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TMM: Triple Micro-Mesh gaseous structure with ultralow ion backflow for gaseous photon detectors

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Gas photomultiplier tubes (gas-PMT) for visible light detection using micro-pattern gas detectors have been widely studied owing to their potential advantages, such as large detection area with low cost, high spatial and time resolutions, and resistance to magnetic field. But photocathodes sensitive to visible light exhibit a significant aging effect when subjected to excessive ions bombardment. Approximately 20% degradation of quantum efficiency was reported even for low accumulated charge of 0.4 μC/mmˆ2 on the bialkali photocathode. Therefore, very low ion-backflow (IBF) is crucial to visible light-sensitive gas-PMTs, and both high gas gain and photoelectron collecting efficiency are required for single photon detection. we have previously reported the design, fabrication and optimization of a double micro-mesh gaseous structure (DMM). An IBF ratio as low as 3 × 10ˆ(-4) was obtained with a DMM detector prototype. In this detector, the most backflow ions come from the secondary gas amplification stage of the DMM. Thus, a triple micro-mesh gaseous structure (TMM) becomes a natural extension of the DMM to further suppress the IBF. In this report, we present the design and fabrication of the TMM based on the DMM experience. Multiple TMM prototypes were built and characterized with X-rays and UV light. A gas gain over 4 × 10ˆ4 and an IBF ratio of lower than 3 × 10ˆ(-5) were achieved in the X-ray test. The achieved IBF of the TMM is one order of magnitude better than that of the DMM. Furthermore, a very high gain with ultra-low IBF ratio for single electrons was obtained with the TMM using UV light. The energy resolution of the TMM for X-rays was optimized by enhancing electron collecting efficiency. The demonstrated performance of the TMM shows that it is a very promising technology for electron amplification for visible-light gas-PMTs. The developing progress of Gas-PMT based on TMM is also reported.

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