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Improvement of GEM gain uniformity: production and verification techniques

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We have developed a gas electron multiplier (GEM), which is mainly applied to the X-ray polarimeter with a micro pattern TPC. The GEM has a hole diameter of 70 μm, a hole pitch of 140 μm, an insulator thickness of 100 μm, and a size of an effective area of 30 × 78 mm^2. We adopted a liquid crystal polymer (LCP) sheet as the GEM insulator. To simplify a polarimeter response, the GEM is required to have a high gain uniformity. In order to improve the gain uniformity, a thickness variation of the insulator should be reduced because we found a negative correlation between the gain and the insulator thickness, and already reported it in the previous conference, MPGD 2015. In this presentation, we report selection procedure for the smooth LCP sheet and improvement the GEM gain uniformity by using the selected sheet.

In order to measure the gain uniformity, we scanned the whole GEM effective area in 1-atm Ar/CO_2 (70%/30%) mixture gas. The scan was performed at 2 mm intervals by irradiating the GEM with collimated 8.0 keV X-rays in the direction perpendicular to the GEM plane from an X-ray generator. A thickness scanning of the LCP was also performed across the effective area. The GEM gain and the insulator thickness show a negative correlation with a correlation coefficient of -0.96. The GEM gain exponentially decreases with the insulator thickness. A thickness increase of 1% is corresponding to a GEM gain decrease of 5%. This result means that the high uniformity of the GEM gain is achievable by using the LCP sheet with a small thickness variation.

In this study we propose the selection procedure to increase the gain uniformity of the GEM. A thickness measurement had been performed to select the LCP sheet on both side of the effective area. Some GEMs was developed with the selected LCP sheet. Then the two-dimensional gain scanning was performed for these GEMs. From this scan, a standard deviation of the gain variation was about 10% smaller than previous GEMs as we expected. Therefore, a GEM quality can be predictable by selecting the smooth LCP sheet before a manufacturing process of the GEM.

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