Development of solid-state detectors for measurements of 1-100 keV electrons

Keiichi Ogasawara[1], Toshifumi Mukai[2]

[1] Earth and Planetary Sci., Univ. of Tokyo, [2] ISAS

Despite the importance of measuring 1-100 keV electrons for studies of particle acceleration processes in space plasma physics, some technical problems have kept us away from the achievement of reliable measurements in space.

Microchannel Plates (MCPs) have been used for detection of low-energy particles owing to a good sensitivity because of the multiplication of secondary electrons. However, the detection efficiency for electrons has a dependence on incident electron energies, with a peak at several hundreds of eV, and gradually decreases toward higher energies. In addition, MCPs are also sensitive to penetrating energetic particles and photons, which cause background noise. At times, the removal of the background noise is a serious problem.

Solid-state detectors (SSDs) are a kind of semi-conductors such as silicon, germanium and so on. These detectors have been used to measure the energy of cosmic rays individually, collecting and capturing electron-hole pairs, created by the ionization loss of corpuscular radiations in the depletion layer of reversely biased diode. The SSDs are used only for high-energy particle detection. In the detection of particles with energies lower than several tens of keV, however, the energy loss in the dead layer near the surface of components is significant, and the small number of electron-hole pairs created make it very difficult to measure the particles under the existence of noise source, such as leakage currents and thermal noise.

Therefore, the development of detection techniques of electrons in the energy range of 1 keV to 100 keV is highly desired. It is challenging, but this study aims to bridge the technical gap in the past measurements. In this presentation, we show some experimental results of a shottkey-type SSD and of an Avalanche diode (AD). ADs are known as Avalanche Photodiodes (APDs) applied for photoelectronic devices which have internal gain due to the avalanche amplification of electrons in the detector.