Glass Gas Electron Multiplier Detector using Dynamic Time-over-Threshold-Based Readout

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Abstract

The Gas Electron Multiplier (GEM)-based detector is compatible with developing large-area detector applications with high gain and spatial resolution. In this work, the Photosensitive Etchable Glass (PEG3C) GEM was coupled with the multichannel charge-sensitive preamplifier and dynamic time over the threshold (dToT)-based readout system. The performance of Glass GEM (G-GEM) and its readout system was evaluated as the first result.

Keywords: Gas Electron Multiplier, Dynamic Time Over Threshold

1. Introduction

The Gas Electron Multiplier (GEM) is a widely used Micro Pattern Gas Detector (MPGD) for large area detection applications with high spatial resolution requirements. To improve spatial resolution performance, GEMs are often coupled with multi-channel readout systems. In large-scale detection applications, the detector can be connected to thousands of readout channels which increases the size and complexity of the readout system. Therefore, the performance of the detector which is supported by the energy resolving capability of a compact readout system is necessary for the entire detector system. In this study, the Photosensitive Etchable Glass (PEG3C) GEM was used as the main component of the detector connected to dynamic time over the threshold Time ToT-based 2D readout. The linearity of dToT readout was evaluated. The energy resolution, gain, and polarization of G-GEM was shown as the first result.

2. Materials and Methods

The PEG3C GEM substrate has sensitive areas of 100 × 100 mm^2. The thickness, hole size, and hole pitch are 680 µm, 170 µm, and 280 µm respectively as shown in Fig. 1a. The G-GEM was placed inside the chamber between the aluminized Kapton cathode and readout anode with gaps of 5 mm and 3 mm, respectively. The chamber window was made of Kapton foil. GEM was supplied with Ar/CH_4 (90/10) gas in gas flow mode with a flow rate of 100 mL/min and a pressure of 0.1 MPa. The GEM is read by a 2D readout board connected to a charge-sensitive preamplifier, shaping amplifier, dynamic time over the threshold, and DAQ system for each output channel.

3. Result and Discussion

As the first result, the GEM performance was evaluated using ITO readout anode, charge-sensitive preamplifier, shaping amplifier, and multichannel analyzer. The Effective gain of PEG3C G-GEM was calibrated with ^{55}Fe source. $\Delta V_{G\text{-}GEM}$ was extrapolated using the measured resistance of G-GEM (3.5 x10^{10}). The maximum effective gain reached 8800 without severe sparks as shown in Fig. 1b. The drift field and induction field were around 30V/mm and 260V/mm, respectively. The energy resolution was 17 % at full-width half maximum (FWHM) of the gaussian fitted result as shown in Fig. 1c. The gain was biased at 8800 with the same value of drift field and induction field.

(a) (b) (c)

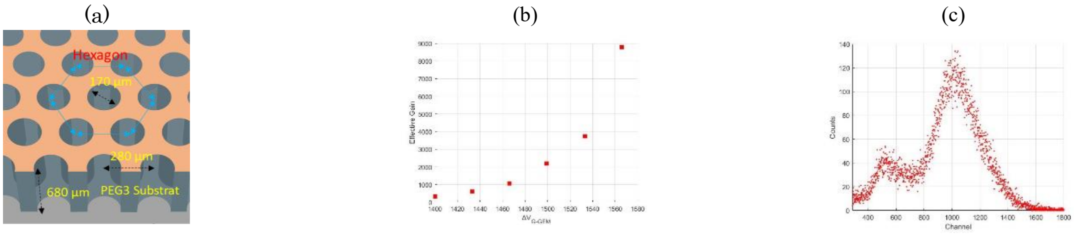

Fig. 1. (a) PEG3C Glass GEM structure and dimension; (b) Gain calibration using 5.9 keV of 55Fe source; and (c) Spectrum of 5.9 keV X-ray from 55Fe source.

4. Conclusion

The Glass Gas Electron Multiplier detector is successfully developed. The G-GEM and dToT performance is evaluated as the first result. The evaluation using dToT-based readout is expected to have a good performance.

References

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