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Commissioning of the Space Radiation Environment Simulator at KOMAC

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1. Introduction

We have developed the space radiation environment Simulator to simulate the space environment based on the 100-MeV proton linac, which is capable of providing quantified beam irradiation on the space components, to induce SEE (Single Event Effect) and make it possible to study the space radiation effects on the space components quantitatively. With the developed thermal-vacuum chamber, specimen temperature can be varied from -55 to +125 ℃ solely through radiation heat transfer under high vacuum condition, along with proton beam irradiation up to 100-MeV.

Fig. 1. Overall design of the thermal-vacuum chamber for space environment simulation

Fig. 2. The installation of the space radiation environment simulator at TR102 facility.

The unique feature of the designed thermal-vacuum chamber is its capability of proton beam irradiation on the space components. To introduce proton beam into the chamber, we used beam windows at both side of the chamber, made of aluminum-beryllium alloy. The chamber is designed to host the large printed-circuit board (up to 254 mm by 254 mm) as well as the unit components. The proton beam is irradiated on large area with uniformity better than 10% by controlling the octupole magnets in the low-flux beamline. The maximum power of DUT (Device under Test) is 5 W, which is large enough to be used for general semiconductor test as well as space component test. The designed thermal vacuum chamber is shown in Fig. 1 and the design parameters are summarized in Table 1.

Table 1. Specification of the space environment simulator

Proton energy	100 MeV
Temperature range	-55 ~ +125 °C
Vacuum baseline	< 1.0E-5 Torr
DUT area	254 mm by 254 mm
DUT power	Max. 5W
Shroud size	Dia. 500 mm, 500 mm length
Effective volume	315 liters
Chamber weight	700 kg
Temperature rate	Faster than 0.5 °C/min
Temperature uniformity	±5 °C

The space radiation environment simulator(SRES) was installed at the TR102 proton irradiation facility successfully as shown as Figure 2. And then, the site acceptance test and commissioning of the SRES was performed. In this paper, the results of commissioning are described.

2. Methods and Results

2.1 Vacuum Test

The requirement of the vacuum performance of SRES was to attain the < 1E-5 Torr within 80 min from the start of the vacuum pumping.

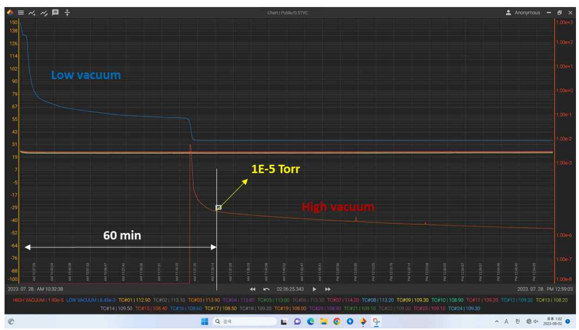

Fig. 3. The vacuum test of the space radiation environment simulator

The result of the vacuum performance test was shown as Figure 3. The vacuum of the SRES reach the 1 E-5 Torr within the 60 min. this vacuum performance of the thermal vacuum chamber satisfies the design goal of the SRES.

2.2 Thermal cycling and vacuum baseline

Figure 4 shows the temperature of the inside of the thermal-vacuum chamber and the degree of the vacuum.

During the thermal cycling performance test, + 130 °C was achieved as the maximum temperature, and then, -70 °C was achieved as the minimum temperature. These temperature range is the satisfy the design goal of the thermal-vacuum chamber. When the maximum temperature is reached, the baseline vacuum was maintained under 1 E-5 Torr, even though the out-gassing inside the thermal-vacuum chamber.

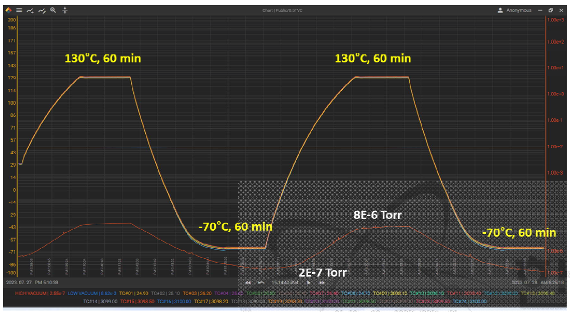

Fig. 4. The Bragg peak chamber detector

2.3 Temperature Uniformity

To check the uniformity of temperature, the G10 Plate, which is the 254 mm × 254 mm, 2 mm thick, can simulate the DUT (Device Under Test) specimen, was prepared as shown as Fig. 5. And then, to measure the temperatures of the simulated specimen, 16 thermocouples were attached.

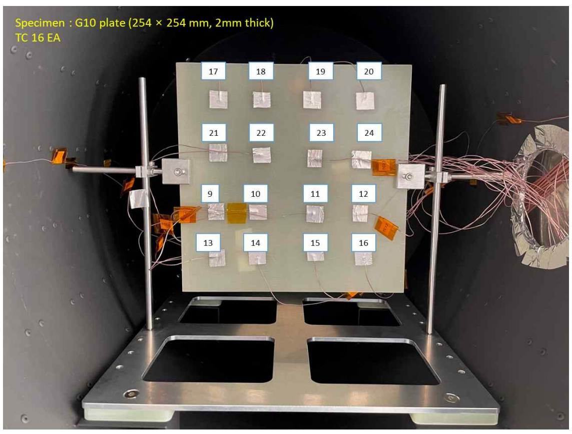

Fig. 5. The simulated specimen and attached 16 thermocouples

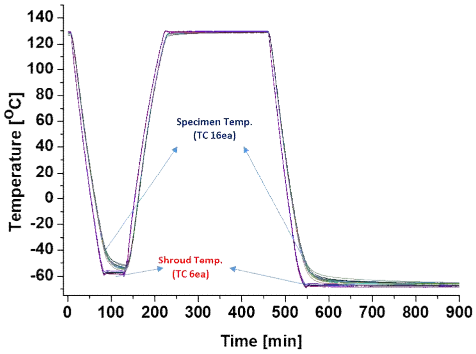

Fig. 6. The thermal cycling and temperature uniformity

During the thermal cycling test, the temperatures of the simulated specimen was monitored by 16 thermocouple sensors as shown as Figure 6. In the heating condition, the temperature uniformity of the 16 thermocouple was the ± 0.382°C which was the measured at 50 min elapsed after reach of the maximum temperature. In the cooling condition, the temperature uniformity of the 16 thermocouple was the ± 2.61°C which was the measured at 60 min elapsed after reach of the minimum temperature. The results satisfy the design goal of the space radiation environment simulator.

3. Conclusions

The space radiation environment simulator was installed at the TR102 proton irradiation facility. The commissioning of the space radiation environment simulator was performed successfully. The commissioning results satisfy all the design parameters.

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REFERENCES

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