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A gaseous imaging detector based on thick GEM-like (THGEM) multipliers

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The thick GEM-like (THGEM) electrode is a rather new gas-avalanche electron multiplier, economically produced by standard printed circuit board (PCB) drilling and etching techniques. Its structure is similar to that of standard GEM, but its dimensions are expanded, with thickness varying from 0.4 to 3.2 mm and the mechanically-drilled hole diameter varying from 0.3 to 1mm. The Cu layer around the drilled hole is further etched by 0.1mm at its rim. The operation principle of the THGEM is similar to that of the standard GEM, though the operation voltages and the charge transport parameters (e.g. diffusion) do not scale with the dimensions. The hole dimensions are large with respect to the electron's mean-free-path and diffusion, which results in very high electron multiplication within the holes and very efficient electron transport into and out of the holes, permitting an efficient cascading of several multipliers. Gains of 105 and 107 were recorded in single- and double-THGEM structures respectively, in various gases including highly scintillating ones such as CF4. Furthermore, the THGEM can operate at very low gas pressures; e.g. gains of 105 and 107 were recorded in 1 and 10 Torr of isobutane, respectively. The avalanche process is fast, with the pulse rise-time in the few-ns range at all pressures investigated, and with a counting rate capability in the range of 1MHz/mm2 at gains above 104. All these properties make the THGEM an attractive solution for efficient radiation detection and imaging, from single electrons to heavily ionizing particles, over very large active area, with resolution in the sub-mm range.

We have investigated the multiplier's performance using THGEM elements of different geometries, at atmospheric and at low gas pressures, down to a fraction of a Torr. In particular we have studied the electron transport, which is very important for single-electron detection applications, e.g. photon counting with gaseous photomultipliers. We present the results of this study, discuss the role of various geometrical and operational parameters and demonstrate conditions for reaching full single-photoelectron detection efficiency.

We present an imaging-detector prototype of 10x10 cm2, comprising a double- THGEM cascaded multiplier coupled through a resistive anode to a 2D readout electrode; the detector performance, studied with various radiation sources, is discussed, and possible applications are illustrated.

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