E113-007 Room: 201B Time: May 22 15:03-15:15

Study on the electron beam irradiation effects on silica glass by cathodoluminescence

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In recent years, in order to reduce the launch cost, spacecrafts are expected to be multifunctional and larger and the electric power for spacecraft can be larger than 10 kW. In this case, the power loss due to longer transmission lines from the solar battery to the main body is not negligibly small. As a result, electrical discharge accidents in the power supply system of the spacecrafts with a higher supply voltage are increasing. Since the electrical discharge phenomenon has occurred at the triple junction between cover glass and inter-connector of the solar panel array surrounded by plasma, the charging of the cover glass has been studied as a suspected cause of the accidents[1].

In this paper, we report a cathodoluminescence (CL) study on silica glass combined with electrical measurements to understand the basic mechanism of charging phenomena under keV-order electron beam irradiation.

Generally, insulators such as glass are excited by the high-energy electrons from the ground state to the excited state. When the excited electrons return to the ground states, luminescence phenomena can be observed. The luminescence phenomenon induced by electron beam irradiation is called cathodoluminescence (CL).

Since the CL study provide information from the microscopic point of view such as defect formation in silica glass under the electron beam irradiation, new insight can be gained through this study. Electrical measurements with a scanning Kelvin probe microscopy (SKPM) on silica were also carried out. The CL measurements were performed under keV-order electron-beam irradiation using a scanning electron microscope (SEM) as an electron beam source.

Figures 1 and 2 show the CL spectra and the time response for various silica glasses with different concentration of impurities. These CL spectra exhibit peaks at 290 nm, 460 nm and 650 nm. The 290-nm and 460-nm bands are the luminescence bands reported to be due to oxygen deficient center (ODC) in silica glass, and the 650-nm is due to nonbridging oxygen hole center (NBOHC) from OH impurity[2].The CL time response curve comprises of increase and subsequent decay components. The increasing component is due to formation of luminescent defects such as the ODC and NBOHC under electron beam irradiation[3], while the decay can be ascribed to the charging of silica glass.

The surface potential measurements of the silica glass by the SKPM method was also carried out and the correlation with the CL measurements will be discussed.

[1] Mengu Cho, 37-th Symposium on Electrical and Electronic Insulating Materials and Applications in Systems.37, S-1, 2006
[2] L. Skuja, Journal of Non-Crystalline Solids, 16-48, 239, 1998.
[3] T.E. Tsai, et al., Phys. Rev. Lett. 61, 444, 1988

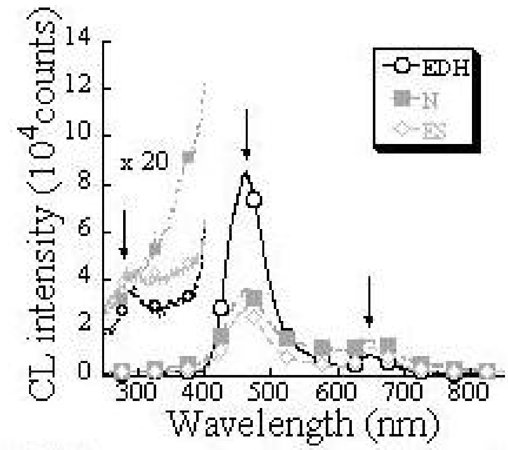

Fig.1 CL spectra of various types of silica glass

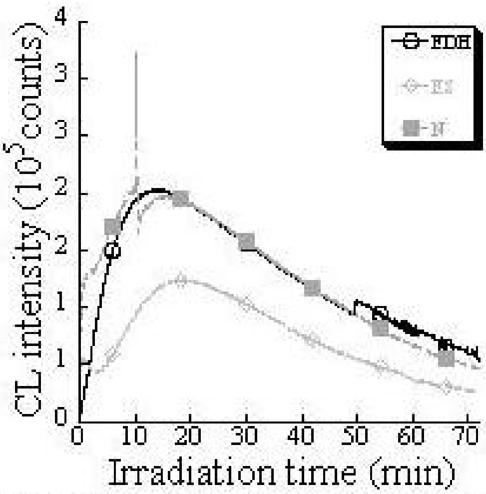

Fig.2 CL time response of various types of glass