

中國會開設求研究隐島類与环境工程部 Center of Spacecraft Assembly, Integration and Test

ESD Test on High Voltage Solar Array of LEO Spacecraft

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1 Introduction



Chinese Academy of Space Technology (CAST) is now developing LEO spacecraft with high voltage array. This paper describe ESD tests of solar array coupon in CAST/BISEE. Tests are: -primary discharge threshold test, -primary discharge degradation test, -secondary discharge threshold test, -power leakage to plasma test. The test methods are based on ISO11221 standard which proved very helpful to perform these ESD tests.

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2 Test Facility



- Diameter: 1.5m, Length: 3m
- ECR plasma source
- Plasma temperature :~10eV, density: 10^{10} ~ 10^{13} /m³
- DC power supply
- Video imaging device
- Plasma diagnostic device
- Digital Oscilloscope



3 ESD Test



- Test method is according to ISO/ CD 11221 Space Systems Space Solar Panels – Spacecraft Charging Induced Electrostatic Discharge Test Methods
- a) Primary discharge threshold test
- b) Primary discharge degradation test
- c) Secondary discharge threshold test
- d) Power leakage to plasma test



a) Primary discharge threshold test

- Test coupons:
 - Silicon solar cells
 - 4s7p
 - Gap distance: 1mm





3 ESD Test (Continued)

- Test conditions

Density N _i	Temperature kT _e
$6.7 \times 10^{12} \mathrm{m}^{-3}$	7.5eV

C _{ext}	Bias Voltage V _b	R _b
200nF	$0\mathrm{V}{\sim}$ -200V	$10 \mathrm{k}\Omega$

Step Voltage	Waiting time
-5V	30min







b) Primary discharge degradation test

- Test coupons:
 - Silicon solar cells
 - 4s7p
 - Gap distance: 1mm





3 ESD Test (Continued)

 Test	cond	litions

Density N _i	Temperature kT _e
$6.7 \times 10^{12} \mathrm{m}^{-3}$	7.5eV

C _{ext}	R _{ext}	L _{ext}	V _b	R _b
2μF	94Ω	8mH	-200V	$10 \mathrm{k}\Omega$

Total numbers of PA	I-V measurement rate
200	Once/10 events

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- Test result-Degradation



3 ESD Test (Continued)



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c) Secondary discharge threshold test

Test coupons:

- Silicon solar cells
- 4s7p
- Gap distance: 1mm/ 1.5mm
- grouting-1mm
- no grouting- 1mm
- no grouting- 1.5mm



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Test conditions

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	Plasma	N _i	Ter	nperature kT _e	
9.	57×10^{12}	² m ⁻³		3.03eV	
	C _{ext}	R _{ext}	L _{ext}	Bias V _b	R _b
	2µF	94Ω	8mH	-200V	10kΩ
				Capaci	tance
				C1=C2=20nF	, C3=21nF

Voltage step	Current	Numbers of PA
5V	0.7A/1.4A/2.1A	40PA











Second discharge threshold results

Grouting	I/A	0.7	1.4	2.1
Gap=1mm	U/V	150(NSA)	120(TSA)	115(PSA)
No grouting	I/A	0.7	1.4	2.1
Gap=1mm	U/V	100(NSA)	75(TSA)	55(PSA)
No grouting	I/A	0.7	1.4	2.1
Gap=1.5mm	U/V	115(NSA)	60(NSA)	55(TSA)



3 ESD Test (Continued)

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Grouting-1mm

d) Power leakage to plasma test

- Test coupons:
 - Silicon solar cells
 - 4s7p
 - Gap distance: 1mm



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3 ESD Test (Continued)

Test conditions

Plasma density N _i	Temperature kT _e
$9.1 \times 10^{12} \mathrm{m}^{-3}$	8.0eV
Bias V _b	$0V\sim 210V$
Voltage step	Waiting time
0.1V	1min



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4 Conclusion



1) Primary discharge threshold for the coupon is about -70Volt;

2) Primary discharge degradation is very small, undetected;

3) Secondary discharge threshold is about 100V for 1mm-RTV grouting coupon.

4) Snapover happened at about 200V, the current is more than 200mA, duration is about 1minut.

All these tests proved that the ISO standard 11221 is much helpful for performing solar array ESD test.



