Quality assurance design guideline for solar panel, Insulation design guideline and spacecraft charging guideline in JAXA

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1. Introduction

As a current JAXA activity on standardization, we are selectively working on domestic standardization to intensively tackle problems raised in ADEOS-II (Midori 2). While we are doing this activity aimed to consequently cumulate technological pool and by sharing it, prevent the problems from recurring, we are taking into account that we should also make good proposals to international standardization groups like ISO. Figure 1 shows the JAXA design guideline outline. In this paper, we introduced a project for quality assurance guideline of solar panel WG8 in JAXA. We explained about a part of the research and analyzes the results for the charging design WG1 and insulation design WG5.

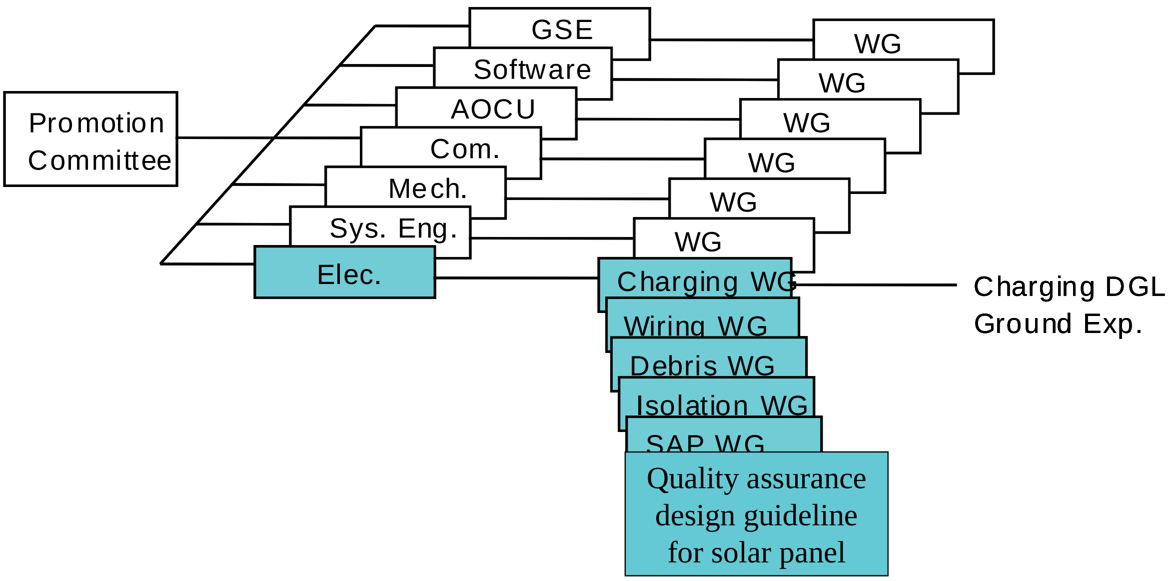

Figure 1 JAXA design guideline outline

2. Quality assurance design guideline for solar panel WG8

This guideline object is quality assurance approach for solar panel. The guideline provides general requirements for solar panel, built with processes, materials, and components that are flight-qualified or proposed flight qualification. The requirements allow for the tailoring in accordance with the aim of each spacecraft projects. Table 1 show the summary of the qualification and characterization tests

In this guideline draft Chapter 3, we explain about the qualification tests. The purpose of this chapter is to show the ways of the thermal vacuum test, thermal vacuum cycling test and acoustic test. The way of ESD test is incorporated herein by reference the charging design WG1

Chapter 4 show the ways of inspection and electrical test. It is define the ways of the visual inspection and the electrical test performance.

In chapter 5 Qualification Controls, we state their fundamental philosophy towards the parts and materials, the fabrication of qualification panel, the test record, the environmental control, the management of test equipment and the management of change of design and/or manufacturing process.

We will decide to the detail based on the some experiments and analysis. We will not only conducts experiments, but designs the research and analyzes the results as needed from next year like the charging design WG1 and WG5.

Table 1 Summary of the qualification and characterization tests

No.	Qualification and Characterization Test	Test specimen
1	Thermal vacuum cycling Test	Coupon :Using at least 2 CICs
2	Humidity test	CIC:
3	Thermal vacuum test	Coupon、Full-sized flight panel
4	Out-gases	—
5	Acoustic test	Full-sized flight panel
6	ESD（Charging・discharging experiment）	Coupon
7	Atomic oxygen exposure	Electronic, mechanical components
8	UV radiation effect characterization	CIC
9	Angle of incidence characterization	CIC
１０	hemispherical emissivity characterization	CIC
１１	Solar absorptance characterization	CIC
１２	(＊)Bypass diode characterization	Coupon 、CIC
１３	(＊)CIC electrostatic discharge sensitivity characterization	CIC
１４	(＊) Four-point bending（Three point bending）	CIC
１５	Electrical test performance	Coupon 、CIC、 Full-sized flight panel
１６	Visual inspection	Coupon 、CIC、 Full-sized flight panel

3. Insulation design guideline WG5

This guideline covered with principal and accessory power source bus. The guideline defines the primary power source bus upper and including separator circuit for short-circuit fault. The guideline carries exhaustive information on vacuum insulation, plastic mold, coating etc…. The design flow on insulation design show the following

1. Depend on Insulation material, thickness, actuation temperature, and transmission frequency.
2. Dielectric breakdown test for the following conditions.
   ・The electrical field strength coefficient Rt at 6mil
   1mil==0.0254mm
   ・Temperature delating coefficient Rc
   ・Frequency delaiting coefficient Rf
   ・Electrical field strength E for operating time
3. Maximum allowable actuation voltage =Rt×Rc×Rf×E×t

Figure 2 show the experimental set-up for the dielectric breakdown test. Figure 3, 4, 5 show the one examples of each experiment.

