Dust particle detector employing Piezoelectric PZT with current sensitive preamplifier

MASANORI KOBAYASHI[1], TAKASHI MIYACHI[1], MAKI H. NAKAMURA[2], SEIJI TAKECHI[3], SEIJI SUGITA[2] and NAGAYA OKADA[4]

[1]*PERC, Chiba Institute of Technology, Japan*
[2]*University of Tokyo, Japan,* [3]*Osaka City University,Japan*
[4]*HONDA ELECTRONICS CO., LTD, Japan*

In situ observations of interstellar dust (ISD) and interplanetary dust particles (IDPs) were conducted from the inner solar system to the outer solar system by space-borne experiments and the density distributions as function of the distance from the sun were investigated [1]. Especially for IDPs, it is clarified from zodiacal light observation that the three-dimension structure of density distribution is very complex [2]. In order to investigate three-dimension structure for smaller-size dust grains, the constant observation of IDP and ISD should be conducted simultaneously at multiple sites. To increase the chance of space-borne experiment, dust observation instrument is required to be compact, low power consumption and low data transmission rate. Piezoelectric PZT element (hereafter PZT) has been used as momentum sensor for in space-borne dust observation. BepiColombo-MDM [3] targets tiny dust grains ranging in mass from 10^{-15} to 10^{-12} kg. PZT sensor can detect micro-vibrations due to peripheral dust impact around the sensors or thermal strain of or around the sensors, which have different shape signal waveform from the true impact event. Accordingly, the signal waveform should be processed by flash ADC and downlink to ground for true-false analysis. In order to avoid use of flash ADC that outputs large amounts of data and consumes large amounts of power, we are developing a dust detector with current sensitive pre-amplifier that outputs a specific signal profile for the true event. By this technique, true-false discrimination can be simply achieved on-board with less arithmetic processing power. Besides, since the response of the current amplifier is much faster than that of other types of amplifiers, a precise positioning sensor based on PZT can be realized by using the same method as a previous study [4].

Keywords: In-situ dust observation; cosmic dust; piezoelectric sensor; PZT

References

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