The Characterization of Thick Gas Electron Multiplier (THGEM)

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Introduction

The Thick Gaseous Electron Multiplier (THGEM) is an ionization detector. In this report we have studied the performance of single-mode configuration of THGEM which is designed and fabricated by Indian effort [1]. The gain property of the indigenously made THGEM has been studied using with Ar/CO_2 (90:10) gas mixture at atmospheric pressure. Here Ar is the main detector medium and CO_2 is the quencher gas which is highly electronegative gas. It absorbs photon released by Ar ion and dissipates the energy through elastic collision and also increases the lifetime of the THGEM.

Calibration of MFC

The gas-mixing has been done existing Mass Flow Controller (MFC) and the calibration was done for Ar and CO_2 gas independently [2]. The cylinder gas pressure of each gas was kept to a fixed value throughout the calibration. These fixed values of pressure for Ar and CO_2 were kept same when the experimental data had been taken. The calibration plots for Ar and CO_2 have been given below in the Fig.1 and Fig.2 respectively.

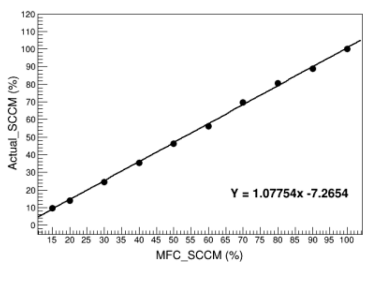

Fig. 1 The calibration plot for Ar

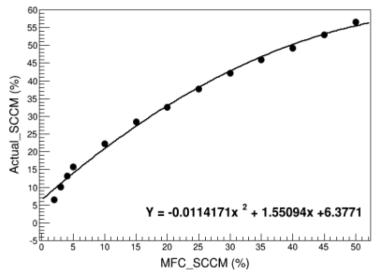

Fig. 2 The calibration plot for CO_2

The Results

The experimental data were taken using the existing set up [1,2]. The calibration was done to extract the charge collected by secondary electrons using an inbuilt circuit in the charge sensitive preamplifier 142IH. A voltage test pulse from pulser between 50mV to 350mV with 25 mV interval had been injected through the test input of the charge sensitive preamplifier. The test input of the preamplifier had an input impedance of 93Ω and its circuitry provided the charge injection to the preamplifier input which had a standard capacitance of 1pF. The shape of the pulse from pulser was such that it had a very fast rise time 0.05µs followed by a slow exponential decay (fall time = 0.5 µs) with frequency maintained at 1000Hz. The calibration plot for charge accumulation due to the secondary electrons as a function of ADC channel has been depicted in Fig.3.

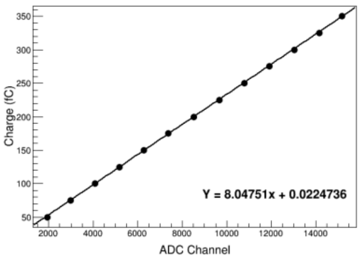

Fig. 3 The calibration plot: charge (fC) as a function of ADC channel

The energy resolution as a function of electron drift field had been measured in the set up of double-THGEM [3]. The minimum E_{Drift} was obtained around 0.4 kV/cm. In this experiment, we kept the E_{Drift} at 0.4 kV/cm. The leakage current was measured below 70% humidity and at 25^0C temperature. In this ambient temperature and humidity, the leakage current was measured 80 nA at V_{THGEM} = 3200V when the detector was flushing with gas mixture with higher percentage of quencher gas CO_2 [4]. The leakage current and the gain of the single THGEM for this experimental set up have been shown in the Fig.4 and Fig.5.

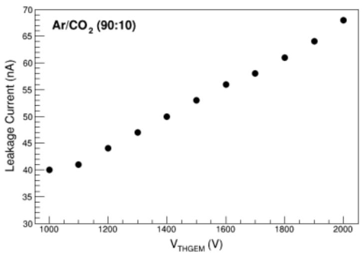

Fig. 4 The leakage current as a function of V_{THGEM}

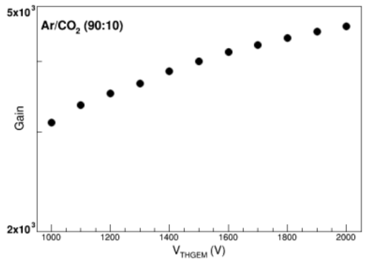

Fig. 5 The Gain as a function of V_{THGEM}

Conclusion & Discussions

The electric field between cathode anode of a gas detector depends on the voltage provided between the cathode to anode distance. The drift plane is the cathode. The electrodes of the plate of the THGEM is the anode. The electric field increases with the increase of V_{THGEM} between the electrodes of THGEM and decreasing the cathode to anode distance. So, increasing the $V_{THGEM,}$ the electric field intensity across the holes of THGEM increases which leads to larger avalanche multiplication of previously generated electrons and enhances the gain of the detector.

Decreasing the ratio of the hole diameter and the pitch of THGEM plate will increase the percentage of electric field lines terminating at the metal surface and it may improve the gain of detector.

References

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