Experimental investigation of mitigation method of flashover discharge on solar array

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1. Background & Purpose

In recent years, the size, multifunctionality, and power consumption of artificial satellites are increasing. As the bus voltage increases, discharge accidents on the surface of the solar array have been confirmed. In some cases, the discharge generated on the solar cell array may lead to serious problems such as a decrease in the power generation efficiency of the solar cell array and a halt at the worst.
As a method of suppressing creeping discharge this time, we examined a method to physically suppress by making a screen on the solar cell surface. In the suppression test, small and large coupons were made.

2. Research principle

In the creeping discharge, electrons emitted from the triple junction impinge on the cover glass surface and emit secondary electrons. Then, the released secondary electrons collide with the surface of the cover glass, thereby newly releasing the secondary electrons. Since this phenomenon occurs like an avalanche, electrons are doubled so as to crawl over the surface of the cover glass. Also, when electrons collide with the surface, gas adhering to the surface of the cover glass is released, and the gas is ionized by electron energy to form a plasma layer. The plasma layer becomes a current path, and the electric charge charged on the surface of the cover glass is neutralized. The creeping discharge suppression method by the partition is to physically disconnect the propagation path of the plasma by making a screen on the surface of the cover glass and to reduce and suppress the range where the creeping discharge current flows

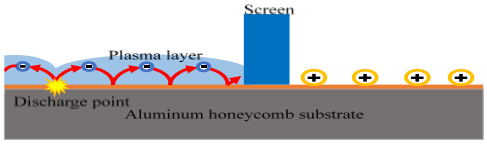


Fig.1 Principle

3. Test with a small coupon

The composition of the coupon simulates the solar cell array surface by attaching Kapton tape to a 40 × 40 cm aluminum plate. The partition uses an aluminum plate and the height is 3 cm. In the test, ultraviolet rays are irradiated by an ozone lamp in order to charge the surface. A discharge point is placed in the coupon for causing the discharge.

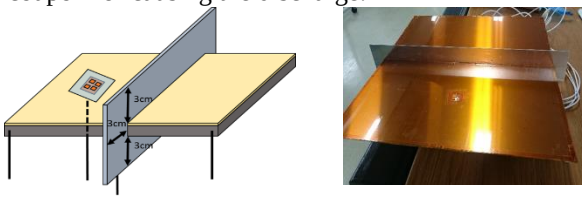


Fig2. Coupon

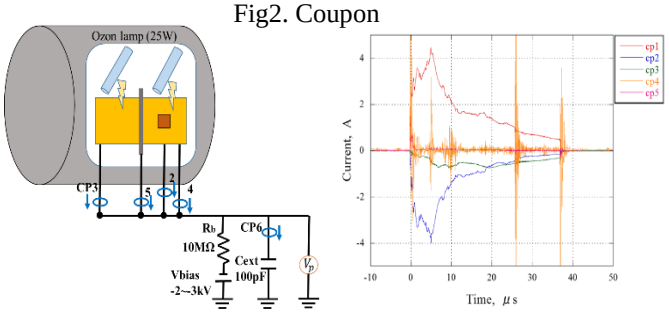
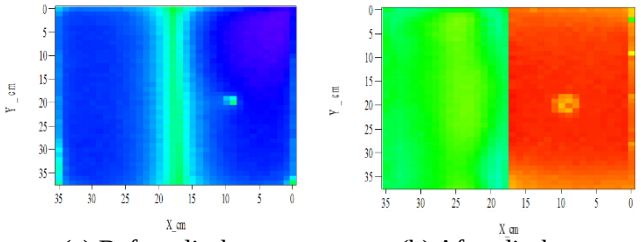


Fig3. Flashover current waveforms



(a) Before discharge (b) After discharge

Fig4. Surface potential

From FIG. 3, it can be seen that the charge escape is observed also on the side suppressed by the partition, and from FIG. 4, the neutralization current flows also on the suppression side. It is thought that the creeping discharge can not be suppressed by the screen with a height of 3 cm higher than this.

4. Test with a large coupon

The height of the screen is 10 cm. On the suppression side, a neutralization current measurement point is installed and the neutralization current on the suppression side is measured. Suppression evaluation was evaluated by current waveform.

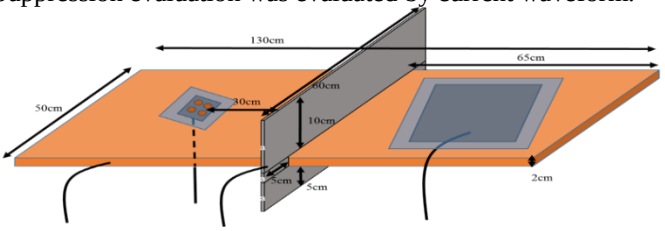


Fig5. Large coupon

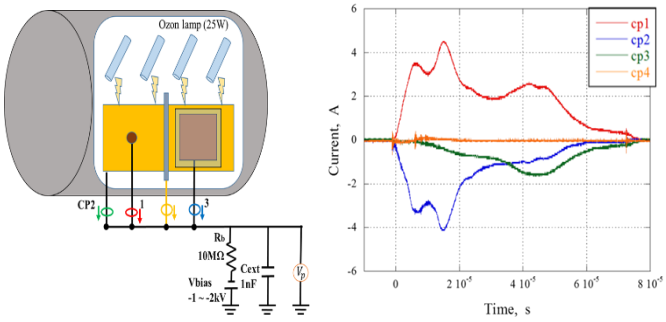


Fig6. Flashover current waveforms

From this result, it is considered that current can not be suppressed at the height of the screen of 10 cm because current flows at the neutralization current measurement point.

5. Conclusion

In a small coupon, a neutralizing current flows on the suppression side due to a 3 cm height partition, and the charge on the surface is missing. From this, it can be considered that it can not be suppressed. In a large coupon, neutralization current flows on the suppression side even if it is 10 cm in height, and it can not be suppressed. Experimental results of large and small coupons also showed that as the coupon became larger, suppression of creeping discharge at the screening became difficult.

Even with a large coupon, it is necessary to measure the surface potential, how the neutralizing current flows on the coupon, and how much charge loss can be seen.