Recent Status of Imaging MicroStrip Gas Chamber

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1. Introduction

Microstrip Gas Chamber was proposed as a new high resolution position detector with gas amplification in 1988[1]. It has been well known that this new detector may satisfy almost of all demands required to tracking detectors for the next decade, as followings, (1) stable operation under a high luminosity condition, (2) a good position resolutions of about 50 μm, (3) radiation hardness and aging resistivity; these are also important requirements for new imaging X-ray detectors operated in high intensity radiation sources. MSGC has been usually made by using microelectronics technology, where a sequence of alternating thin anodes and cathodes is drawn in a few hundred micron pitch on an insulating substrate. The closeness of electrodes and the simpleness of the structure are regarded as key factors in resolving these problems. Recent drastic progress of MSGC in the world are described in Ref.[5].

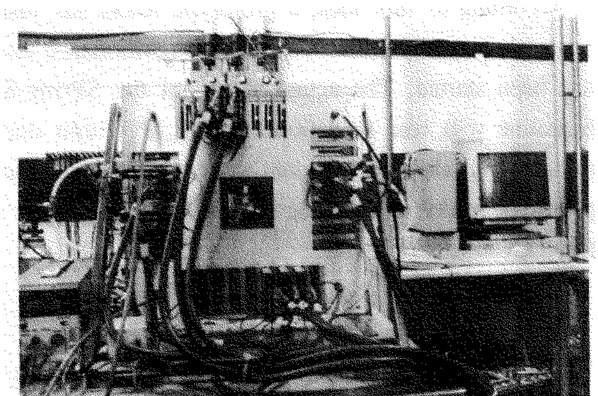

Figure 1. Photograph of MSGC and new read-out system.

We have developed a new type of MSGC having a very thin substrates of ~10 μ thickness, which enables us to control the flow of an ion easily [2-4]. Also, due to the very thin thickness of a few μm between a backplane and an anode, a large and fast signal is induced on a backplane, which enables two dimensional readout from one MSGC. We have developed a two-dimensional MSGC with 50 x 50 mm^2 effective area and 200 μm anode pitch.The fundamental features of this MSGC was already described in our last years report.

2. X-ray Image of MSGC

In this fiscal year, in order to evaluate the newly developed MSGC as quickly as possible, we have developed a read-out system specified for two-dimensional MSGC, which can manage 500 independent channels, corresponding to 50x50 mm^2 area with both 200 μm pitch anode and backplane strip. This system consists of pre-amplifiers, discriminator-boards, multi-hit CAMAC TDCs (Timing digital Convertor), and an Unix workstation for data acquisition from the CAMAC system. A small low-noise charge pre-amplifier was designed for this particular system to access such a small space of the signal lines. Also multi-hit TDCs and high-performance Unix workstation enabled us to get more than a few thousand events per second and to reconstruct the image from the MSGC data in real-time. Figure 2 shows a clear image of a small pendant obtained from our two dimensional MSGC using this read-out system. The pendant was placed just

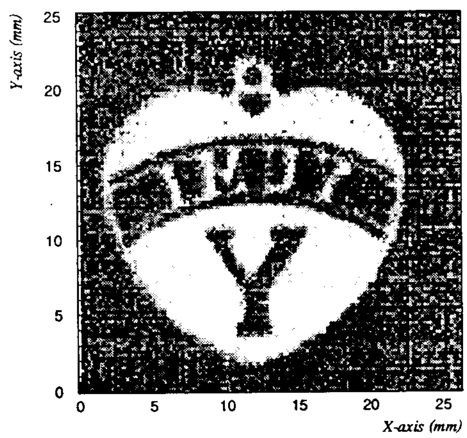

Figure 2. Image of the small pendant placed on the front of MSGC.

in front of the MSGC. A radiation source of $Fe^{55}$was used as an X-ray source, of which X-ray beam was not perfectly parallel. The best position resolution which can be evaluated with this X-ray beam was about 200 μm. Therefore, the upper characters craved in the pendant of which line width is ~100 μm only faintly be seen in the image. We will be able to get more clear images from this MSGC with an X-ray generator.

3. Stable Operation

It has been generally noticed that choices of the structure and the material of the substrate are crucial to attain a stable operation of a MSGC. The major properties required to substrates are a good surface quality and a moderate surface resistivity. The former is both to be necessary for micro-etching and to avoid strip discharges. The latter is to suppress charging-up processes on the substrate. The time variation of the gain due to charging-up on the substrate has been pointed out as the most important issue to be overcome prior to any applications. The most reliable solution to prevent this effect is to decrease the resistivity of the surface or the bulk of substrate. Polyimide has however a relatively high resistivity of 10^{16} Ωcm. In order to control the resistivity of the substrate in the range of less than 10^{13} Ωcm, we applied the adhesion promoter on the polyimide substrate, in which a very thin layer of organic titanium was coated on a surface of polyimide. The resistivity of the coated substrate was measured to be about 10^{12} - 10^{13} Ωcm. Adjustment of the shape of electric-field around an anode is another method. We have found a suitable configuration of the electric potential for our MSGC having a substrate with thickness of more than 15 μm, in which almost ions generated in avalanches can move to a cathode without crossing the surface. This solution was at first derived in the simulation study of the behavior of the ion. Thereafter two MSGCs, each having different thickness of substrates of 8 μm and 16 μm, were examined in terms of the time variation of the gain. As shown in Fig,3, stable operation was obtained only for 16 μm thickness, as expected from the simulation. In addition, this simulation enabled us to estimate the gain of the MSGC. Based on the simulation study and the results obtained from the first version of the two-dimensional MSGCs, a second version of MSGC is being produced, of which gain and stability are expected to be improved.

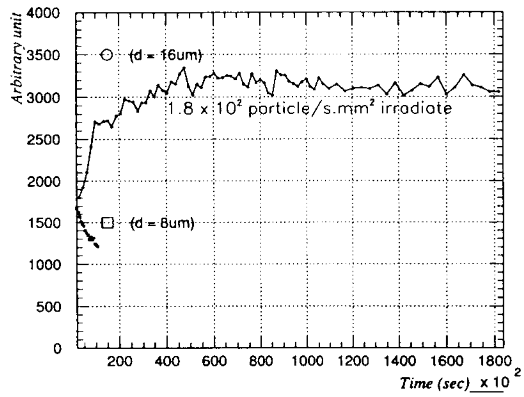

Figure 3. Time variations of the gains of 16 μm and 8 μm thick substrates. The gain of 8 μm thick substrate was drastically decreased and could not be measured.

References

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