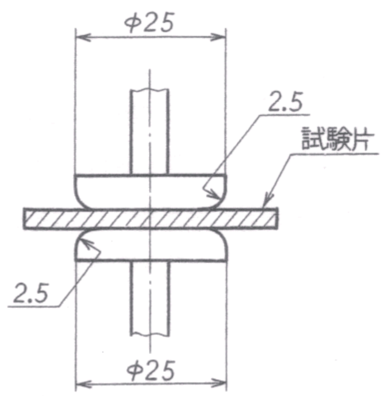

Figure 2 the experimental set-up for the dielectric breakdown test

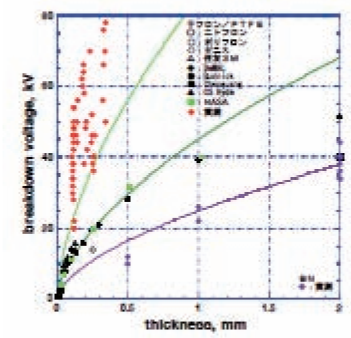

Figure 3 Thickness

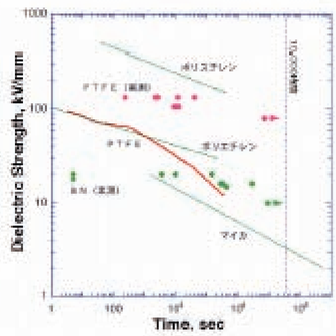

Figure 4 Time

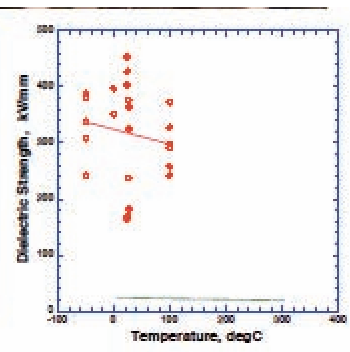

Figure 5 Temperature

4. Spacecraft charging/discharging guideline WG1

Quantitative analysis from the viewpoint of charging-arcing issues from the early stage of satellite designing phase has thus become necessary. Electric potential of a satellite body with respect to ambient plasma and differential voltage of each surface component with respect to the satellite body potential are the most important elements to consider in charging-arcing problems. A spacecraft potential analysis tool that is available from the satellite designing phase is necessary to support the satellite operations.

JAXA has decided to develop a computational tool that can calculate charging the status of a polar orbiting satellite jointly with Kyushu Institute of Technology. The simulation code can be used not only for polar satellites but also for GEO satellites or a low inclination LEO satellite. The aim of the simulation code is to give satellite designers chances to identify the charging hazard in the satellite design phase with a user-friendly interface. The development of software, named Multi-utility Spacecraft Charging Analysis Tool (MUSCAT), started in December 2004[2].

The most influential electrical properties of materials related to the electrostatic charge phenomena and the measurement means used for characterizing them have been extensively explained. The main properties to be taken into account are secondary emission under an electron flow, secondary emission under a proton flow, photoemission, bulk conductivity, surface conductivity, and radiation-induced conductivity (remanent conductivity).

We take particular note of the photoemission and the secondary electron emission yield. We conducted joint studies for the Japan Aerospace Exploration Agency (JAXA) at the High Energy Accelerator Research Organization (KEK), at the Musashi Institute of Technology and at the Saitama University to investigate the relations among spacecraft charging parameters of solid state properties.

We measured SEE using a SEM with short-pulsed electron for accelerating voltage of 600V-5kV at KEK. We also measured SEE by low energy electron emission and PE current at Musashi Institute of Technology. Furthermore, we obtained photoelectron emission images at Saitama University. We started this work in December 2005.

Table 1 Framework for the measurements of materials properties parameter

Material property	The range of primary energy	Place
Secondary electron emission (SEE)	Accelerating voltage : 600V-5kV	The High Energy Accelerator Research Organization (KEK)
	Accelerating voltage : 200V-1kV	Musashi Institute of Technology
Photoelectron emission (PE)	Wavelength 110 to 400 nm	Musashi Institute of Technology
Bulk resistivity, Surface resistivity		Saitama University

5. Conclision

・We introduced a project for quality assurance guideline of solar panel in JAXA.
・We explained about a part of the research and analyzes the results for the charging design WG1 and insulation design WG5.

6. Reffrence

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