

“Atomic Oxygen Degradation effect on Solar Cell of Nano Satellite”

Nguyen Duc Minh

14350944

Department of Applied Science for Integrated System Engineering

Laboratory of Spacecraft Environment Interaction Engineering

Degradation of spacecraft materials is attributed to the harsh environment that materials are exposed to. When satellite operate on orbit, there are six main mechanisms that contribute to degradation: high energy vacuum UV radiation, temperature extremes, collisional impacts from space debris and micrometeoroids, ionizing radiation, proton and plasma, and the presence of atomic oxygen. Satellite material can be changed under the impact of these cause degradation. Due to the degradation, the Electrostatic Discharge can occur on solar cell. Sometimes, ESD at high threshold voltage can damage the solar cell's efficiency and it can cause the satellite failure.

Currently, solar cells are coated with coverglass to provide protection from the harsh radiation environment. To know the effect of Atomic Oxygen on solar cell coverglass, this experiment measure the threshold voltage of ESD on coverglass CMG100AR.

To do this experiment, CMG100AR coverglass produced by Qioptiq Ltd. has been selected and GEO (Geosynchronous orbit) vacuum chamber was used. This experiment used 4 CMG100-AR coverglass samples to measure the threshold voltage of ESD. Four samples were placed inside the GEO vacuum chamber directly under the electron beam irradiation path. One copper plate was used to make sure that the current density of electron beam around $7.5 \mu\text{A}/\text{m}^2$ incident on the sample. The Quick Look LabVIEW program was used to take the discharge image. By using 8-channels Oscilloscope, the current probe signals and high voltage probe sign were fed. 2D surface potential distributions before and immediately after the ESD were measured by a non-contact potentiometer (TREK) controlled by a LabVIEW program.

The first step is to measure the threshold voltage of ESD on virgin coverglass. The minimum threshold voltages found for the virgin samples were 612V. By using Normal and Weibull distribution, the ESD threshold voltage of virgin samples were determined around 1kV.

By using AO chamber, with AO fluence equivalent to 570 days in LEO orbit at 540 km, the AO exposed CMG samples have been created. By using microscope the AO-exposed surface shows clear difference from the virgin sample surface.

After do experiments in GEO chamber with AO exposed samples, the threshold voltage of ESD on AO exposed coverglass samples can be measured. The minimum threshold voltage found for AO exposed samples were 186.4V. Analyzing the result by Normal and Weibull distribution, ESD threshold voltage of AO exposed coverglass was 621V with Normal and 705V with Weibull distribution.

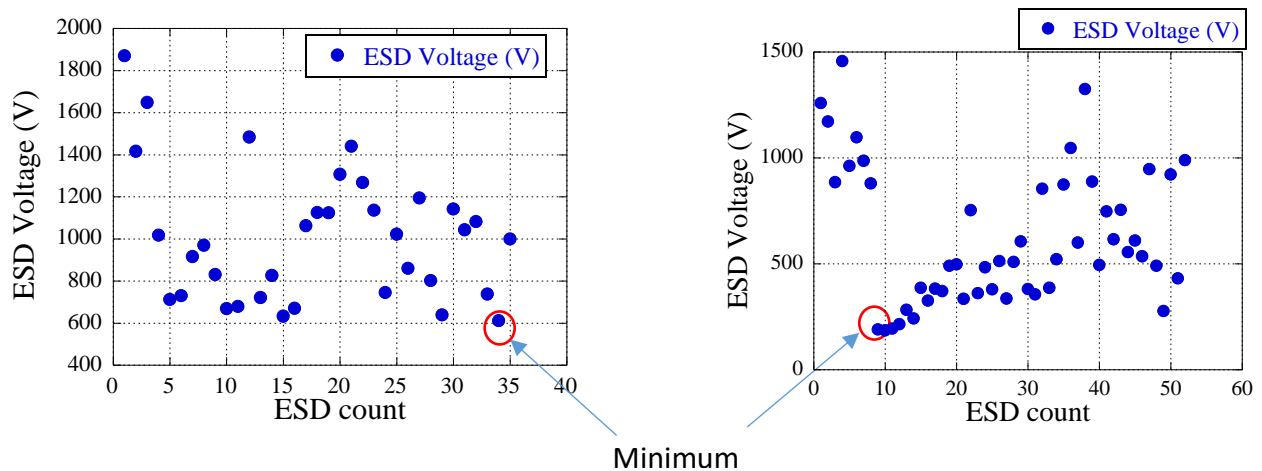


Figure: Threshold voltage of ESD on virgin samples (left side) and AO exposed samples (right side) while under electron beam irradiation.

From the experimental results, we can conclude that Atomic Oxygen affects both the surface discharge characteristics and the surface structure of the coverglass.

In the future, I want to apply one or two ATO (Antimony Tin Oxide) samples on Micro Dragon satellite to measure the leak current of ATO coat and measure the temporal leak current change (ageing effect).