Position Dependent Behavior of a Piezoelectric Lead-Zirconate-Titanate (PZT) Cosmic Dust Detector

Maki Hattori[1], Masanori Kobayashi[2], Takashi Miyachi[2], Seiji Takechi[3], Osamu Okudaira[4], Takeo Iwai[5], and Seiji Sugita[1]

[1] Department of Complexity Science and Engineering, University of Tokyo, Kashiwa 277-8561, Japan

[2] Planetary Exploration Resarch Cemter, Chiba Insitute of Technology, Chiba 275-0016, Japan

[3] Graduate School of Engineering, Osaka City University, Osaka 558-8585, Japan

[4] Institute of Space and Astronautical Science, Japan Aerospace and Exploration Agency, Tsukuba 350-8505, Japan

[5] Nuclear Professional School, School of Engineering, University of Tokyo, Tokai, Ibaraki 319-1106, Japan

We have developed an in-situ cosmic dust detector covering mass ranging from 10^{-15} to 10^{-9} kg and velocity from 1 to 100 km/sec in heliocentric velocity. Since resources for a science payload are limited, a compact and light detector is recommended for space exploration. In this sense, we have engaged in developing a cosmic dust detector using piezoelectric lead-zirconate-titanate, PZT. Since the PZT detector is compact and light, it is suitable for an onboard detector onto a spacecraft. When a particle collides with a PZT element, a certain amount of voltage is induced by the piezoelectricity of PZT element. Miyachi *et al.*[1)] studied a relation between incident momentum and output signal by bombarding hypervelocity particles with it.

We use a charge sensitive amplifier as an interface between the detector and the signal processing electronics. A detector capacitance should be matched with an input capacitance of the subsequent signal processing electronics. Because $C_s << C_f \times A$ is required, where C_s, C_f and A are the capacitance of the PZT, the feed back capacitance and the open loop gain, respectively, we are interested in use of a small collecting electrode that covers a part of the sensor area. Since C_s is expressed as $C_s = \varepsilon$ (S/d), using the dielectric constant of PZT (ε), area of the electrode (S), and thickness of the PZT element (d), the capacitance C_s is lowered by reducing S. A possible jump of the sensitivity in the vicinity of collector edges is considered accordingly.

In this report, we discuss a sudden change of the detector sensitivity with respect to the position where a particle collides.

Reference

1) T.Miyachi et al., Adv. Space Res. 34 (2004) 935.