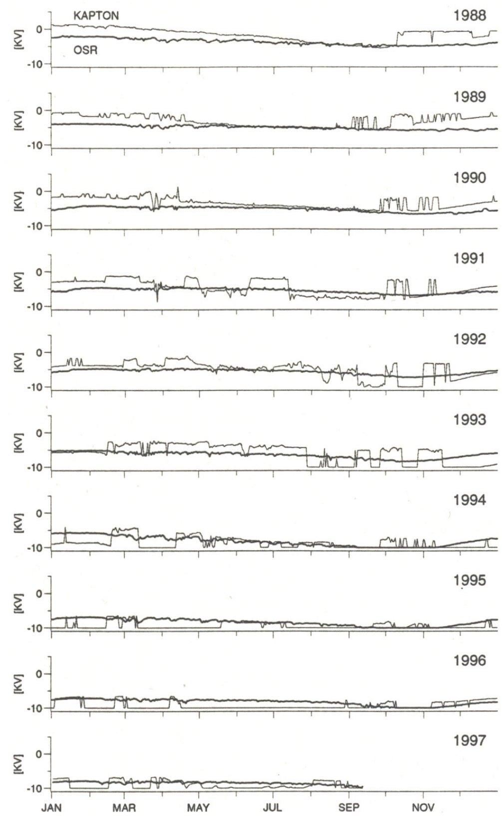


Figure 4. Surface charging potential characteristic over the 10 years

3.2 ETS-VI

The main source of the current are plasma, photoelectrons (negative current) from the satellite, ions (positive current) and noisy electromagnetic wave. Figure 5 shows the fluctuation of the leakage current, when the ion engine on the satellite has been started. It is considered that it is possible to control the electrification, because the electrification condition changes with the ion engine firing.

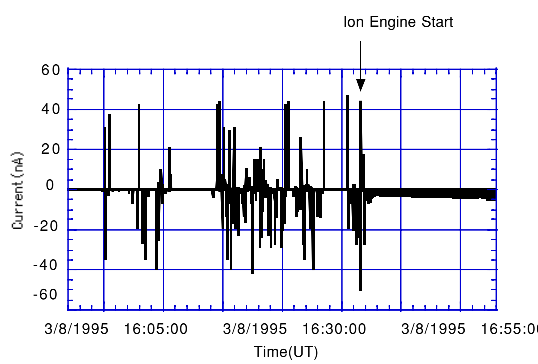
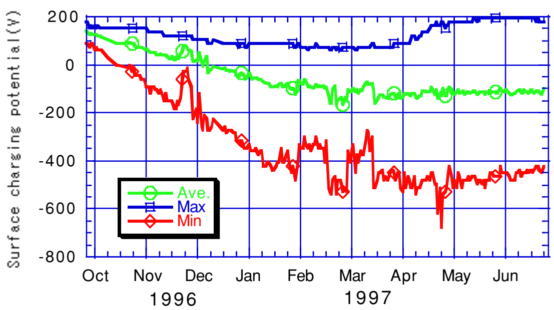


Figure 5 Fluctuation of the leakage current by the ion engine operation.

3.3 ADEOS

ADEOS was launched into sun synchronous sub-recurrent orbit of an altitude of about 800 in 1996. The fluctuating range of the charged potential gradually increased, as time passes in a day and it became with largest 867V on April 29th, 1997. Figure 6 shows the long term trend of the charge potential. Figure 7 shows the daily variation of it on April 29th. From these figures, the potential is decreased as the satellite is in shade, while the potential in increased in the sun.



Long term of trend the charge potential.

Figure 6 Long term of trend the charge potential.

4 CONCLUSIONS

We find the following points from the POM data.

1) In the space, insulating surface material is charged actually, and the electrification level is dependent on environmental condition and material. It would be changed the electrification level of hardly insulating material with a rapidly fluctuation of plasma caused by a large solar flare.
2) The increasing in the negative polarity of the electrification potential is observed. This is mainly caused by the lack of discharging by the photoelectric effect on the sample materials shaded by the antenna and solar paddle.
3) From the long term measurement of electrification potential by the monitor on ETS-V, the electrification potential gradually increases in the negative polarity the half-year shade condition, gradually decreases under the sunshine condition in the half-year.
4) Similarly, for the low earth orbit satellite, the electrification potential , when it comes out from the eclipse, increase in the negative polarity , and decrease when it comes out from the eclipse.
5) It would be able to change the electrification condition with the ion engine firing.

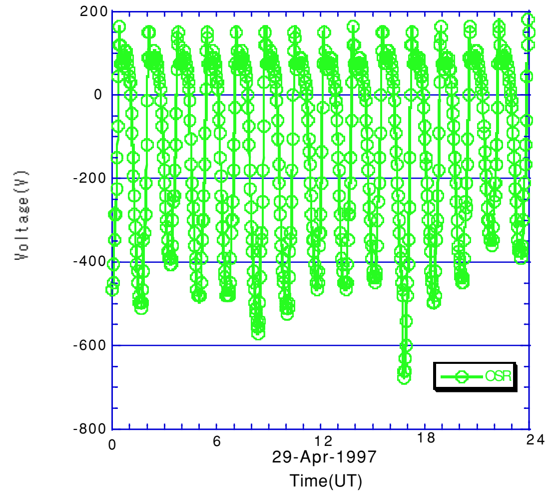


Figure 7 Daily variation

REFERENCE

1) T. Kawanishi, H. Nishimoto, T. koizumi & T. Abe : "Satellite environmental monitor and material degradation monitor installed on Engineering Test Satellite (ETS-V) ", IFAC workshop on Electrostatic Charge and Discharges and Cosmic Ray Interaction in Satellite (1986)

2) H. Nishimoto, H. Fujii & Abe : "Observation of surface charging on Engineering Test Satellite V of Japan", AIAA 27th Aerospace Sciences Meeting , AIAA-89-0613(1989)

3) H. Nishimoto, H. Fujii & T. Abe : "Surface charging on Engineering Test Satellite V of Japan", Proc. Spacecraft Charging Technology Conf. 1989, p.98 (1991)